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POWERTRAIN ELECTRONIC CONTROL STRATEGY BOOK

| STRATEGY LEVEL "CDAN2"

FOR USE WITH EEC-V MODULES: ML2-300, ML2-330, ML2-370

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STRATEGY PLANNING & PROCESS DESIGN SECTION

CONTROL SYSTEMS DEPT

POWERTRAIN ELECTRONICS

DEVELOPMENT - PTE

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OBTAINING DOCUMENTATION - CDAN2

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CHAPTER 1

STRATEGY EVOLUTION

1-1

STRATEGY EVOLUTION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

1.1 OBTAINING STRATEGY EVOLUTION INFORMATION (CDAL0)

STRATEGY EVOLUTION was a listing of EMRs implemented in the release

of a particular software version. The report also listed the URD

number and a short description of the change. While this information

is no longer contained in each strategy book, it is recognized that

it may still remain useful to some. To view the information

on-line in a different format you may perform the following steps:

A. Log onto the VAX system: SYS2, SYS3, SYS4.

B. At the system prompt, enter EDTS. The EDTS Main Menu

appears.

C. Select 6 - STANDARD REPORTS MENU and press ENTER.

The Standard Reports Menu appears.

D. Select 4 - EMR STATUS REPORT and press ENTER. The

EMR Status Report Definition screen appears.

| E. Type in the Software Version CDAN2.

If you want to view the report on line (the default),

press ENTER. You may TAB through the report.

If you want the report sent to a file rather than the

screen, TAB through the screen and at the bottom

change the "S" to an "F" and press ENTER. When the report

has been successfully written to a file, a message will

appear at the bottom of the screen:

"The report has been sent to a file called EMR\_STATUS\_132.EDTS

in your current directory."

F. To exit EDTS, keep pressing ENTER until you are once again

at the system prompt.

1-2

CHAPTER 2

SYMBOLOGY

2-1

SYMBOLOGY - CDAN2

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2.1 SYMBOLOGY (CDAA0)

INPUTS

The inputs to most logical operations will be conditional statements of the

form:

X > Y

where, X is a variable (RAM), and Y is a calibration constant, fox function

or table look-up, or a mathematical expression. In some cases, Y may also

represent a variable.

Typically, six types of conditional statements will appear in the strategy

logic diagrams. They are; X > Y, X < Y, X >= Y, X <= Y, X = Y, and X <> Y.

SYMBOL MEANING

------ ------------------------

= EQUAL TO

<> NOT EQUAL TO

> GREATER THAN

>= GREATER THAN OR EQUAL TO

< LESS THAN

<= LESS THAN OR EQUAL TO

It should be noted that when the expression X > Y or X < Y is encountered,

the conditional statement can be calibrated such that it will never be true,

and the appropriate strategy action will never take place. For example, if

the variable X has a range of 0 to 255, and the calibration constant in the

logical statement, X > Y, is selected to be 255, the statement will always be

false. This provides a means for calibrating out certain strategy functions.

When any conditional statement is true, the INPUT STATE to the logical

operation is said to be 'TRUE', and is assigned a value of '1'. When the

statement is false, the INPUT STATE is 'FALSE', and is assigned a value of

'0'.

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SYMBOLOGY - CDAN2

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LOGICAL OPERATIONS

Two logical operations are used, the 'AND' gate and the 'OR' gate. An 'AND'

gate is represented by the following symbol:

A ---------------------|

|AND -| C

B ---------------------|

where A and B are INPUT STATES and C is defined as the OUTPUT STATE of the

logical 'AND' operation. The value of the OUTPUT STATE is a function of the

INPUT STATES as shown in the following truth table:

AND GATE

============================================

INPUT STATE INPUT STATE OUTPUT STATE

A B C

============================================

0 0 0

--------------------------------------------

0 1 0

--------------------------------------------

1 0 0

--------------------------------------------

1 1 1

============================================

Likewise, the 'OR' gate is represented by:

A ---------------------|

|OR --| C

B ---------------------|

And the OUTPUT STATE for various INPUT STATES is given by the 'OR' truth

table:

OR GATE

============================================

INPUT STATE INPUT STATE OUTPUT STATE

A B C

============================================

0 0 0

--------------------------------------------

0 1 1

--------------------------------------------

1 0 1

--------------------------------------------

1 1 1

============================================

2-3

SYMBOLOGY - CDAN2

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OUTPUTS

The output of all logical operations results in one of two possible paths:

1) The output is an input to another logical operation.

A ----------|

|AND -- C --|

B ----------| |OR -| E

|

D ----------------------|

In this case, OUTPUT STATE C is an input to an 'OR' gate. It should be

treated like any other conditional statement when determining the value

of the final OUTPUT STATE E.

2) ACTION is taken based upon the OUTPUT STATE.

A ---------------|

|AND -- C --| Energize OUTPUT

B ---------------| |

| --- ELSE ---

|

| De-energize OUTPUT

The ACTION described in the action box is taken when OUTPUT STATE C is

'true'. If an ALTERNATE ACTION is required when OUTPUT STATE C is

'false', the alternate action is described below an ELSE statement in

the action box. If no alternate action is required, no ELSE statement

will appear.

2-4

SYMBOLOGY - CDAN2

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Multiple "ELSE/ACTION" blocks can appear in a logic diagram in which three or

more alternate actions are possible. Consider the following example:

A ---------------|

|AND -- C --| ACTION #1

B ---------------| |

| --- ELSE ---

D ---------------| |

|AND -- F --| ACTION #2

E ---------------| |

| --- ELSE ---

|

| ACTION #3

The procedure is:

1. Test for ACTION #1. If "C" is true, perform ACTION #1.

2. Otherwise, test for ACTION #2. If "F" is true, perform ACTION #2.

3. Otherwise, perform ACTION #3.

Notes about multiple "ELSE/ACTION" logic:

1. When logic has multiple "ELSE/ACTION" blocks, only one action block can

be performed during a program pass. Priority is always top down. In the

example, if "C" and "F" are simultaneously true, "C" takes precedence and

ACTION #1 is performed.

2. If the final "ELSE/ACTION" block does not have logic as input pointing to

it (as in the example), the final action block is performed when no

preceeding action block is true. Action is always performed during each

program pass with this type of logic.

3. If the final "ELSE/ACTION" block has logic as input pointing to it, the

final action block is performed only when no preceeding action block is

true and when its input logic is true. Action is not always performed

during each program pass with this type of logic.

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SYMBOLOGY - CDAN2

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HYSTERESIS

Hysteresis in a strategy is a situation in which the logic used to make an

output true is different from the logic used to make the output false. An

example use would be to prevent on/off cycling of an output because of jitter

in an input parameter.

Hysteresis is represented in strategy logic diagrams using the following

"flip-flop" notation:

A ---------------------|S Q-| C

|

B ---------------------|C

The actual conditional statements and direction of hysteresis will depend

upon the specific application in each strategy module The action of this

hysteresis notation is given by the following truth table:

HYSTERESIS FLIP-FLOP

==========================

S(SET) C(CLEAR) Q-OUTPUT

A B C

==========================

0 0 no change

--------------------------

0 1 0

--------------------------

1 0 1

--------------------------

1 1 1

==========================

The action of the flip-flop can be described as follows:

When the "A" (set) input is true, regardless of the "B" (clear) input level,

the flip-flop sets and the "C" output is true. When the "B" input is true

and the "A" input is false, the flip-flop clears and the "C" output is false.

When "A" and "B" are both false, the "C" output remains unchanged.

ADVICE:

1. Since the intent of a flip-flop is to provide hysteresis, the state of a

flip-flop must be remembered from pass to pass. The output is usually

defined as a flag.

2. All flip-flops must be serviced every pass through the program, even

though some flip-flops are shown in portions of logic that may not

execute each pass. The normal practice is to lump and service the

flip-flops together at the beginning of a routine. This guarantees that

all flip-flop outputs will reflect the correct state based on current

input conditions. Then, when logic refers to a flip-flop, the logic only

needs to look at the flag which represents the state of the flip-flop.

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SYMBOLOGY - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

3. Clear (0) is the default initial value of the output flag for a

flip-flop. The strategy specification must explicitly state if the

initial value should be set (1).

4. The set input always takes precedence over the clear input. When both

are true, the flip-flop output should set. In some instances, the

software practice has been to perform the clear logic first, followed by

the set logic. The procedure may initially clear the flag and then

reverse the decision later. This practice could cause problems if the

flip-flop output flag is tested during an EOS interrupt because the EOS

can catch the flag in the wrong state.

The flip-flop procedure should always be:

IF set condition met

THEN set flip-flop output flag

ELSE IF clear condition met

THEN clear flip-flop output flag

ELSE

No change to flip-flop output flag

ENDIF

Some flip-flops are specified without a hysteresis term to save bytes; this

is the preferred method of presenting flip-flops. In this case there are two

calibration parameters, one for the set condition, and one for the clear

condition. When flip-flops are specified this way, the calibration parameter

used to set the flip-flop will end in \_SH or \_SL. The parameter used to

clear will end in \_CH or \_CL. The H or L determines the larger (H) or

smaller (L) parameter.

Example:

DEL\_LOAD < DLOD\_SL ----|S Q-| C

|

DEL\_LOAD >= DLOD\_CH ---|C

1.0 |

|

DEL\_LOAD | /|\ | o = state change

| | clear region |

DLOD\_CH | -------o-----------------|--------------

| | |

| | |

| | no change (hysteresis)

DLOD\_SL | -------|-----------------o--------------

| | |

| | set region \|/

|

0.0 ---------------------------------------------------------

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HOW TO INTERPRET THE HEXADECIMAL REPRESENTATION

OF A REGISTER CONTAINING BIT FLAGS

1) Display the register on the calibration console.

2) Press the 'HEX' button on the calibration console to display the register

in hexadecimal format.

3) Two hexadecimal digits will be displayed. In order to determine which bit

flags are set, use the following hexadecimal-to-binary conversion chart:

HEXADECIMAL DIGIT DISPLAYED BINARY EQUIVALENT STRING

--------------------------------------------------------------

|

0 | 0000

1 | 0001

2 | 0010

3 | 0011

4 | 0100

5 | 0101

6 | 0110

7 | 0111

8 | 1000

9 | 1001

A | 1010

B | 1011

C | 1100

D | 1101

E | 1110

F | 1111

The LEFTMOST hexadecimal digit represents the state of bit flags in bit

positions 7 through 4. The RIGHTMOST hexadecimal digit represents the state

of bit flags in bit positions 3 through 0.

Consider the following: The 8-bit binary string representing the leftmost

and rightmost hexadecimal digits together, read from left to right,

represents the state of bit flags in bit position 7 through bit position 0.

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EXAMPLE:

You want to examine the state of NDSFLG, a bit flag in bit position 5 of a

register which is at address B0.

1) Display the contents of B0 on the calibration console.

2) Display the contents in hexadecimal format.

3) The hexadecimal value '2F' is displayed.

----------------------------------------------------

| HEXADECIMAL | 2 | F |

|------------------|---------------|---------------|

| BINARY | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |

|------------------|---------------|---------------|

| BIT POSITION | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

----------------------------------------------------

This means that bit flags in position 5 (NDSFLG), 3, 2, 1 and 0 are set to 1.

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THE "DO:" STATEMENT

The DO: statement is used to call a logic subroutine in strategy. It is not

used, as it often is by software, to avoid repeating a frequently used piece

of code. It is primarily used to allow a process to be broken up into

smaller pieces so that the strategy can be easily represented without

resorting to large, cumbersome, confusing pieces of logic. The DO:

statement can also provide an "executive routine" or calling structure for a

series of sequential pieces of logic.

The DO: statement can call either an entire strategy module or strategy

process. A strategy module is a segment of strategy that has an overview,

definitions and a process and usually corresponds to a software module. A

strategy process is a subset of a strategy module, usually used to

conveniently break up a logic diagram in a strategy book. Do not use the

version type extension for strategy modules, i.e. COM1, COM5. This makes

the calling module independent of various module varieties. The syntax is:

DO: DSDRD\_GR MODULE or DO: RPM LIMITER PROCESS

The DO: statement is used on the "ACTION" or right hand side of logic

diagram.

The format for the called subroutine (Module or Process) is that it must have

an explicitly stated start and end point. This shows that the piece of

strategy contained within the start and end points is executed as a

subroutine, not necessarily every background loop through the strategy. The

syntax is:

BEGIN: DSDRD\_GR MODULE BEGIN: RPM LIMITER PROCESS

. .

. .

. .

CONTINUE: DSDRD\_GR MODULE CONTINUE: RPM LIMITER PROCESS

(if required) (if required)

. .

. .

. .

END: DSDRD\_GR MODULE END: RPM LIMITER PROCESS

The CONTINUE: syntax is used to identify the continuation of a logic diagram

on to a page that does not have either a START: or an END: statement. The

intent is to have any page of a strategy book be able to be identified as

being part of a subroutine or not. For example, a logic diagram that takes

up 3 pages will begin with a START: statement on the first page, begin with

a CONTINUE: statement on the second page and end with an END: statement on

the third page.

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At the end of the module or process, there is an implicit "RETURN" statement,

that is, the next execution step of the strategy must return to the place

where the DO: statement was called. For example, if a DO: statement is

executed in the middle of an ELSE/ACTION block, the strategy continues

execution after returning to the originating point.

A ---------------------|

|AND -| ACTION 1

B ---------------------| |

| --- ELSE ---

C ---------------------| |

|AND -| DO: XYZ PROCESS ------> BEGIN: XYZ PROCESS

D ---------------------| | <--| .

| --- ELSE --- | .

| | .

| ACTION 2 | END: XYZ PROCESS

|

| |

|--------------|

E > F -----------------------| ACTION 1

|

| --- ELSE ---

|

| ACTION 2

If the first AND gate containing "A" and "B" is false and the second AND gate

containing "C" and "D" is true, then the XYZ PROCESS is called and executed.

After returning to the DO: statement, strategy execution continues with the

evaluation of the "E > F" condition in the second ELSE/ACTION block.

DO: statements can be nested, that is, one DO: statement can call a

subroutine which contains another DO: statement within itself. There are no

restrictions on this other than the basic rule continues to apply: Each

process or module that is executed must return to the originating point upon

its execution.

Flip flops should not be included within a DO: statement since they must be

evaluated every background loop. The strategy designer must have the flip

flops shown as being executed every background loop and use the appropriate

flop flop output flags within the DO: statement.

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The "ROLAV" Statement

The ROLAV statement is used to invoke the rolling average routine in the

strategy. The EEC-IV filters inputs using this rolling average routine.

This is a difference equation implementation of a first order low pass

filter. The filter behaviour is defined by the discrete time solution to the

first order differential equation and takes the form:

- (FK\_TMR/TC)

f = 1 - e

Where "f" is called the filter constant in the difference equation:

new\_average = f \* new\_value + (1 - f) \* old\_average

Using the first two terms of the series expansion:

x x²

e = 1 + x + -- + · · ·

2!

Simplifying, the exponential "f" becomes:

- (FK\_TMR/TC) 1

f = 1 - e = 1 - ------------- = . . .

(FK\_TMR/TC)

e

1 1

f = 1 - ----------------- = ------------------- .

1 + (FK\_TMR / TC) 1 + (TC / FK\_TMR)

The time constant (TC) is a function of the input being filtered. It is

calibratable. Generally, a longer time constant filters more heavily, but

also introduces more time lag into the signal.

For most filters, the sampling period (FK\_TMR) will equal the background loop

time (BG\_TMR). In those case where the sample period is not equal to the

background loop time, the true sample period is to be passed to the rolling

average routine. See the calling convention below.

The ROLAV statement is used on the "ACTION" or right hand side of a logic

diagram. The strategy will specify calls to the rolling average routine

using the following convention:

condition -------------| new\_average = ROLAV(new\_value,TC[,FK\_TMR])

Where:

- old\_average = Current value of new\_average prior to filtering. This

parameter is implicit in the call to the rolling average routine.

- new\_average = Output value of rolling average filter. This parameter

becomes the old\_average on the next filtering event.

- new\_value = Input value to be filtered.

- TC = Time constant.

- FK\_TMR = Elapsed time between successive calculations. This is an

optional argument only to be specified if it is different from background

loop time.

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The "pid\_def()" Construct

A PID is a way to access parameter values by name via a communication

protocol between the Powertrain Control Module and an outside requestor.

Parameter values from within the PCM can be accessed from the outside

environment via the communication network. This is done by the generic scan

tool as required by CARB-OBDII regulations to obtain information in reference

to OBDII system monitors and their status. This can also be done by SBDS or

other systems capable of establish and sustaining communications using the

SCP.

CARB regulations require the availability of a number of PIDs regarding the

state of the on board diagnostic system. These, as well as the Ford specific

PIDs, will be defined via the strategy documents in a similar manner. A

construct will be used in the strategy documents to define the data conveyed

in a PID request. That construct is the:

pid\_def(pid\_number, description)

Where:

"pid\_number" is the symbol used to refer to the PID. For example, all PIDs

defined by SAE standard J1979 will by of the form j1979\_xx[\_xxx]. The

portion inside the brackets [] is optional. Other conventions will be used

for j2190 or SBDS specific PIDs.

"description" is the actual data to be used in the transmission of the PID.

This could reference a register (RAM, KAM or ROM) that is maintained in the

strategy. For example ECT or TEST\_SW. This could also be an equation used

to compute the PID. This equation may or may not reference other internal

registers in the strategy. An example of this would be (((ECT - 32) \* 5/9) +

40). The PID may also be a bit map of a number of flag bits. In this case

the following convention is used for the "description" parameter:

pid\_def(xxxx\_xx\_xxx,(b0: FLG\_1,

b1: FLG\_2,

b2: 1,

b3: 0,

b4: FLG\_3,

b5: FLG\_4,

b6: 0,

b7: 0)

Whenever a parameter is referenced in the "description" and is in lower case

in the pid\_definitions context, logic will be present in the context that

describes how that parameter is to be determined. The pid\_definitions

context is delineated by a "BEGIN: pid\_defintions" statement and a "END:

pid\_defintions" statement. The pid\_defintions context is located in the

module in the strategy that is most relavent to the PIDs being defined. The

pid\_definitions contexts will therefore be distrubuted throughout the

strategy. See the following for an example of a module with PID definitions:

The "pid\_def()" constructs do not imply anything with respect to

implementation. It is left up to the best judgement of the software designer

as to how to implement the PID scheme.

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MODULE NAME

OVERVIEW

Put overview text here. . .

DEFINITIONS

Put definitions text here. . .

PROCESS

STRATEGY MODULE: STRATEGY\_MODULE\_COM1n

BEGIN: pid\_definitions

;comment describing that this section is defining PIDs.

REGISTER1 = Y --------------|

|AND -| flag1 := 1

REGISTER2 = X --------------| |

| --- ELSE ---

|

| flag1 := 0

unconditionally ------------------| parameter1 := (REGISTER3 \* M) + B

pid\_def(j1979\_xx\_xxx, REGISTER4)

pid\_def(j2190\_xx, parameter1)

pid\_def(sbds\_xx\_xxx, FNnnn(REGISTER5))

pid\_def(xxxx\_xx\_xxx, (REGISTER6 \* M) + B))

pid\_def(xxxx\_xx, bo: flag1,

b1: FLG\_1,

b2: 0,

b3: 1,

b4: FLG\_2,

b5: CAL\_SW\_1,

b6: 0,

b7: 0)

END: pid\_definitions

Continue with the control strategy logic here. . .

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The "send()" Construct

The SCP interface strategy allows for numerous messages to be supported by

the Powertrain Control Module and the vehicle network databus.

These messages can be sent from various locations in the strategy, depending

on their functional intent, to be received by one or more recieving nodes on

the bus.

In order to provide a uniform method of sending an SCP message, a construct

will be used in the strategy documents to define the data to be transmitted

in an SCP message. That construct is the

send(msg\_name, scp\_data\_[])

Where:

"msg\_name" is the name of the particular message to be sent. For example, a

response to an SAE standard J1979 request might be named REPORT\_OBDII\_PID.

"scp\_data\_[]" is the actual data to be sent in the message transmission.

Since there are up to seven (7) data bytes available to be sent in each

message, the values of scp\_data\_[] could all be defined. These values could

be either register names, or constant hex values, or even a PID which was

defined in the "pid\_def()" construct. While not all seven of the scp\_data\_[]

values are required to be defined in a "send()" command, the construct does

not allow for data to be missing in between defined values.

An example of the use of the "send()" construct follows:

send(REPORT\_OBDII\_PID, 41h, 01h,

j1979\_01\_011,

j1979\_01\_012,

j1979\_01\_013,

j1979\_01\_014)

..which tells the software designer to send a message called REPORT\_OBDII\_PID

over the network with the following defined values:

scp\_data\_1 = 41h

scp\_data\_2 = 01h

scp\_data\_3 = the value defined in pid\_def(j1979\_01\_011,...)

scp\_data\_4 = the value defined in pid\_def(j1979\_01\_012,...)

scp\_data\_5 = the value defined in pid\_def(j1979\_01\_013,...)

scp\_data\_6 = the value defined in pid\_def(j1979\_01\_014,...)

NOTE: Certain portions of a message are not variable and are thus not

defined in the "send()" construct. Thus, REPORT\_OBDII\_PID must be defined in

the SCP interface strategy for the software designers' reference.

The "send()" constructs do not attempt to imply software implementation, but

rather a means of communicating information to the software designer to

transmit over the SCP network.

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CHAPTER 3

EEC OVERVIEW

3-1

EEC OVERVIEW - CDAN2

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3.1 OVERVIEW (CDAL0)

STRATEGY MODULE: EEC\_CD

ELECTRONIC ENGINE CONTROL SYSTEM OVERVIEW

The Electronic Engine Control system is intended to provide a more optimum

engine control strategy than is possible through a strictly mechanical

system. This is accomplished by using a microprocessor which interprets

input data from a number of engine parameter sensors, and based on a control

strategy in the microprocessor's program chips, generates output control

signals to a number of actuators.

The control strategy is divided into two segments, an engine control

strategy, and self test diagnostics. The diagnostics will be discussed in

another section. The engine control strategy is segmented into three

principal modes:

-CRANK

-UNDERSPEED

-RUN

The strategy description and the entrance and exit conditions for

CRANK/UNDERSPEED/RUN are shown on the following pages. RUN is of particular

interest because it contains the control logic for most engine operating

regions. The RUN strategy is further broken down into three modes to

facilitate optimum control. Based primarily on throttle position, they are:

-CLOSED THROTTLE

-PART THROTTLE

-WIDE OPEN THROTTLE

The specific entrance and exit conditions for these modes are described in

the throttle mode selection section.

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EEC OVERVIEW - CDAN2

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EEC IV OUTPUTS

HARDWARE MODULES

AIR MANAGEMENT 1 (AM1) (SFI-MA2)

This Software output controls (via software) a Thermactor Air Bypass (TAB)

valve; via a vacuum solenoid. When AM1 is OFF, the air is bypassed (dumped

to the atmosphere). When AM1 is ON air is routed to an up/down-stream valve.

AIR MANAGEMENT 2 (AM2) (SFI-MA2)

This Software output controls a vacuum solenoid which controls the secondary

air system to a catalyst via an up/down-stream divertor valve (TAD) but this

output only controls if AM1 output is ON.

CANISTER PURGE (CANP)

This software controls a solenoid which purges fuel vapor from a carbon

canister. The carbon canister collects fuel vapor when the engine is off.

DATA OUTPUT LINK (DOL)

This software generates a digital signal to one of the Economy Display

Subsystems: Tripminder, Fuel Economy Meter Clock, etc). This displays such

information as current Miles per Gallon to the driver.

ELECTRONIC VACUUM REGULATOR (EVR)

This software output controls a solenoid which varies the vacuum to the EGR

valve via a varying frequency and/or duty cycle pulse train to the regulator.

The Actuator contains a clamping diode which eliminates the need for a diode

in the control module.

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EEC OVERVIEW - CDAN2

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FUEL PUMP (FP)

The software for the fuel pump controls a relay which provides power to

operate the electric fuel pump.

IMRC (SFI-MA3)

The Inlet Manifold Control opens a valve (upstream of the intake manifold)

which increases the engine airflow. The Engine strategy uses this valve to

increase the horsepower at high RPM.

INJECTORS

The Sequential Fuel Injection system uses one output driver per injector (as

compared to the EFI systems which have two or more injectors controlled by

each driver). The SFI system provides more precise timing and duration of

the fuel injection. As most EFI systems, SFI uses high resistance (16 Ohms)

high pressure (39 psi) injectors.

IDLE SPEED CONTROL - BYPASS AIR - CONSTANT CURRENT (ISC-BPA)

The EEC controls a linear actuator which varies air intake (from 0 to

maximum) through a bypass valve in the throttle body. The software outputs a

duty- cycled pulse train which is coverted into a constant current. This

output is cycled at a frequency of 160 Hz.

SPARK OUTPUT (SPOUT)

The Spark software generates an ignition control signal capable of driving

the Thick Film Ignition Module (TFI). The driver is a tri-state device

(High, low, open) which interfaces with the TFI-IV module (This Module can

accomodate a 250 Hz/sec acceleration). The spout signal is referenced to the

PIP signal. Its timing is controlled by the SAF calculation. If the EEC is

in LOS mode, the TFI module causes the spark timing to be equal to 10 deg BTC

(same as PIP).

SPEED WARNING CHIME (SWC)

The software operates a chime module when a calibrated vehicle speed is

exceeded. This is a legal feature required in Saudi Arabia and is for export

purposes only.

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EEC OVERVIEW - CDAN2

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HARDWARE PRESENT SWITCHES

Hardware present switches define the types of devices connected to the EEC

module through the wiring harness.

FUEL RELATED HARDWARE PARAMETERS

- DEGPIP = Degrees per PIP period = 360/ENGCYL.

- ENGCYL = Number of PIPs per revolution

= cylinder number/2.

- FN1327 = Fuel pulsewidth to injector map;

0 -> use FUELPW1,

1 -> use FUELPW2.

- FN1329 = Injector Firing order map.

- HP\_CIDSEL = CID Hardware select switch;

0 -> Hall Effect present,

1 -> VRS sensor.

- IGN\_TYPE = Indiactes the type of ignition hardware;

0 -> Push start or start wireless TFI

1 -> ICCD-TFI

2 -> Dual plug LDR-DIS

3 -> Single plug LDR-DIS

4 -> EDIS HDR-DIS (36 tooth - 1)

- MHPFD = Signature PIP duty cycle

.99 = Sig PIP distributor not present

.20 = 8 cyl, <= 35% rduty cycle

.24 = 6 cyl, <= 30% duty cycle

.29 = 4 cyl, <= 30% duty cycle.

- NUMCYL = Number of engine cylinders.

- NUMEGO = Number of EGO sensors (1 or 2).

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EEC OVERVIEW - CDAN2

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OUTPUTS

- HPACL = Ride Control Hardware present;

1 -> Ride Control present,

0 -> No Ride Control present.

- IMRCHP = Inlet Manifold Runner Control hardware present;

1 -> IMRC hardware present,

0 -> IMRC hardware not present.

- SWC\_HP = Speed Warning Chime Hardware Present;

0 -> No SWC hardware present.

1 -> SWC hardware present.

- THRMHP = Thermactor Hardware Present Switch;

0 -> None of the following hardware present,

1 -> Thermactor Hardware present, AM1, AM2.

- TSTRAT = Transmission Strategy Switch,

The TSTRAT software switch selects which transmission

control strategy is to be executed;

TSTRAT 0 -> No transmission control,

(Manual trans., AOD, ATX, C6, C3, etc.),

1 -> SIL (Shift Indicator Light),

2 -> A4LD with 3-4 shift control and converter

clutch control,

3 -> AXOD,

4 -> E4OD,

5 -> A4LD-E,

6 -> AXOD-E,

7 -> AOD-I,

8 -> F4E,

9 -> CD4E,

10 -> JATCO

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EEC OVERVIEW - CDAN2

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INPUTS

- BIHP = Brake input;

0 -> No Brake input,

1 -> Brake input available.

- HPOC = Overdrive cancel hardware present switch; -1 -> no OCS (no OCIL),

0 -> OCS is a latched relay (no OCIL logic), 1 -> OCS is a momentary

contact (OCIL output is a bulb - LSO-3), 2 -> OCS is a momentary contact

(OCIL output is a LED - LSO-4).

- HWRT, ACRT = Heated Windshield recognition times,

If no H/W present, set HWRT = 65,535

and set ACRT = 0

If H/W present, see strategy book description.

- PSPSHP = Power Steering Pressure Switch;

0 -> No Power Steering Pressure switch input,

1 -> Power steering pressure switch.

- TRLOAD = Transmission Load;

0 -> Manual Transmission, no clutch or gear switches,

forced neutral state (NDSFLG = 0),

1 -> Manual Transmission, no clutch or gear switch,

2 -> Manual Transmission, one clutch or gear switch,

3 -> Manual Transmission, both clutch and gear switches,

4 -> Auto Transmission, non-electronic, neutral drive switch,

5 -> Auto Transmission, non-electronic, neutral pressure switch

(AXOD),

6 -> Auto Transmission, electronic, PRNDL sensor - park,

reverse, neutral, overdrive, manual 1, manual 2.

- VSTYPE = Vehicle speed sensor H/W present switch;

0 -> No Vehicle Speed Sensor,

1 -> Vehicle speed sensor present (VSS).

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EEC OVERVIEW - CDAN2

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INITIALIZATION ROUTINE

After Power is first applied, the software initializes all of the Read/Write

(RAM) registers before executing the strategy. All RAM registers are set

equal to zero unless initialized to another value (either set value or a

calculated value) as shown below.

NOTE: The parameters are not necessarily initialized in the order shown.

RAM/FLAG INITIAL VALUE

ACCSTMR 63.99 sec

ACTPTMR2 31.875 sec

ACT 60 Deg F

ACT\_MIN 254 Deg F

AIR\_CHG\_WOT 0.001

ANPIP1 1

ANPIP2 1

APT -1 (Closed Throttle)

BP\_INTR 1

CONPR 650.0 Counts

CRKFLG 1 (Crank Mode)

DOL\_COUNT 0.5

ECT 60 Deg F

ENPIP1 1

ENPIP2 1

F\_A\_RATIO1 6.8298e-2

F\_A\_RATIO2 6.8298e-2

GEAR\_CUR 1

GEAR\_OLD 1

GR\_CM GR\_CM\_KAM

GR\_CM\_LST 1

GR\_DS 1

GR\_DS\_LST 1

GR\_OLD 1

IBAP BP

INJ\_PIP\_CNT1 1.0

INJ\_PIP\_CNT2 1.0

ISCMOD 1.0

LAMAVE1 1.0

LAMAVE2 1.0

LAMBSE1 1.0

LAMBSE2 1.0

LAMMUL 1.0

LAM\_OLD1 0.0

LAM\_OLD2 0.0

(continued on next page)

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EEC OVERVIEW - CDAN2

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(continued from previous page)

RAM/FLAG INITIAL VALUE

OLFLG 1 (Open Loop)

PPCTR PIPNUM

PUMP 1.0

RANNUM 8193

RT\_NOVS 1

SAF 10 Deg BTDC

SIM\_MIN SIMLIM4

TBART RATIV

TC\_HRD\_OFF TCHRDINT

TPBART RATIV

TPBARTV RATIV

TQ\_INTRP 1

TSLMPH ^FF (255 msec.)

UNDSP 1 (Underspeed)

VBAT 12.5 Volts

The strategy checks the validity of the Adaptive Fuel and Idle Airflow

(ISCKAM) after the RAM initialization. This particular KAM qualification is

described in the KAM Chapter.

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EEC OVERVIEW - CDAN2

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CHAPTER 4

HARDWARE INTERFACE

4-1

HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

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4.1 I/O CHANNEL ASSIGNMENTS (CDAN0)

STRATEGY MODULE: HWINT\_IO\_CD

APPLICATION SUMMARY

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

This chapter is intended to accurately summarize I/O information that links

hardware to software. All features described have been verified to exist in

the strategy. The applications listed below, however, may utilize only a

subset of the available features.

NOTE: ALL applications -- developmental, experimental, production and

non-production, etc. that are supported at the time of the release of this

book are listed below. The interface has been verified to support these, and

only these, applications. Any deviations are noted.

| S U P P O R T E D P A T H S / V E R S I O N S: CDAN2

A P P L I C A T I O N S:

(1) VEHICLE: 1996 EN114

ENGINE: 4.6L-2V

TRANSMISSION: 4R70W

MODULE SPECIFICATION: HCR #387 (Phase 2)

MODULE TYPE: ML2-333

WIRING DESIGN TRANSMITTAL: A10363674 Dated: 12/23/93 Level: CP

DEVIATIONS: See below

(3) VEHICLE: 1996 FN116

ENGINE: 4.6L-2V

TRANSMISSION: 4R70W

MODULE SPECIFICATION: HCR #387 (Phase 2)

MODULE TYPE: ML2-333

WIRING DESIGN TRANSMITTAL: A10355172 Dated: 12/20/93 Level: CP

DEVIATIONS: See below

(4) VEHICLE: 1996 SN95

ENGINE: 3.8L

TRANSMISSION: 4R70W, T5

MODULE SPECIFICATION: HCR #387 (Phase 2)

MODULE TYPE: ML2-309, ML2-306

WIRING DESIGN TRANSMITTAL: EF-20399-3 Dated: 11/4/93 Level: N/A

DEVIATIONS: See below

(5) VEHICLE: 1996 SN95

ENGINE: 4.6L-2V

TRANSMISSION: 4R70W, T45

MODULE SPECIFICATION: HCR #387 (Phase 2)

MODULE TYPE: ML2-334, ML2-332

WIRING DESIGN TRANSMITTAL: EF-20326-5 Dated: 11/4/93 Level: N/A

DEVIATIONS: See below

(continued on next page)

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

(6) VEHICLE: 1996 SN95

ENGINE: 4.6L-4V

TRANSMISSION: T45

MODULE SPECIFICATION: HCR #387 (Phase 2)

MODULE TYPE: ML2-334

WIRING DESIGN TRANSMITTAL: EF-20390-4 Dated: 11/4/93 Level: N/A

DEVIATIONS: See below

(7) VEHICLE: 1996 MN12

ENGINE: 3.8L

TRANSMISSION: 4R70W

MODULE SPECIFICATION: HCR #387 (Phase 2)

MODULE TYPE: ML2-309

WIRING DESIGN TRANSMITTAL: A10420493 Dated: 6/29/94 Level: Prod.

DEVIATIONS: See below

(8) VEHICLE: 1996 MN12

ENGINE: 4.6L-2V

TRANSMISSION: 4R70W

MODULE SPECIFICATION: HCR #387 (Phase 2)

MODULE TYPE: ML2-334

WIRING DESIGN TRANSMITTAL: A10420504 Dated: 6/29/94 Level: Prod.

DEVIATIONS: See below

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

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D E V I A T I O N S:

1. Digital Transmission Range Sensor (DTRS) is supported via the following

four inputs: TR1 (RPA-2, J1-03), TR2 (DARC PI/O-0, J1-49), TR3A (ACH-2,

J1-64), and TR4 (DARC PI/O-4, J1-40). This is not currently required and

is not shown on HCR #387 or the Design Transmittal.

2. Reverse Lockout Solenoid (RLS) is output via UPOD3-2 (J1-53). This is no

longer required and does not appear on HCR #387.

3. Low Fan Control (LFC) is supported on UPOD3-3 (J1-28). This is no longer

required and is not shown on HCR #387.

4. Acceleration output, or Ride Control (ACL) is supported on SSPOD1-3

(J1-19) and is shown on HCR #387 for 4.6L MN12. This feature, however,

is not supported by Design Transmittal EF-20450-7 for 4.6L MN12.

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OVERVIEW

The Hardware Interface chapter specifies relationships between strategy I/O

parameters and EEC-V module I/O operation. It is intended to accurately

summarize I/O information that links hardware to software, and it attempts to

document each signal's path from the CPU to the wiring harness. To do this,

each I/O port and IC device is considered separately. A description of each

is given first, followed by a listing of each channel, its specified

function, its associated parameter names, and its I/O path. Any additional

information thought to be of interest is given following each section.

Included information, however, is subject to the following guidelines.

o The only strategy parameters that are referenced in this module are those

that are directly and unconditionally mapped to the I/O channels

identified in this module. The ONLY exceptions to this are

hardware-present switches referenced in this module FOR INFORMATION

PURPOSES ONLY.

o NO RUN-TIME LOGIC IS SPECIFIED IN THIS MODULE. Some I/O channels may be

configurable at calibration time. Any run-time logic that controls the

mapping of strategy feature I/O parameters to I/O channels is specified

in SEPARATE, DEDICATED strategy modules.

The field legend below describes those fields that may be contained in an I/O

description table. The last four fields pertain only to output driver

devices which communicate via the Serial Peripheral Interface (SPI). Please

refer to the descriptions preceding each table for more specific information.

F I E L D L E G E N D:

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CHNL-N Hardware channel name and number.

FUNCTION: SAEFUNC SAE J1930 function name.

REGISTER: FUNC\_ON Strategy/software parameter.

SWITCHES: FUNC\_SW Relevant switches and calibration parameters.

INPUT: PIN-N Input path reference.

OUTPUT: PIN-N Output path reference.

I/O: PIN-N Path reference with INPUT or OUTPUT designation.

CONTROL: CTRL\_MECH Method of POD channel control.

SOURCE: CHNL\_N Source for parallel control of POD device.

COMMAND REG: POD\_BIT Command data for serial control of SPI device.

FAULT REG: POD\_FAULT Fault status received from SPI device.

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENHANCED EEC MODULE/LSI CONFIGURATION SKETCH

-----------------------------------------------------------------------

| |

| ------ | 6

| ---------- ------ |----|UPOD1 |===/==>

| ------ | | | 2K | | ------ |

| | | SLAP | 8065 | M-BUS | RAM | | ------ | 6

| | AICE |--------| |============| EBC | |----|UPOD2 |===/==>

| | | | exp mode | || | DUCE | | ------ |

| ------ | | || ------ | ------ | 6

| | ---------- || |----|UPOD3 |===/==>

| | | | || | ------ |

| ------------------| | M|| ------ | |

| PIP -|--|- B|| | 2.5K | SPI | ------ | 6

| 4 | | U||=====| DARC |---------|----|SSPOD1|===/==>

| ----- =====/===| EDIS | S|| | I/O | | ------ |

|| CD1 |---|||| | | || ------ | ------ | 6

| ----- ||| ------ || |----|SSPOD2|===/==>

| ----- ||| || | ------ |

|| CD2 |----||| -------- || | |

| ----- || | | || | ------ | 2

| ----- || | 112K |=====|| |----| SCCD |===/==>

|| CD3 |-----|| | Flash | | ------ |

| ----- | | EEPROM | | |

| ----- | | | | ------ | 4

|| CD4 |------| -------- |----| IMP |===/==>

| ----- ML-2 ------ |

| 104 Pin J1 |

-----------------------------------------------------------------------

(Refer to current hardware specifications for a more complete drawing.)

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

ANALOG INPUT CHANNELS (ACH)

The sixteen 8065 analog inputs convert analog voltages (0-5V) to A/D counts

(0-1023 counts). Typically, these values are filtered and converted to more

convenient engineering units. The registers that contain the 'raw' input

values are given below.

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ACH-0

FUNCTION: TOT Transmission Oil Temperature.

REGISTER: TOT\_CNTS Raw input counts.

SWITCHES: none

INPUT: J1-37

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ACH-1

FUNCTION: FTPT Fuel Tank Pressure Transducer.

REGISTER: ICHAN\_1 Raw input counts.

SWITCHES: none

INPUT: J1-62

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ACH-2

FUNCTION: MLPS/ Manual Lever Position Sensor.

TR3A DIGITAL TRANSMISSION RANGE SENSOR, BIT 3

REGISTER: INDS Raw input counts.

SWITCHES: none

INPUT: J1-64

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

ACH-3

FUNCTION: TP1 Primary Throttle Position.

REGISTER: TP\_CNTS Raw input counts.

SWITCHES: none

INPUT: J1-89

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ACH-4

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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ACH-5

FUNCTION: ACPSW A/C Pressure Switch.

REGISTER: IACPSW Raw input counts.

SWITCHES: ACPSW\_HP

INPUT: J1-86

FUNCTION: ACPT A/C Pressure Transducer.

REGISTER: IACPRES\_SEN Raw input counts.

SWITCHES: ACPSEN\_HP

INPUT: J1-86

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ACH-6

FUNCTION: PSPT/PSPS Power Steering Pressure Transducer/Switch.

REGISTER: IPSPS Raw input counts.

SWITCHES: none

INPUT: J1-31

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ACH-7

FUNCTION: DPFE (DEPT) Delta Pressure Feedback EGR. (DEPT is old name).

REGISTER: IEGR Raw input counts.

SWITCHES: none

INPUT: J1-65

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ACH-8

FUNCTION: ECT Engine Coolant Temperature.

REGISTER: ECT\_CNTS Raw input counts.

SWITCHES: none

INPUT: J1-38

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ACH-9

FUNCTION: IAT (ACT) Intake Air Temperature Sensor (ACT is old name).

REGISTER: ACT\_CNTS Raw input counts.

SWITCHES: none

INPUT: J1-39

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ACH-10

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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ACH-11

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

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ACH-12

FUNCTION: HTRCM HEGO Heater Current Monitor

REGISTER: HTRCM\_CNTS Raw input counts.

SWITCHES: none

INPUT: Internal to EEC-V module.

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ACH-13

FUNCTION: IMRCM1 Intake Manifold Runner Position Sensor - Bank 1

REGISTER: IMRCP1\_CNTS Raw input counts.

SWITCHES: none

INPUT: J1-08

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ACH-14

FUNCTION: IMRCM2 Intake Manifold Runner Position Sensor - Bank 2

REGISTER: IMRCP2\_CNTS Raw input counts.

SWITCHES: none

INPUT: J1-09

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ACH-15

FUNCTION: VMV-OSM Vapor Management Valve Output State Monitor.

REGISTER: VMV\_OSM\_CNTS Raw input counts.

SWITCHES: none

INPUT: --

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HIGH SPEED DIGITAL INPUTS (HSI)

Each of the eight 8065 high-speed digital inputs (HSIs) can be configured to

capture the state of the input signal after either (1) each transition with a

rising-edge or (2) each transition with either edge, rising or falling. The

latter is the configuration of each HSI unless otherwise noted below.

All inputs, except HSI-0, are updated at 1ms (nominal) intervals and at all

PIP edges. HSI-0 is updated at all PIP up and down edges. Actual values

vary with engine operating conditions.

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HSI-0

FUNCTION: PIP Profile Ignition Pickup signal.

REGISTER: PIP\_HIGH Most recently captured state of input.

SWITCHES: none

INPUT: via EDIS

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HSI-1

FUNCTION: KS1 Knock Sensor.

REGISTER: KNK\_HIGH Most recently captured state of input.

SWITCHES: KIHP Knock hardware present switch.

INPUT: J1-57 via AICE.

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HSI-2

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HSI-3

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HSI-4

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

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HSI-5

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

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HSI-6

FUNCTION: CID1 Cylinder ID #1.

REGISTER: CID\_HIGH Most recently captured state of input.

SWITCHES: HP\_CIDSEL CID hardware type select -- determines type

of CID sensor (Hall Effect or VRS).

INPUT: J1-85 Via AICE.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HSI-7

FUNCTION: EDM Electronic Diagnostic Monitor.

REGISTER: EDM\_HIGH Most recently captured state of input.

SWITCHES: none

INPUT: via EDIS

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ROM PORT INPUTS (RPA)

Each of the five ROM-port digital inputs is individually read by 8065

software at 1 ms (nominal) intervals. They are typically filtered by

software for noise rejection.

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RPA-0

FUNCTION: FPM Fuel Pump Secondary Circuit Monitor.

REGISTER: F\_PUMP\_S\_MON Most recently captured state of input.

SWITCHES: none

INPUT: J1-40

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RPA-1

FUNCTION: TCS Transmission Control (Over-Drive Cancel) Switch.

REGISTER: ITCS Most recently captured state of input.

SWITCHES: none

INPUT: J1-29

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RPA-2

FUNCTION: TR1 DIGITAL TRNS. RANGE SENSOR, BIT 1

REGISTER: TR1

SWITCHES: NONE

INPUT: J1-17

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RPA-3

FUNCTION: OCTADJ Octane Adjust.

REGISTER: OCTADJ Most recently captured state of input.

SWITCHES: none

INPUT: J1-30

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RPA-4

FUNCTION: LFCM (EDFM) Low-Speed Fan Control Monitor (EDFM is old name).

REGISTER: EDFM Most recently captured state of input.

SWITCHES: none

INPUT: J1-04

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HIGH SPEED DIGITAL OUTPUTS (HSO)

The 8065 has ten high-speed digital outputs (HSOs). Software schedules HSO

events and calculates the corresponding event times during PIP and/or

time-slice interrupts. HSO EVENTS are the rising-edge and falling-edge state

transitions on the HSOs. HSO event TIMES are the desired event execution

times, and are calculated directly in terms of 8065 clock time. The event

times are used by the CPU in scheduling the HSO events via the 8065 HSO

'carousel'. The carousel executes the HSO events at the scheduled times,

independent of current CPU operation.

There are no RAM parameters that show the desired or actual states of the

HSOs, nor are there any that show the 8065 clock times of the HSO state

transitions. Output circuit fault data is not directly available from 8065

During HLOS, HSOs are in the OFF state.

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HSO-0

FUNCTION: INJ1 Output for injector #1.

REGISTER: n/a

SWITCHES: none

OUTPUT: UPOD1-5

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HSO-1

FUNCTION: INJ2 Output for injector #2.

REGISTER: n/a

SWITCHES: none

OUTPUT: UPOD1-4

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HSO-2

FUNCTION: INJ3 Output for injector #3.

REGISTER: n/a

SWITCHES: none

OUTPUT: UPOD1-1

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HSO-3

FUNCTION: INJ4 Output for injector #4.

REGISTER: n/a

SWITCHES: none

OUTPUT: UPOD1-0

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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HSO-4

FUNCTION: INJ5 Output for injector #5.

REGISTER: n/a

SWITCHES: none

OUTPUT: UPOD2-5

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HSO-5

FUNCTION: INJ6 Output for injector #6.

REGISTER: n/a

SWITCHES: none

OUTPUT: UPOD2-4

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HSO-6

FUNCTION: INJ7 Output for injector #7.

REGISTER: n/a

SWITCHES: NUMCYL Number of cylinders in engine.

OUTPUT: UPOD2-1

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HSO-7

FUNCTION: INJ8 Output for Injector #8.

REGISTER: n/a

SWITCHES: NUMCYL Number of cylinders in engine.

OUTPUT: UPOD2-0

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HSO-8

FUNCTION: SAPW Spark Advance Pulse-Width.

REGISTER: n/a

SWITCHES: none

OUTPUT: to EDIS

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HSO-9

FUNCTION: KTS Knock Threshold Select output.

REGISTER: n/a

SWITCHES: KIHP Knock hardware present.

OUTPUT: to AICE

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

LOW SPEED DIGITAL OUTPUTS (LSO)

Each of the eight 8065 LSOs are controlled directly by the 8065 CPU software.

The CPU controls the state of an LSO by writing a "1" or a "0" to a

memory-mapped location corresponding to the LSO.

When the 8065 is in I/O Expander mode with Memory Expansion, only one LSO is

available. It is updated at 1 ms (nominal) intervals. The other outputs are

used for hardware functions required to support the expanded capabilities

(clocks, memory bank selects, etc.)

Output circuit fault data is not directly available from 8065 LSOs.

During HLOS, LSOs are in the OFF state.

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LSO-3

FUNCTION: DOL Data Output Link.

REGISTER: DOL Commanded state of output.

SWITCHES: DOLHP DOL hardware present.

OUTPUT: SSPOD1-0

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DUTY CYCLE EXPANDER OUTPUTS (DUCE/DCO)

The DUCE chip provides 8 programmable pulse width modulated outputs. The CPU

controls the outputs by writing a period and pulse width to DUCE registers.

The pulse width for each is calculated in software from an associated duty

cycle. The period for each channel is controlled by a corresponding

calibration scalar (xxx\_PRD\_DT) whose units are 'DUCE ticks'. If the output

frequency of a particular DUCE channel is known, the period can be calculated

from the formula:

f(clock)

xxx\_PRD\_DT = ----------------- - 1

54 \* f(channel)

Where: f(clock) = CPU clock frequency (Hz, example: 18,000,000)

f(channel) = Desired DUCE channel output frequency (Hz)

Optionally, DUCE channels 6 and 7 can be configured to output Variable Force

Solenoid (VFS) data. In addition, any channel can be configured as an

'on/off' output if its associated period scalar (xxx\_PRD\_DT) is set to 0. In

this case, any non-zero duty cycle will turn the output on.

The output pins are listed for reference only. Special methods must be used

to monitor these outputs.

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DCO-0

FUNCTION: unused

REGISTER:

SWITCHES:

OUTPUT:

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DCO-1

FUNCTION: unused

REGISTER:

SWITCHES:

OUTPUT:

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DCO-2

FUNCTION: VMV-CC Vapor Management Valve - Constant Current.

REGISTER: PG\_DC Purge duty cycle.

VMV\_PRD\_DT VMV signal period.

SWITCHES: PCOMP\_SW PCOMP strategy present switch.

OUTPUT: J1-56 (ISC-IC/ACSPD-IC)

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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DCO-3

FUNCTION: MCC-H Modulated Converter Clutch-High Impedence

REGISTER: BCSDC\_OUT MCC duty cycle.

LUS\_PRD\_DT MCC signal period.

SWITCHES: TSTRAT Transmission strategy switch.

OUTPUT: UPOD3-5 Parallel input to UPOD.

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DCO-4

FUNCTION: unused

REGISTER:

SWITCHES:

OUTPUT:

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DCO-5

FUNCTION: unused

REGISTER:

SWITCHES:

OUTPUT:

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DCO-6

FUNCTION: EPCDA1 Electronic Pressure Control-VFS mode.

REGISTER: TV\_COUNTS TV pressure counts to VFS.

SWITCHES: TSTRAT Transmission strategy switch.

OUTPUT: J1-81

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DCO-7

FUNCTION: unused

REGISTER:

SWITCHES:

OUTPUT:

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ANALOG INPUT CONDITIONER CALIBRATION (AICE)

The AICE IC provides dedicated input interfaces for a variety of sensors.

Commands and information are communicated to the AICE via either dedicated

parallel lines or the Serial Link Address Protocol (SLAP) interface.

The AICE provides the A/D conversion for four HEGO sensor signals, the Mass

Air Flow (MAF) sensor signal, and eight additiona1 "external" A/D input

channels. Each is described in the sections that follow.

When computing calibration constants, however, other AICE inputs must be

considered. The AICE has inputs and detection circuitry for two knock

sensors, a channel for receiving and conditioning the Misfire Detection

Sensor (MFDS), and a dedicated input for a standard PIP signal.

Parameter Description

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AICE\_VERS AICE IC version select switch.

(Correct setting is essential for proper operation.)

1 = AICE-1, 2 = AICE-2.

AICE\_SETR1\_B Miscellaneous AICE function controls.

AICE\_SETR1\_C Sensor mode and type selects.

AICE\_SETR1\_D OSS sensor type select.

AICE\_VRS\_VAL Sensor hysteresis values.

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N O T E:

For specific hardware information, please refer to the HCR(s) and Wiring

Diagram(s) listed in the APPLICATION SUMMARY on the first page of this

chapter.

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

AICE ANALOG-TO-DIGITAL INPUTS (AICE A/D)

The AICE has analog inputs and conditioning circuits for a MAF sensor and

four HEGO sensors. The signal on each of these input pins is conditioned and

then multiplexed into the AICE's analog-to-digital converter.

A/D conversions of the MAF, HEGO1I, and HEGO2I inputs are initiated by

software or by hardware (at PIP transitions). HEGO3I and HEGO4I conversions

are done at the request of software only.

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A/D-1 MAFI

FUNCTION: MAF Mass Air Flow Sensor.

REGISTER: IMAF Raw input counts.

SWITCHES: none

INPUT: J1-88/36 88-MAF; 36-MAFRTN.

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A/D-2 HEGO1I

FUNCTION: HO2S-11 Bank 1 front heated O2 sensor (HEGO-11).

REGISTER: IEGO11 Raw input counts.

SWITCHES: none

INPUT: J1-60

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A/D-3 HEGO2I

FUNCTION: HO2S-21 Bank 2 front heated O2 sensor (HEGO-21).

REGISTER: IEGO21 Raw input counts.

SWITCHES: none

INPUT: J1-87

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A/D-4 HEGO3I

FUNCTION: HO2S-12 Bank 1 rear heated O2 sensor (HEGO-12).

REGISTER: IEGO12 Raw input counts.

SWITCHES: none

INPUT: J1-35

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A/D-5 HEGO4I

FUNCTION: HO2S-22 Bank 2 rear heated O2 sensor (HEGO-22).

REGISTER: IEGO22 Raw input counts.

SWITCHES: none

INPUT: J1-61

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

AICE EXTERNAL ANALOG-TO-DIGITAL INPUTS (AICE E-A/D)

The AICE IC has eight "external" general-purpose analog input channels. Each

input has an applied voltage range of 0-5 volts, and can be read as either an

analog or a digital input. If the channel is configured as digital, the

high/low center point value is 2.5 volts with a hysteresis of 1 volt. If the

channel is configured as analog, the digital representation of the pin

voltage has a range of 0-1023 'A/D counts' and is mapped linearly with no

offset. Overall gain is 1.0.

A/D conversion of the voltage on any of these inputs is performed in response

to a request from software.

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E-A/D-0

FUNCTION: IVPWR Vehicle Power.

REGISTER: IIVPWR Raw input counts.

SWITCHES: none

INPUT: -- ANALOG.

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E-A/D-1

FUNCTION: EPCOCM1 EPC Over-Current Monitor.

REGISTER: EPCOCM1\_CNTS Raw input counts.

SWITCHES: none

INPUT: -- ANALOG.

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E-A/D-2

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

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E-A/D-3

FUNCTION: BOO Brake on/off.

REGISTER: BOO\_LVL Most recently captured state of input.

SWITCHES: none

INPUT: J1-92 DIGITAL.

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E-A/D-4

FUNCTION: ACCS A/C Clutch Switch.

REGISTER: ACCS Most recently captured state of input.

SWITCHES: none

INPUT: J1-41 DIGITAL.

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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E-A/D-5

FUNCTION: PFSNS Purge Flow Sensor

REGISTER: PFS\_CNTS Raw input counts.

SWITCHES: none

INPUT: J1-11 ANALOG

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E-A/D-6

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

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E-A/D-7

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DUAL ACCESS RAM CONTROLLER (DARC)

The DARC-I/O LSI provides the following, each of which is described in a

section to follow:

o 6 configurable parallel bidirectional digital I/Os (PI/O).

o 12 configurable multiplexed parallel bidirectional digital I/Os (MPI/O).

o 8 programmable pulse-width modulated outputs (with configurable HLOS

states) (PWM).

o 6 Delta-Time capture Inputs (DTI).

The DARC also provides a Serial Peripheral Interface (SPI) port for

communication of commanded output states and output fault data between the

DARC and EEC-V module power output driver devices.

DARC BI-DIRECTIONAL PARALLEL I/O PORT (DUCE PI/O)

The DARC chip provides a memory-mapped six-channel bidirectional parallel I/O

port. Each I/O channel can be programmed to serve as either an input or an

output. The inputs are filtered for noise rejection, and may be inverted

prior to filtering.

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PI/O-0

FUNCTION: TR2 DIGITAL TRNS. RANGE SENSOR, BIT 2 (INPUT)

REGISTER: TR2

SWITCHES: NONE

I/O VIA: J1-49

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PI/O-1

FUNCTION: unused.

REGISTER:

SWITCHES:

I/O VIA:

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PI/O-2

FUNCTION: 4X4L Four wheel drive, low input switch.

REGISTER: I4X4L Most recently captured state of input.

SWITCHES: none

I/O VIA: J1-14 INPUT (INVERTED).

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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PI/O-3

FUNCTION: EAMM Electric Air Management Secondary Circuit Mon.

REGISTER: EAMM Most recently captured state of input.

SWITCHES: none

I/O VIA: J1-05 INPUT.

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PI/O-4

FUNCTION: TR4 DIGITAL TRNS. RANGE SENSOR, BIT 4

REGISTER: TR4

SWITCHES: NONE

I/O VIA: J1-50

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PI/O-5

FUNCTION: unused

REGISTER:

SWITCHES:

I/O VIA:

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DARC DELTA-TIME INPUTS (DARC DTI)

The DARC chip provides 6 channels of timer-capture inputs that automatically

compute a 24-bit delta-time for each channel. The 24-bit delta-time and

24-bit prior delta-time are available to software via memory mapped

locations. These locations are not, however, accessible via RCON/VDAS. Each

of the six DTI's can be configured to identify each rising, each falling or

each of both types of input signal transition edges.

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DTI-0

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

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DTI-1

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

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DTI-2

FUNCTION: VSS+/- Vehicle Speed Sensor.

REGISTER: n/a

SWITCHES: none

INPUT: J1-58/33 58-VSS+; 33-VSS-.

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DTI-3

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

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DTI-4

FUNCTION: OSS Output Shaft Speed Sensor.

REGISTER: n/a

SWITCHES: none

INPUT: J1-84

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DTI-5

FUNCTION: unused

REGISTER:

SWITCHES:

INPUT:

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4-24

HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DARC PULSE-WIDTH MODULATED OUTPUTS (DARC PWM)

The DARC chip provides a general purpose pulse width generator with eight

individually software-programmable PWM output channels. The CPU controls

each output by writing a period and pulsewidth to registers on the DARC chip.

The output period or frequency of each channel is calibratible (units are

seconds or Hertz, respectively). The pulsewidth is calculated in software

from an associated duty cycle.

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PWM-0

FUNCTION: unused

REGISTER:

SWITCHES:

OUTPUT:

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PWM-1

FUNCTION: FP Fuel Pump

REGISTER: FPUMP\_DC Fuel Pump output duty cycle.

FPUMP\_FREQ Fuel Pump output signal frequency.

SWITCHES: none

OUTPUT: SSPOD1-1 Parallel input to SSPOD1.

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PWM-2

FUNCTION: unused

REGISTER:

SWITCHES:

OUTPUT:

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PWM-3

FUNCTION: IMCC Intake Manifold Communicator Control

REGISTER: IMCC\_DC IMCC output duty cycle.

IMCC\_FREQ IMCC output signal frequency.

SWITCHES: IMCCHP IMCC hardware present switch.

OUTPUT: UPOD2-2 Parallel input to UPOD2.

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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PWM-4

FUNCTION: unused

REGISTER:

SWITCHES:

OUTPUT:

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PWM-5

FUNCTION: unused

REGISTER:

SWITCHES:

OUTPUT:

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PWM-6

FUNCTION: unused

REGISTER:

SWITCHES:

OUTPUT:

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PWM-7

FUNCTION: unused

REGISTER:

SWITCHES:

OUTPUT:

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4-26

HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DARC MULTIPLEXED PARALLEL PORT (DARC MPI/O)

The DARC chip provides a memory-mapped multiplexed parallel port. The MP

port provides 12 general-purpose bidirectional I/O channels that can be

individually programmed as either inputs or outputs. Currently, 8 of the 12

channels (0-7) are used by software to enable the various driver devices

(UPOD, SSPOD, SCCD). The four remaining are unused at this time.

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MPI/O-8

FUNCTION: unused

REGISTER:

SWITCHES:

I/O:

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MPI/O-9

FUNCTION: unused

REGISTER:

SWITCHES:

I/O:

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MPI/O-10

FUNCTION: unused

REGISTER:

SWITCHES:

I/O:

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MPI/O-11

FUNCTION: unused

REGISTER:

SWITCHES:

I/O:

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4-27

HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

UNIVERSAL POWER OUTPUT DRIVER (UPOD)

Each UPOD provides 6 outputs that may be controlled serially (via the DARC

chip) or by dedicated parallel inputs. The "CONTROL" field indicates whether

an input is serial or parallel. If an input is serial, the parameter

containing the commanded output state is given in the "COMMAND REG" field.

If an input is parallel, the CPU/DARC/DUCE source of the output is listed in

the "SOURCE" field.

UPODs will return output fault information to the DARC. Typically, this

information is stored in RAM. The fault status parameter is given in the

"FAULT REG" field.

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UPOD1-0

FUNCTION: INJ4 Injector #4.

CONTROL: PARALLEL

SOURCE: HSO-3

FAULT REG: INJ4\_FAULT Fault status of output driver.

SWITCHES: none

OUTPUT: J1-100

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UPOD1-1

FUNCTION: INJ3 Injector #3.

CONTROL: PARALLEL

SOURCE: HSO-2

FAULT REG: INJ3\_FAULT Fault status of output driver.

SWITCHES: none

OUTPUT: J1-74

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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UPOD1-2

FUNCTION: LFC (EDF) Low Fan Control (formerly Electro-Drive Fan)

CONTROL: SERIAL

COMMAND REG: EDF Commanded state of output.

FAULT REG: EDF\_STAT1 Fault status of output driver.

SWITCHES: EDFHP = 1 EDF hardware present switch.

OUTPUT: J1-45

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UPOD1-3

FUNCTION: MIL Malfunction Indicator Light.

CONTROL: SERIAL

COMMAND REG: MIL Commanded state of output.

FAULT REG: MIL\_FAULT Fault status of output driver.

SWITCHES: none

OUTPUT: J1-02

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UPOD1-4

FUNCTION: INJ2 Injector #2.

CONTROL: PARALLEL

SOURCE: HSO-1

FAULT REG: INJ2\_FAULT Fault status of output driver.

SWITCHES: none

OUTPUT: J1-101

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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UPOD1-5

FUNCTION: INJ1 Injector #1.

CONTROL: PARALLEL

SOURCE: HSO-0

FAULT REG: INJ1\_FAULT Fault status of output driver.

SWITCHES: none

OUTPUT: J1-75

-----------------------------------------------------------------------------

UPOD2-0

FUNCTION: INJ8 Injector #8.

CONTROL: PARALLEL

SOURCE: HSO-7

FAULT REG: INJ8\_FAULT Fault status of output driver.

SWITCHES: NUMCYL Number of cylinders in engine.

OUTPUT: J1-98

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UPOD2-1

FUNCTION: INJ7 Injector #7.

CONTROL: PARALLEL

SOURCE: HSO-6

FAULT REG: INJ7\_FAULT Fault status of output driver.

SWITCHES: NUMCYL Number of cylinders in engine.

OUTPUT: J1-72

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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UPOD2-2

FUNCTION: HFC (HEDF) High Fan Control (formerly High Speed EDF)

CONTROL: SERIAL

COMMAND REG: HEDF Commanded state of output.

FAULT REG: HEDF\_STATUS Fault status of output driver.

SWITCHES: HEDFHP HEDF hardware present switch.

IMCCHP IMCC hardware present switch.

OUTPUT: J1-46

FUNCTION: IMCC Intake Manifold Communitor Control

CONTROL: PARALLEL

SOURCE: PWM-3

FAULT REG: IMCC\_FAULT Fault status of output driver.

SWITCHES: IMCCHP IMCC hardware present switch.

OUTPUT: J1-46

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UPOD2-3

FUNCTION: IMRC Intake Manifold Runner Control.

CONTROL: SERIAL

COMMAND REG: IMRC\_OUT Commanded state of output.

FAULT REG: IMRC\_FAULT Fault status of output driver.

SWITCHES: IMRCHP IMRC hardware present.

OUTPUT: J1-42

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UPOD2-4

FUNCTION: INJ6 Injector #6.

CONTROL: PARALLEL

SOURCE: HSO-5

FAULT REG: INJ6\_FAULT Fault status of output driver.

SWITCHES: none

OUTPUT: J1-99

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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UPOD2-5

FUNCTION: INJ5 Injector #5.

CONTROL: PARALLEL

SOURCE: HSO-4

FAULT REG: INJ5\_FAULT Fault status of output driver.

SWITCHES: none

OUTPUT: J1-73

-----------------------------------------------------------------------------

UPOD3-0

FUNCTION: SS1 Shift Solenoid #1.

CONTROL: SERIAL

COMMAND REG: FLG\_SS\_1 Commanded state of output.

FAULT REG: SS1\_FAULT Fault status of output driver.

SWITCHES: TSTRAT Transmission strategy switch.

OUTPUT: J1-27

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UPOD3-1

FUNCTION: SS2 Shift Solenoid #2.

CONTROL: SERIAL

COMMAND REG: FLG\_SS\_2 Commanded state of output.

FAULT REG: SS2\_FAULT Fault status of output driver.

SWITCHES: TSTRAT Transmission strategy switch.

OUTPUT: J1-01

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UPOD3-2

FUNCTION: RLS Reverse Lockout Solenoid

CONTROL: SERIAL

COMMAND REG: FLG\_RLS Commended state of output.

FAULT REG: none

SWITCHES: TSTRAT Transmission strategy switch.

OUTPUT: J1-53

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UPOD3-3

FUNCTION: unused

CONTROL:

COMMAND REG:

FAULT REG:

SWITCHES:

OUTPUT:

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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UPOD3-4

FUNCTION: TCIL Transmission Control Indicator Light.

CONTROL: SERIAL

COMMAND REG: TCIL\_B Commanded state of output.

FAULT REG: TCIL\_FAULT Fault status of output driver.

SWITCHES: TSTRAT Transmission strategy switch.

OUTPUT: J1-79

FUNCTION: FPL Fuel Pump high/low speed control.

CONTROL: SERIAL

COMMAND REG: FPL Commanded state of output.

FAULT REG: FP\_2SPD\_ERR Fault status of output driver.

SWITCHES: FP\_TYPE Fuel pump type.

OUTPUT: J1-79

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UPOD3-5

FUNCTION: TCC-H Torque Converter Clutch - High impedence.

CONTROL: PARALLEL

SOURCE: DCO-3

FAULT REG: TCC\_H\_FAULT Fault status of output driver.

SWITCHES: TSTRAT Transmission strategy switch.

OUTPUT: J1-54

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SIX SERIAL/PARALLEL OUTPUT DRIVER (SSPOD)

Each SSPOD provides 6 outputs which may be controlled serially (via the DARC

chip). Alternatively, the first three channels (0-2) on each SSPOD may be

controlled by dedicated parallel inputs. The "CONTROL" field indicates

whether an input is serial or parallel. If an input is serial, the parameter

containing the commanded output state is given in the "CONTROL REG" field.

If an input is parallel, the CPU/DARC/DUCE source of the output is listed in

the "SOURCE" field.

SSPODs will return output fault information to the DARC. Typically, this

information is stored in RAM. The fault status parameter is given in the

"FAULT REG" field.

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SSPOD1-0

FUNCTION: DOL Data Output Link.

CONTROL: PARALLEL

SOURCE: LSO-3

FAULT REG: DOL\_FAULT Fault status of output driver.

SWITCHES: none

OUTPUT: J1-43

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SSPOD1-1

FUNCTION: FP Fuel Pump

FSV Fuel Solenoid Valve

CONTROL: PARALLEL

SOURCE: PWM-1

FAULT REG: F\_PUMP\_ERROR

SWITCHES: none

OUTPUT: J1-80

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SSPOD1-2

FUNCTION: WAC A/C cutout relay.

CONTROL: SERIAL

COMMAND REG: ACR Commanded state of output.

FAULT REG: ACC\_STATUS Fault status of output driver.

SWITCHES: none

OUTPUT: J1-69

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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SSPOD1-3

FUNCTION: ACL Acceleration output for Ride Control

CONTROL: SERIAL

COMMAND REG: ACL Commanded state of output.

FAULT REG: none

SWITCHES: HPACL Ride Control hardware present switch.

OUTPUT: J1-19

FUNCTION: SWC Speed Warning Chime

CONTROL: SERIAL

COMMAND REG: SWC Commanded state of output.

FAULT REG: SWC\_FAULT Fault status of output driver.

SWITCHES: SWC\_HP Speed Warning Chime hardware present switch.

OUTPUT: J1-19

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SSPOD1-4

FUNCTION: CANP Canister Purge Solenoid.

CANVNT Canister Vent Valve.

CONTROL: SERIAL Serviced at 1ms intervals.

COMMAND REG: CANVNT\_CMD Commanded state of output.

FAULT REG: CANP\_FAULT Fault status of output driver.

CANVT\_FAULT Fault status of output driver.

SWITCHES: PCOMP\_SW PCOMP strategy present switch.

OUTPUT: J1-67

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SSPOD1-5

FUNCTION: EAIR (EAM) Electric Secondary Air Injection

(formerly Electric Air Management)

CONTROL: SERIAL

COMMAND REG: EAM Commanded state of output.

FAULT REG: EAM\_FAULT Fault status of output driver.

SWITCHES: THRMHP Thermactor hardware present.

OUTPUT: J1-70

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SWITCHING CONSTANT CURRENT DRIVER (SCCD)

The SCCD provides two average-current outputs (SCCD-A, SCCD-B) used to drive

inductive loads.

During Normal operation, a digital value corresponding to a desired load

current is sent to the SCCD via the SPI. The SCCD creates a sawtooth

waveform by oscillating the output current (+/-10%) around the digital value.

This results in an average current output equal to the desired value. By

using this method, a constant current is supplied to the inductive loads but

with a lower power dissipation in the drivers.

In Normal mode, the SCCD can detect an over-current fault (shorted load or

short-to-Vbatt) on an output while the output is ON, and can detect

open-circuit and short-to-ground faults on an output when it is ON or OFF.

The fault information is sent from the SCCD to the CPU via the SPI.

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SCCD-A

FUNCTION: EVR-CC Exhaust Gas Recirculation - Constant Current.

COMMAND REG: EVR\_CURRENT Percent current register.

FAULT REG: EVR\_OPEN Open-circuit fault status of output driver.

(Bit 5 of fault data from SCCD via SPI)

EVR\_SHORT Short-circuit fault status of output driver.

(Bit 4 of fault data from SCCD via SPI)

SWITCHES: none

OUTPUT: J1-47

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

SCCD-B

FUNCTION: IAC (ISCBPA) Idle Air Control

(formerly Idle Speed Control - Bypass Air)

COMMAND REG: ISC\_CURRENT ISC percent current register.

FAULT REG: IAC\_NO\_CUR Open circuit or short-to-ground detected.

(Bit 3 of fault data from SCCD via SPI)

IAC\_OVER\_CUR Shorted load or short-to-VPWR detected.

(Bit 2 of fault data from SCCD via SPI)

SWITCHES: none

OUTPUT: J1-83

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HARDWARE INTERFACE, EEC-V I/O CHANNEL ASSIGNMENTS - CDAN2

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INTELLIGENT MOSFET PRE-DRIVER (IMP)

The IMP IC has four outputs which can control external MOSFET drivers for

four external loads. The four outputs are controllable by means of periodic

serial communication from the DARC via the SPI. The four outputs are

configured in pairs. The IMP can detect over-current faults on an output

pair while the pair is commanded ON, and open-circuit and short-to-ground

faults on an output pair when the pair is commanded OFF. The IMP transmits

to the DARC (via the SPI) the fault status of each of its outputs.

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IMP-0

FUNCTION: HTR-11 Bank 1 front HEGO heater

COMMAND REG: HEGOHTR11 Commanded state of output.

FAULT REG: HTR\_FAULT11 Fault status of output driver.

SWITCHES: none

OUTPUT: J1-93

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IMP-1

FUNCTION: HTR-21 Bank 2 front HEGO heater

COMMAND REG: HEGOHTR21 Commanded state of output.

FAULT REG: HTR\_FAULT21 Fault status of output driver.

SWITCHES: none

OUTPUT: J1-94

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IMP-2

FUNCTION: HTR-12 Bank 1 rear HEGO heater

COMMAND REG: HEGOHTR12 Commanded state of output.

FAULT REG: HTR\_FAULT12 Fault status of output driver.

SWITCHES: none

OUTPUT: J1-95

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IMP-3

FUNCTION: HTR-22 Bank 2 rear HEGO heater

COMMAND REG: HEGOHTR22 Commanded state of output.

FAULT REG: HTR\_FAULT22 Fault status of output driver.

SWITCHES: none

OUTPUT: J1-96

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HARDWARE INTERFACE, HARDWARE-SPECIFIC INPUT PROCESSING - CDAN2

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4.2 HARDWARE-SPECIFIC INPUT PROCESSING (CDAN0)

OVERVIEW

Input functions which require special processing due to hardware

configuration are listed below.

DEFINITIONS

Registers:

- ICHAN\_1 = 8065 Analog input, channel 1, counts.

- IPSPS = Power steering analog input.

- TPR\_CNTS = Tank pressure sensor input counts.

Bit Flags:

- CURRENT\_CKD = Semaphore to signal when the HTRCM data is available.

- EDF = Electro-Drive Fan output driver #1 commanded state; 1 -> driver ON.

- EDF\_STATUS = EDF output driver fault status.

- PSPS\_LVL = Power steering pressure switch input.

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HARDWARE INTERFACE, HARDWARE-SPECIFIC INPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: HWINT\_INPUT\_CD

ANALOG CHANNEL 1 INPUT SELECTION

Analog channel 1 provides Fuel Tank Pressure input. This logic is performed

once per background loop.

unconditionally -----------------------| TPR\_CNTS := ICHAN\_1

POWER STEERING PRESSURE SWITCH STATE DETERMINATION

The analog input IPSPS is converted to the bit flag PSPS\_LVL based upon a

switchpoint of 512 A/D counts (~2.5 volts).

IPSPS > 512 counts --------------------| PSPS\_LVL := 1

|

| --- ELSE ---

|

| PSPS\_LVL := 0

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HARDWARE INTERFACE, HARDWARE-SPECIFIC INPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

LOW SPEED FAN OUTPUT DRIVER FAULT STATUS PROCESSING

The Low Speed Electro-Drive Fan (EDF) is directed to one of two UPOD outputs,

depending upon the calibration of VCAMHP. Since each output furnishes its

own fault information, the actual EDF output driver fault status must be

determined based upon which EDF output is used.

To further complicate matters, the UPOD circuitry will erroneously indicate a

fault when the driver is ON and the output impedence is greater than 45 ohms.

Some CD applications utilize a IRCM which has an output impedence of 60 - 80

ohms. For this reason, the fault status of the EDF output driver is only

saved if the driver state is OFF.

EDF = 0 -------------------------|

;driver is OFF |

;fault status is valid |AND -| EDF\_STATUS := 0

| | ;indicates driver OK

edf\_fault = 0 -------------------| |

;no fault present |

| --- ELSE ---

EDF = 0 -------------------------| |

;driver is OFF | |

;fault status is valid |AND -| EDF\_STATUS := 1

| | ;indicate driver fault

edf\_fault = 1 -------------------|

;fault is present

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HARDWARE INTERFACE, HARDWARE-SPECIFIC INPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HEATER CURRENT MONITOR SEMAPHORE

This logic is necessary for Current Monitoring strategy compatibility with

both ML-1 and ML-2 module input configurations.

Analog channel 12 is read once per background loop and software transfers the

ACH-12 data to HTRCM\_CNTS. The logic below sets a semaphore to notify the

Current Monitoring strategy that data is available.

Once per background loop:

unconditionally ----------------------| CURRENT\_CKD := 1

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HARDWARE INTERFACE, HARDWARE-SPECIFIC OUTPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

4.3 HARDWARE-SPECIFIC OUTPUT PROCESSING (CDAN0)

OVERVIEW

Outputs which require special processing due to hardware configurations are

listed below.

DEFINITIONS

Registers:

- DOL\_COUNT = Number of pulses to be output to the fuel economy display

device.

- EGRDC = EGR duty-cycle.

- EVR\_CURRENT = SCCD percent current register for EGR EVR.

- ISC\_CURRENT = SCCD percent current register for ISC.

- ISCDTY = Idle speed duty cycle.

- PG\_DC = Canister Purge duty cycle.

- PGM\_CVS\_DC = Purge monitor canister vent solenoid duty cycle.

- PRG\_ON\_TIME = Time per output period that CANP/CANVNT output is held

high, clock ticks.

- PRG\_PERIOD = CANP/CANVNT output period, clock ticks.

- START\_CVS\_PER = Time stamp of beginning of last CANP/CVS period, clock

ticks.

- VMV\_PW\_DTKS = VMV pulsewidth, DUCE ticks.

- VMV\_PW\_DUCE = DUCE hardware register for VMV output.

Bit Flags:

- CANVT\_CMD = Commanded CANVNT output state; 1 -> output energized.

- CHTIL\_CMD = Desired state of Cylinder Head Temperature Indicator Light; 1

-> CHTIL on.

- CHTIL = Cylinder Head Temperature Indicator Light output state; 1 ->

output energized.

- DOL = Commanded Data Output Link output state; 1 -> output energized.

- PRG\_OUT\_ENA = Foreground CANP/CANVNT output routine enable flag.

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HARDWARE INTERFACE, HARDWARE-SPECIFIC OUTPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- CANP\_PRD\_DT = Output period of CANP signal, DUCE ticks.

- COOL\_CAL\_SW = Fail Safe Cooling strategy enable; 1 -> enabled.

- CVS\_PERIOD = Output period of Canister Vent Valve solenoid; clock ticks.

- DOLHP = Data Output Link hardware present switch.

- VMV\_PRD\_DT = Output period of VMV signal, DUCE ticks.

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HARDWARE INTERFACE, HARDWARE-SPECIFIC OUTPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: HWINT\_OUTPUT\_CD

CYLINDER HEAD TEMPERATURE INDICATOR LIGHT OUTPUT PROCESSING

Cylinder Head Temperature Indicator Light (CHTIL) is controlled by the value

of CHTIL\_CMD, provided the feature is calibrated in. NOTE: This function

shares an output with EDF and VCT1. The software makes no provisions for

enabling more than one of these functions.

COOL\_CAL\_SW = 1 ------------------|

|AND -| CHTIL := 0

CHTIL\_CMD = 0 --------------------| |

| --- ELSE ---

|

COOL\_CAL\_SW = 1 ------------------------| CHTIL := 1

IDLE SPEED CONTROL BYPASS AIR SOLENOID OUTPUT PROCESSING

ISCDTY is translated in software to a 'percent current', ISC\_CURRENT, using a

SCCD current conversion factor (sccf).

always ---------------------------------| ISC\_CURRENT := sccf(ISCDTY)

EGR ELECTRONIC VACUUM REGULATOR (EVR) OUTPUT PROCESSING

EGRDC is translated in software to a 'percent current', EVR\_CURRENT, using a

SCCD current conversion factor (sccf).

always ---------------------------------| EVR\_CURRENT := sccf(EGRDC)

VAPOR MANAGEMENT VALVE DUCE OUTPUT PROCESSING

The Vapor Management Valve (VMV) signal is output on a DUCE channel. The

on-time of the signal is computed in software from the VMV strategy's

calibrated output period and its calculated duty-cycle. The on-time is then

written by software to a memory mapped dedicated register on the DUCE chip.

BEGIN: vapor\_management\_valve\_output

; This process is executed only when called.

unconditionally ------------------------| VMV\_PW\_DTKS := PG\_DC \* VMV\_PRD\_DT

| ;clip to 65535 duce\_ticks

|

| VMV\_PW\_DUCE := VMV\_PW\_DTKS

END: vapor\_management\_valve\_output

4-44

HARDWARE INTERFACE, HARDWARE-SPECIFIC OUTPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DATA OUTPUT LINK OUTPUT PROCESSING

The Data Output Link outputs a number of pulses proportional to the amount of

fuel consumed. The register DOL\_COUNT contains the current number of pulses

needing to be output. The duration of each pulse is approximately 1 ms.

; Once per millisecond:

DOLHP = 1 ------------------------|

|

DOL\_COUNT > 0.5 ------------------|AND -| DOL\_COUNT := DOL\_COUNT - 0.5

| | DOL := 1

DOL = 0 --------------------------| |

| --- ELSE ---

DOLHP = 1 ------------------------| |

|AND -| DOL\_COUNT := DOL\_COUNT - 0.5

DOL\_COUNT > 0.5 ------------------| | DOL := 0

|

| --- ELSE ---

|

DOLHP = 1 ------------------------------| DOL\_COUNT := 0.5

4-45

HARDWARE INTERFACE, HARDWARE-SPECIFIC OUTPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CANISTER PURGE SOLENOID OUTPUT PROCESSING

Canister Purge Solenoid, (CANP) shares a serially controlled SSPOD channel

with Canister Vent Valve (CANVNT).

The commanded output is updated once every 20 ms when PRG\_FLG\_ENA = 0, or

every 1 ms when PRG\_FLG\_ENA = 1.

This process is called from the Canister Purge Selection logic.

BEGIN: canister\_purge\_output

; If the use of a Canister Purge solenoid (CANP) is desired, the

; period of the output signal is determined by converting the scalar

; CANP\_PRD\_DT from DUCE ticks to clock ticks.

; This process is executed only when called.

PG\_DC = 0 ------------------------------| PRG\_OUT\_ENA := 0

; CANP full off | ; Disable 1 ms output routine.

| CANVT\_CMD := 0

| ; Turn CANP off during next

| ; 20 ms timeslice.

|

| --- ELSE ---

|

PG\_DC = 1.0 ----------------------------| PRG\_OUT\_ENA := 0

; CANP full on | ; Disable 1 ms output routine.

| CANVT\_CMD := 1

| ; Turn CANP on during next

| ; 20 ms timeslice.

|

| --- ELSE ---

|

| PRG\_PERIOD := CANP\_PRD\_DT \* 9 / 16

| ; Convert CANP period from DUCE

| ; ticks to clock ticks.

| PRG\_ON\_TIME := PRG\_PERIOD \* PG\_DC

| PRG\_OUT\_ENA := 1

| ; Enable 1 ms output routine.

END: canister\_purge\_output

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HARDWARE INTERFACE, HARDWARE-SPECIFIC OUTPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CANISTER VENT VALVE OUTPUT PROCESSING

Canister Vent Valve (CANVNT) shares a serially controlled SSPOD channel with

Canister Purge Solenoid (CANP).

The commanded output is updated once every 20 ms when PRG\_FLG\_ENA = 0, or

every 1 ms when PRG\_FLG\_ENA = 1.

This process is called from the Canister Purge Selection logic.

BEGIN: canister\_vent\_valve\_output

; If the use of a Canister Vent Valve (CANVNT) is desired, the period of

; the output signal is the scalar CVS\_PERIOD (units are clock ticks).

; This process is executed only when called.

PGM\_CVS\_DC = 0 -------------------------| PRG\_OUT\_ENA := 0

; CANVNT full off | ; Disable 1 ms output routine.

| CANVT\_CMD := 0

| ; Turn CANVNT off during next

| ; 20 ms timeslice.

|

| --- ELSE ---

|

PGM\_CVS\_DC = 1.0 -----------------------| PRG\_OUT\_ENA := 0

; CANVNT full on | ; Disable 1 ms output routine.

| CANVT\_CMD := 1

| ; Turn CANVNT on during next

| ; 20 ms timeslice.

|

| --- ELSE ---

|

| PRG\_PERIOD := CVS\_PERIOD

| PRG\_ON\_TIME := PRG\_PERIOD \*

| PGM\_CVS\_DC

| PRG\_OUT\_ENA := 1

| ; Enable 1 ms output routine.

END: canister\_vent\_valve\_output

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HARDWARE INTERFACE, HARDWARE-SPECIFIC OUTPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: purge\_1ms\_output\_routine

; This routine determines the commanded state of the CANP/CANVNT output

; (CANVT\_CMD) when 0 < duty-cycle < 100%. A PWM signal is generated by

; software using a calculated duty-cycle, a calibrated period, and the

; system clock.

;

; The commanded state of the output is updated each millisecond.

; |<------------ PRG\_PERIOD ----------->|

; ->| |<- PRG\_ON\_TIME

; \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

; | | | |

;\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

; A A

; |<----- elapsed\_time -->|

; | |

; START\_CVS\_PER clock

; This process is executed once per millisecond:

PRG\_OUT\_ENA = 0 ------------------------| EXIT this process.

clock - START\_CVS\_PER < PRG\_ON\_TIME ----| CANVT\_CMD := 1

|

| --- ELSE ---

|

clock - START\_CVS\_PER < PRG\_PERIOD -----| CANVT\_CMD := 0

|

| --- ELSE ---

|

| START\_CVS\_PER := clock

END: purge\_1ms\_output\_routine

4-48

HARDWARE INTERFACE, OUTPUT STATE CONTROL TABLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

4.4 OUTPUT STATE CONTROL TABLE (CDAL0)

STRATEGY MODULE: HWINT\_OSC\_CD

OVERVIEW

There exists a table of values related to the Output State Control function

in the PCM. This table is used to hold the actual values that the offboard

diagnostic unit wishes to use in palce of those calculated by the strategy.

This table is also used to hold the enable mask transmitted from the offboard

diagnostic unit to the PCM to unlock the individual channels. The enable

mask is to be compared to a predetermined, hardcoded enable bit pattern.

This acts as a key to unlock each individual channel in the table. There are

currently 20 channels substitution is allowed to be performed on. These are

shown in a diagram below. If one or more of these parameters are not present

in a given strategy, a request from the ODU to override would have no

external effect. This is because the substitute() process would never be

invoked with the channel number that does not exist in the strategy.

IMPLEMENTATION NOTE: The OSC\_VALUE[] parameters will have binary scaling to

match the parameter they will be used to override. This implies that each

OSC\_VALUE[] will have its own unique scaling. The OSC\_VAULE[] parameters

have been created in the EDTS parameter dictionary as OSC\_VALUE0,

OSC\_VALUE1... with the appropriate scaling. The binary scaling information

is also to be provided to the ODU designers so that they will load a bit

pattern into OSC\_VALUE[] that is scaled properly and no further action will

be required by the EEEC once the value has been transmitted and loaded into

the table.

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HARDWARE INTERFACE, OUTPUT STATE CONTROL TABLE - CDAN2

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OSC TABLE

--- -----

+----------+--------------+----------------+----------------+-----------+

| channel\* | parameter | OSC\_VALUE[] | OSC\_ENA[] | SCALING\*\* |

+----------+--------------+----------------+----------------+-----------+

| 0 | ISCDTY | . | . | b15,u,w |

| 1 | EAM | . | . | flag |

| 4 | LAMBSE1 | . | . | b15,u,w |

| 5 | LAMBSE2 | . | . | b15,u,w |

| 7 | EGRDC | \*---------------------------\* | b15,u,w |

| 8 | GR\_CM | |These values are initially | | b1,u,b |

| 9 | PG\_DC | |equal to zero. The ODU | | b15,u,w |

| | | |will download parameters | | |

| | | |through custom SCP commands| | |

| | | |to this area. | | |

| | | \*---------------------------\* | |

| 10 | PGM\_CVS\_DC | . | . | b15,u,w |

| 11 | FLG\_SS\_1 | . | . | flag |

| 12 | FLG\_SS\_2 | . | . | flag |

| 15 | BCSDC\_OUT | . | . | b15,u,w |

| 16 | TV\_PRES\_BAR | . | . | b1,u,b |

| 17 | SAF | . | . | b2,s,w |

| 19 | FPUMP\_DC | . | . | b10,u,w |

| 20 | FPUMP\_SPEED | . | . | flag |

| 21 | IMRC\_CMND | . | . | flag |

| 25 | HEGOHTR11 | . | . | flag |

| 26 | HEGOHTR12 | . | . | flag |

| 27 | HEGOHTR21 | . | . | flag |

| 28 | HEGOHTR22 | . | . | flag |

+----------+--------------+----------------+----------------+-----------+

'\*'...Channel numbers shown are offset 128 from SCP hex values.

'\*\*'...Where scaling references a flag, the least significant bit of the

substitute word shall be used to control the channel value (ie. the LSb is

the flag state). When scaling references a byte, the least significant byte

commands the value.

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CHAPTER 5

SCP INTERFACES

5-1

SCP INTERFACES

5.1 FEATURE: SCP - V6.2A\_SCP\_EATC\_PATS (CDAN0)

5.1.1 SCP MESSAGE OVERVIEW (CDAA0)

STRATEGY MODULE: SCP\_OVERVIEW\_COM1

SCP Messages - Reception & Transmission

Message Format:

Messages are composed of a variable number of bytes. Currently defined

messages are from 53 to 101 bits in length, depending upon the message type

and content. Each message is composed of fields which possess a predefined

interpretation. Fields are organized along byte boundaries. All messages

must begin with a Start Of Message (SOM) followed by a field which determines

bus priority as well as defining the message type. All messages end with an

End Of Message (EOM) field.

The SCP protocol currently has defined 6 specific network message types.

They are: Functional, Broadcast, Function Query, Function Read, Node to

Node, and BCC Access. Further definition of these messages can be found in

the EEC Bus Controller (EBC) Functional Specification.

The general message format is:

Message Field Length Field Description & Data Handling

----------------------------------------------------------------------------

SOM 2 bits Start Of Message indicator

Priority/Type 1 Byte Priority (bits 7:4) & Type (bits 3:0)

(NOT STORED IN MBFIFO)

Target Specifier 1 Byte Outgoing Message Target Specifier Byte

Depending upon the message type, this

byte could be a Physical Address or a

Generic Function code.

(NOT STORED IN MBFIFO)

Source Address 1 Byte Outgoing Message Source Address

(STORED IN MBFIFO)

Data 0-7 Bytes Depending on application, this field may

contain further definition of a command

function, or it may carry a variable to

be passed on to the receiving node.

(STORED IN MBFIFO)

CRC 1 Byte Message Cyclic Redundancy Check.

(NOT STORED IN MBFIFO)

EOD 1 bit End Of Data Field; idle bus indicates

conclusion of sender transmission.

ACK 1 Byte Response by receiving node(s) to indicate

the message was received properly, OR,

single byte of function read data (or BCC

data) to be sent to the requesting node.

(FUNCTION READ DATA STORED IN MBFIFO)

5-2

SCP INTERFACES, SCP MESSAGE OVERVIEW - CDAN2

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EOM 2 bits End Of Message field; idle bus indicates

completion of message.

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SCP INTERFACES, SCP MESSAGE OVERVIEW - CDAN2

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Typical SCP Communications:

The strategy includes a construct, used to identify the message name and

variable data to be sent with the message, which is called "send()". This

construct is described in detail in the SYMBOLOGY section.

Most messages are transmitted only when a set of conditions are met. The

message definition in these cases will define a "Message Transmit Routine"

which controls the "send" command. Messages which are transmitted every

background loop still require the "send()" command for message initiation,

with an "unconditionally" statement included in the "Message Transmit

Routine".

When a message is received, the EEC will execute a "Receive Message Routine",

which is only executed upon reception of a particular message. These

routines can include merely loading a register with a new value, or decoding

the data bytes of the incoming message in order to affect an action in the

EEC strategy.

All SCP messages are defined in the Module: SCP\_MSG\_LST\_COM\*, which provides

an overview of the messages supported by a particular strategy as well as a

detailed definition of the message specification. Other data defined in the

message spec include Message Type, Purpose, Data Flow, Scaling and Format

information, and Strategy which controls the EEC handling of that message.

Message Reception:

The EEC Bus Controller (EBC) chip was designed to require minimal host inter-

vention for transmission and reception of messages on the SCP Bus. In

message reception, the EBC monitors bus transactions on the network on a

individual message basis without intervention from the host. Network

communications intended for the EEC must be qualified by the EBC before it

can acknowledge the message. Qualification of a message is performed by

examining the Message Type and Target Specifier, which are found in the

3-Byte header of all messages.

For non-physically addressed messages (such as Functional, Broadcast,

Function Read, and Function Query messages), qualification of a message is

based on comparing the Target Specifier Byte of the message to internal

look-up tables in the EBC. The appropriate look-up table, based on message

type, is searched for a match against the Target Specifier Byte of the

incoming message. A match on any of the bytes in the tables qualifies the

message.

Physically addressed messages do not require qualification through the

look-up table process. Therefore, Node to Node and BCC Access messages are

qualified by comparing the Target Specifier Byte of the incoming message

against the physical Node Address Register (NAR), which is downloaded from

ROM to the EBC upon initialization.

After message qualification, the first byte stored in the EBC's 256 Byte

buffer (MBFIFO) is the message number. This is simply the location of the

look-up table entry found in qualification of a message relative to the start

of the look-up table except for Node to Node messages, for which the message

number is always 00H. Because Look-up Table 2 is only used to qualify

Function Read messages, which are not transferred to the host, the message

number, for this case has no meaning.

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SCP INTERFACES, SCP MESSAGE OVERVIEW - CDAN2

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Once the message number has been stored in the MBFIFO's first available

location, the source identifier and following data, up to EOD (end of data),

are then stored in sequential locations after the message number. Received

messages are emptied from the MBFIFO once per background loop. There are two

options for handling message processing. The first option, called Direct

Data Storage, writes the received data directly to locations defined for that

message number. The second option, called Routine Dispatch, will call a

routine which performs some action based on the message contents.

Information on which type of message handling is required is stored in ROM,

in a structure called a Receive Message Descriptor Block (RMDB). An RMDB

describes the length of the expected message as well as its destination

address.

Message Transmission:

To unburden the host software of message transmission delays, a simple queue

is used to quickly store the messages needing transmission. As each message

in the queue is sent, the next message is retrieved and loaded into the EBC

via an interrupt indicating that the previous message was sent. The

background routine continues without having to interface directly with the

EBC. Messages are transmitted from the queue on a FIFO basis. The EBC will

recognize and transmit any new message which was added to the queue during

the transmission sequence.

Each queue entry holds a status byte (empty, pending, complete & status) and

a pointer to the structure used to define transmitted messages, called the

Transmit Message Descriptor Block (TMDB). The TMDB list resides in ROM and

contains the body of the message to be sent, along with information on how to

handle the results of the transmission (acknowledgers, errors, etc.).

When a message is to be transmitted on the bus, the host must load the

outgoing message body (using the TMDB) into an EBC transmit buffer and then

tell the EBC to transmit the message. When this request is made, the EBC

will arbitrate for control of the bus in order to send the message. The EBC

will notify the host that the message has been transmitted through an

external interrupt, which is used to empty the transmit queue or reset the

strategy to wait for any future transmit message command in background.

5-5

SCP INTERFACES, SCP BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

5.1.2 SCP BACKGROUND (CDAN0)

OVERVIEW

Each of the following logic blocks contain an execution timing specification

which is required for proper SCP communications. The main background loop

logic contains monitors for various state machines which control the EEC SCP

communication characteristics. This logic handles the normal

background-based communications as well as referencing those communications

which reference foreground data to be transmitted at a faster rate. Another

type of communication are those messages which are transmitted upon EEC

initialization, called the Initial Message Set. Function Read registers, if

defined, are updated in this specification as well.

The initial message set is a set of messages which are transmitted shortly

after key-on, or after a crank-run transition of the ignition key. These

messages describe the module's current state to the network. The messages

are queued at 6 +/-2 msec intervals. This process is enabled by the flag:

SCP\_ENA\_IMS.

THE INITIAL MESSAGE SET IS TRANSMITTED ONLY ONCE DURING NETWORK

INITIALIZATION. THERE IS NO RE-QUEUEING STRATEGY FOR ANY TYPE

ERROR DURING IMS EXECUTION.

All SCP messages and function reads are identified in separate message

modules. The strategy module controling the message transmits is called

SCP\_MSG\_CONTROL\_pp\_COMx (where pp is a specific strategy path reference).

DEFINITIONS

Registers:

- DLOAD\_EXEC\_KEY = Command Key byte to enable execution of a download

program.

- DLOAD\_PROG\_STRT = Address at which to begin execution of a download

program.

- ODU\_UP\_TMR = Timer used to indicate the Offboard Diagnostic Unit is

on-line. (incrementing timer, msec).

- PUTMR = Time since last power-up, sec.

- SCP\_DIAG\_ST = State register for the On-demand test scheduler.

- SCP\_DWNLD\_ST = Current level of Download and Execute State Machine.

- SCP\_TMR = SCP network initialization timer, msec.

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SCP INTERFACES, SCP BACKGROUND - CDAN2

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Bit Flags:

- A\_RATE\_ENA = Flag set when SCP Packets are requested at Type 'A' rate.

- CRKFLG = Crank flag; 1 -> in crank mode.

- DEMAND\_MODE = Flag set when an On-Demand selt test mode is active.

- NO\_FUEL\_SCP = SCP logic indicates that injectors should be disabled

(Latched bit); 1 -> DO NOT deliver any fuel to engine.

- ODU\_UP\_STATE = Flag set to indicate status of ODU tester; 1 -> active.

- RESULTS = Flag set when an On-Demand test has executed successfully.

- SCP\_ENA\_IMS = Flag to enable transmit of the PCM Initial Message Set upon

- SCP\_UP = Flag to indicate the EBC chip has been successfully initialized.

- UNDSP = Underspeed Flag; 1 -> in underspeed mode.

- KAM\_ERROR = KAM error flag; 1 -> KAM data invalid.

Calibration Constants:

- ODU\_TIMEOUT = Time-out value for certain offboard diagnostic routines.

- SCP\_DT1 = Time delay to begin transmitting SCP network initial message

set.

- SCP\_DT2 = Time delay to stop transmitting SCP network initial message

set, begin transmitting SCP status requests, and to begin sending normal

broadcast messages.

- SCP\_IT1 = Time to which SCP\_TMR is set upon initialization, to ensure

that the PCM is synchronized with the rest of the network modules.

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SCP INTERFACES, SCP BACKGROUND - CDAN2

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PROCESS

STRATEGY MODULE: SCP\_BKGND\_COM1

;parameter\_definitions

The following assignments define key parameter logicals which are

referenced throughout this chapter. They are not necessarily intended

to be executable.

unconditionally ------------------------| dwnld\_not\_ready = 0

(Definitions used for SCP\_DWNLD\_ST | dwnld\_entrd = 1

documentation purposes only) | dwnld\_data = 2

| execute\_ready = 3

| dwnld\_&\_execute = 4

|

(Definitions used for SCP\_DIAG\_ST | initial\_state = 0

documentation purposes only) | no\_results\_avail = 1

| test\_running = 2

| results\_avail = 3

;kam\_init\_scp

Execute Every Background Loop.

Clear EBC RAM area when a reset of KAM is detected.

KAM\_ERROR = 1 --------------------------| Clear EBC User RAM

| address location 3F

;ram\_init\_scp

Execute only once upon RAM initialization.

unconditionally ------------------------| SCP\_TMR := SCP\_IT1

| ; synchronize time with network

|

| ODU\_UP\_TMR := 31.875

| ; ensure that heartbeat is sent

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SCP INTERFACES, SCP BACKGROUND - CDAN2

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;scp\_background\_logic

Execute Every Background Loop.

SCP\_UP = 0 -----------------------------| SCP\_DWNLD\_ST = 0

(EBC not up) | SCP\_DIAG\_ST = 0

| (reset state machines)

| A\_RATE\_ENA = 0

| (disable repetitive transmissions)

|

| SCP\_ENA\_IMS = 0

|

| Do: INITIALIZE\_EBC

| (detailed in SCP\_INIT module)

|

| --- ELSE ---

|

SCP\_TMR < SCP\_DT1 ----------------------| SCP\_ENA\_IMS = 0

(receive-only mode) |

| Do: UPDATE\_FUNCTION\_READS

| (detailed in MSG\_CONTROL module)

|

| --- ELSE ---

|

SCP\_TMR < SCP\_DT2 ----------------------| SCP\_ENA\_IMS = 1

(send initial messages) | (enable Initial Message Set)

|

| Do: UPDATE\_FUNCTION\_READS

| (detailed in MSG\_CONTROL module)

|

| --- ELSE ---

|

| ;Begin Normal Network Activity

|

| SCP\_ENA\_IMS = 0

|

| Do: SEND\_STATUS\_REQUESTS

| Do: UPDATE\_FUNCTION\_READS

| Do: TRANSMIT\_VEHICLE\_MESSAGES

| (detailed in MSG\_CONTROL module)

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SCP INTERFACES, SCP BACKGROUND - CDAN2

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;Empty\_MBFIFO

Execute Every Background Loop

SCP Receive Message Routine

SCP\_UP = 1 -----------------------------| Read FSTAT/MBFIFO to check for

| any messages\_waiting.

if message\_waiting ---------------------| Empty buffer and perform

| appropriate individual

| "Receive Message" operations.

| (See individual message logic)

;reset\_state\_machines

Execute Every Background Loop

The following logic determines if the EEC will allow

access to its Download State or for Rapid Data Transfer.

ODU\_UP\_TMR <= ODU\_TIMEOUT --------------| ODU\_UP\_STATE = 1

(ODU connection is active) |

| --- ELSE ---

|

| ODU\_UP\_STATE = 0

| SCP\_DWNLD\_ST = 0

| A\_RATE\_ENA = 0

| (disable repetitive transmissions)

;state\_machine\_servicing

Execute Every Background Loop

PUTMR <= 4 -----------------------------| SCP\_DIAG\_ST = initial\_state

(Upon EEC power-up...) | SCP\_DWNLD\_ST = dwnld\_not\_ready

| (Initialize state registers to 0)

|

| --- ELSE ---

|

DEMAND\_MODE = 1 ------------------------| SCP\_DIAG\_ST = test\_running

(When OBDII Exec sets this flag...) | (An On-Demand test is running; 2)

|

| --- ELSE ---

|

RESULTS = 1 ----------------------------| SCP\_DIAG\_ST = results\_avail

(When OBDII Exec sets this flag...) | (A test executed successfully; 3)

|

| --- ELSE ---

|

| SCP\_DIAG\_ST = no\_results\_avail

| (A test aborted, or wasn't run; 1)

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SCP INTERFACES, SCP BACKGROUND - CDAN2

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;jump\_to\_dwnld\_routine\_logic

Execute Every Background Loop

The following two logic blocks determine if a Downloaded Program

is to be executed and, if so, which mode of execution is selected.

THESE TWO EXECUTION MODES ARE MUTUALLY EXCLUSIVE.

SCP\_DWNLD\_ST >= execute\_ready (3)-|

|

ODU\_UP\_STATE = 1 -----------------|AND -| Execute routine at RAM address:

| | DLOAD\_PROG\_STRT with the Normal

DLOAD\_EXEC\_KEY = 8002h -----------| | Background List enabled.

This logic will truncate the EEC-V background sequence to merely execute SCP

and whatever Foreground necessary to keep out of HLOS mode. The parameter

NO\_FUEL\_SCP is serviced only within the SCP logic and thus cannot be

overwritten by any other portion of the strategy. This will insure that the

injectors are disabled in the following Download and Execute mode.

SCP\_DWNLD\_ST >= execute\_ready (3)-|

|

ODU\_UP\_STATE = 1 -----------------|

|AND -| NO\_FUEL\_SCP = 1

DLOAD\_EXEC\_KEY = 8102h -----------| | (disable all injectors)

| | Execute routine at RAM

CRKFLG = 1 -----------------| | | address: DLOAD\_PROG\_STRT

|OR --| | with the SBDS Background

UNDSP = 1 ------------------| | List enabled.

|

| --- ELSE ---

|

| NO\_FUEL\_SCP = 0

| (normal injector service)

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SCP INTERFACES, SCP BACKGROUND - CDAN2

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;ebc\_lockup\_check\_logic

Execute Every Background Loop

Check for an EBC Lock-up condition.

(More than 25 msec have passed since

last message transmit without the

occurrence of any of the following

IR2 interrupts: Bits 7, 6, or 5) -----| Do: INITIALIZE\_EBC

| (reset EBC)

|

| --- ELSE ---

|

| Exit (no action)

;rapid\_packet\_logic

Execute on a Fixed Midground Interrupt

Send Type A packets as specified.

A\_RATE\_ENA = 1 -------------------------| send(REPORT\_RAPID\_PACKET)

(Packets enabled at Type 'A' rate) | (Send type 'A' packets which are

| queued for transmission - cycle

| through ALL packets, transmitting

| no more than two packets at

| intervals less then or equal to

| 12 msec).

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SCP INTERFACES, EXTERNAL INTERRUPT - CDAN2

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5.1.3 SCP EXTERNAL INTERRUPT SERVICE ROUTINE (CDAK0)

OVERVIEW

This module services the external interrupt which is generated by the EBC

chip upon completion of an SCP message transmission or upon detection of a

fault condition within the EBC. The registers and commands referenced in

lower case in this logic are EBC-specific and not accessible via the RCON.

This interrupt carries the same execution priority as the PIP interrupt.

If an EBC error has occurred, the status of the EBC faults would be carried

in interrupt registers IR2(b3 & b4) and IR3(b1 & b7). These registers must

be read/cleared by the Host Software. If an EBC error condition does exist,

the Host Software will reinitialize the EBC and continue on (where

applicable) to transmit the next pending message. Note that IR3 is examined

first. If an error is found through the access to IR3, then IR2 is not

tested.

If an EBC error is not indicated, the interrupt is due to a resolution of the

last message transmit attempt. A transmitted message should always result in

an EBC interrupt being raised, with one of the three MS bits of IR2 being

set. The Host software first determines if the message was transmitted

successfully ("Tx\_OK" flag). If so, this routine checks the Transmit Message

Descriptor Block (TMDB) for that message, which resides in software only, to

determine how to handle the SCP acknowledge byte. If the TMDB flag

"sav\_ret\_dat" is set (as in Function Read messages), the host will execute

the appropriate routine described in the TMDB (which must reset the ECR byte

to 72h). If this flag is not set, then the PCM will carry on to transmit any

awaiting messages in the internal software transmit queue.

If the interrupt is not due to any internal EBC error or due to a "Tx\_OK",

then the interrupt was probably due to either a "loss of arbitration" error

or a "transmit error" on the network. If the failure is due to a "transmit

error", then the PCM will reset the ECR register to 72h (since the last

transmit attempt may have driven the network single-ended), and carry on to

transmit any awaiting messages in the internal software transmit queue. If

the failure is due to a "loss of arbitration" error, the PCM treats it as if

it were a valid transmit attempt and carries on to transmit any awaiting

messages in the host software transmit queue. NOTE: There is no 'software

retry' message failure management logic for either loss of arbitration or

lack of acknowledgment errors. However, the Function Read Retry strategy may

be invoked in the message transmit logic in order to drive the network

single-ended if the Function Read Acknowledgement is not received.

!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

Since an interrupt can be set high while this routine is executing (without

being recognized by the host software), the appropriate interrupt registers

(IR2 and IR3) are read and cleared upon exiting this routine.

!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

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SCP INTERFACES, EXTERNAL INTERRUPT - CDAN2

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!!!! NOTE !!!!

IN ORDER TO PREVENT THE EBC FROM LOCKING UP DUE TO NOISE ON THE SCP LINK, A

CHECK IS MADE IN THE BACKGROUND (SCP\_BKGND\_COMx MODULE) TO ENSURE THAT

RESOLUTION IS OBTAINED FOR ANY TRANSMIT MESSAGE (IE. Tx\_OK, Tx\_Error, LOA).

IF MORE THAN 25 MILLISECONDS PASSES IN BETWEEN MESSAGE TRANSMIT AND RESO-

LUTION OF THE MESSAGE, THEN THE EBC IS RE-INITIALIZED AND THE TRANSMIT

ROUTINES CONTINUE WHERE THEY LEFT OFF (AFTER THE LAST TRANSMIT COMMAND).

DEFINITIONS

INPUTS

Bit Flags:

- illegal\_op = Bit 1 of IR3 in EBC chip indicating an illegal read or write

of an EBC register (reset required): NOT DISPLAYABLE.

- intrnl\_err = Bit 3 of IR2 in EBC chip indicating an internal EBC error

was detected (reset required): NOT DISPLAYABLE.

- reset\_occurd = Bit 7 of IR3 in EBC chip indicating a EBC occurred (reset

required): NOT DISPLAYABLE.

- ntwk\_dvr\_wd = Bit 4 of IR2 in EBC chip indicating a Network Driver

Watchdog Failure was detected by the EBC (reset required): NOT

DISPLAYABLE.

- sav\_ret\_dat = Bit 7 of the SCP message ACK Handler Byte (in the TMDB)

which tells the external interrupt handling routine to either save or

discard the data returned over the SCP link at the end of an

EEC-initiated message transmission: NOT DISPLAYABLE.

- tx\_ok = Bit 7 of IR2 in EBC chip indicating that the previous transmit

attempt was successfully completed: NOT DISPLAYABLE.

OUTPUTS

Registers:

- ECR = EBC Control Register (NOT DISPLAYABLE).

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SCP INTERFACES, EXTERNAL INTERRUPT - CDAN2

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PROCESS

STRATEGY MODULE: SCP\_EXTINT\_COM1

Execute the following routine ONLY when the EBC external

interrupt (INT pin) has been pulsed high.

Tests of the bits in IR2 and IR3 implies that a

read/clear command was executed on those registers.

These registers are also read/cleared

upon exit of this logic sequence.

reset\_occurd = 1 -----------------|

(Bit 7 of IR3 in EBC. NOT due |

to any Host S/W command) |

|OR --| Do: INITIALIZE\_EBC

illegal\_op = 1 -------------------| | (Reset EBC chip)

(Bit 1 of IR3 in EBC chip) | |

| | Read and Clear registers IR2 & IR3

ntwk\_drvr\_wd = 1 -----------------| |

(Bit 4 of IR2 in EBC chip) | |

| |

intrnl\_err = 1 -------------------| |

(Bit 3 of IR2 in EBC chip) |

| --- ELSE ---

tx\_ok = 1 ------------------------| |

(Bit 7 of IR2 in EBC chip) |AND -| Execute Returned Data Service

| | Logic (in message specification)

sav\_ret\_dat = 1 ------------------| |

(Bit 7 of Ack Handler Byte in TMDB) | Read and Clear registers IR2 & IR3

|

| Transmit next pending message

| (if any are queued up)

|

| --- ELSE ---

|

tx\_ok = 1 ------------------------------| Read and Clear registers IR2 & IR3

(Bit 7 of IR2 in EBC chip) |

| Transmit next pending message

| (if any are queued up)

|

| --- ELSE ---

|

| ECR := 72h

| ; Reset EBC to Differential SCP

| ; PRIOR to sending another msg.

|

| Read and Clear registers IR2 & IR3

|

| Transmit next pending message

| (if any are queued up)

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SCP INTERFACES, LOAD TRANSMIT BUFFER - CDAN2

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5.1.4 SCP MESSAGE TRANSMIT SERVICE ROUTINE (CDAK0)

OVERVIEW

This module is executed when it has been determined that a message should be

transmitted and that the SCP bus is idle.

The process executed when a message is sent is paraphrased as follows:

1) The Transmit Message Descriptor Block (TMDB) offset is obtained from the

host software message transmit queue, which will locate the TMDB in EEC-V

ROM. The TMDB describes message content and characteristics.

2) Begin TMDB processing to assemble and load the appropriate message bytes

into the transmit buffer on the EBC chip. During this process, the message

type is obtained from the TMDB PRI/TYP byte. If the message is a function

read, a process (UPDATE\_FRECR) is called to service the the ECR register

prior to actually transmitting the message. This process will ensure that

the software retry strategy for function reads (which drives the SCP first

differential, then Single-ended on the A Bus, then Single-ended on the B Bus)

is executed for the correct message. If the message is not a function read,

then the UPDATE\_FRECR process is not called.

3) Finally, when the message is completely loaded into the EBC Chip transmit

buffer, the message transmit command is issued via the ACB/DBR registers in

the EBC chip.

DEFINITIONS

INPUTS

Bit Flags:

- FRECR = Commanded ECR register state for a Function Read message

transmit.

OUTPUTS

Bit Flags:

- ECR = EBC Control Register (NOT DISPLAYABLE).

- FRECR = See above.

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SCP INTERFACES, LOAD TRANSMIT BUFFER - CDAN2

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PROCESS

STRATEGY MODULE: SCP\_LOAD\_TX\_BUFFER\_COM1

Execute the following routine when it has been determined that a

message should be sent and that the SCP Bus is in an idle state.

unconditionally ------------------------| Get TMDB data to control loading

| of message bytes into the

| EBC Transmit buffer.

TMDB msg Type nibble = 3h --------------| ; SCP bus driver configuration.

(Function Read message) | Do: UPDATE\_FRECR

(Obtained from PRI/TYP byte in TMDB) | ECR := FRECR

unconditionally ------------------------| Complete loading of message bytes

| from TMDB into the EBC Transmit

| buffer.

BEGIN: UPDATE\_FRECR

PRIVATE process called only when a Function Read is to be transmitted.

FRECR = 72h ----------------------------| FRECR := 52h

; Last try was Differential | ; Next try is on Bus 'A' only

|

| --- ELSE ---

|

|

FRECR = 52h ----------------------------| FRECR := 32h

; Last try was Single-ended 'A' Bus | ; Next try is on Bus 'B' only

|

| --- ELSE ---

|

| FRECR := 72h

| ; Default to Differential

END: UPDATE\_FRECR

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SCP INTERFACES, SCP MESSAGE CONTROL - CDAN2

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5.1.5 SCP MESSAGE CONTROL (CDAN0)

OVERVIEW

SCP Message List Summary

The table below outlines the messages which are serviced by the PCM on the

SCP Network. Additional information is supplied to describe the Function

Read Data Registers, which are refreshed each background loop by the host

software. Function Read messages can be accessed by any other node on the

bus and require no direct host intervention.

The details of each message are specified on the following pages, which are

referenced by the message name provided in the table below. Each message

specification includes a routine reference to identify the conditions upon

which to send the EEC-initiated transmit messages, and to identify the

modules affected by any received messages.

The "Targ Spec" column indicates the value of the generic function code or

node address, depending on whether the message is functionally or physically

addressed. The "Spec Func" column indicates either a secondary function code

or data which is required to further define the message. The "Num Data"

column indicates how many data bytes are included in the message; the count

includes the byte from the Spec Func column, if used.

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SCP INTERFACES, SCP MESSAGE CONTROL - CDAN2

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Message Targ Spec Num

Type Spec Func Data Message Name Description

---------------------------------------------------------------------------

MESSAGES - Module Receiving:

Broadcast 6Ah xxh yy PROCESS\_OBDII\_REQUEST (Req J1979 data/action)

Broadcast 54h var 2 RX\_PT\_STAT\_RQST (Stat. Req. From SCP to EEC)

Broadcast 93h C1h 1 REQUEST\_SECURITY\_STATUS (PATS status request)

Node-Node 10h 2Ch yy DEFINE\_RAPID\_PACKET (Rapid data transfer block)

Node-Node 10h 31h yy DIAGNOSTIC\_ROUTINE\_ENTRY (Request Self Test)

Node-Node 10h 32h 3 DIAGNOSTIC\_ROUTINE\_EXIT (Exit/Abort Self Test)

Node-Node 10h 34h 7 DOWNLOAD\_ROUTINE\_ENTRY (Enter Program Rcv Mode)

Node-Node 10h 37h 2 DOWNLOAD\_ROUTINE\_EXIT (Stop Downloading Data)

Node-Node 10h 36h yy DOWNLOAD\_BLOCK\_DATA (Block Data Transfer Mes'g)

Node-Node 10h B1h yy EXECUTE\_ROUTINE (Specific Execute Routine Mode)

Node-Node 10h other yy MODE\_NOT\_SUPPORTED (Any other node-node mode)

Node-Node 10h 13h 1 REQUEST\_ALL\_CODES (All Set & Pending DTC's)

Node-Node 10h 25h 1 REQUEST\_ALL\_DATA\_STOP (Stop Repetitive Data)

Node-Node 10h 14h yy REQUEST\_CLEAR\_CODES (Clear All DTC's)

Node-Node 10h 33h 2 REQUEST\_DIAG\_RESULTS (On-Demand test codes)

Node-Node 10h 23h yy REQUEST\_DMR\_ACCESS (One Request/One Respns DMR)

Node-Node 10h 03h 1 REQUEST\_MIL\_CODES (Legislated Codes request)

Node-Node 10h 22h yy REQUEST\_PID\_ACCESS (One Request/One Respns PID)

Node-Node 10h 2Ah yy REQUEST\_RAPID\_PACKET (Packet data at optl rate)

Node-Node 10h 3Fh 1 TESTER\_PRESENT (ODU heartbeat message)

----------------------------------------------------------------------------

where: xxh = J1979 request modes (01h, 02h, 03h, 04h, 06h, or 07h).

yy = Message length determined by request type (0 to 7 bytes).

var = Variable data - determined by message transmit routine.

zz = Message length determined by type of information reported.

Fxh = Node Address register of Offboard Diagnostic Unit (ODU).

other = Any other Node to Node message which is NOT listed above.

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SCP INTERFACES, SCP MESSAGE CONTROL - CDAN2

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Message Targ Spec Num

Type Spec Func Data Message Name Description

---------------------------------------------------------------------------

MESSAGES - Module Transmitting:

Func Read 97h N/A 0 ANTI\_THEFT\_STATUS (Anti-theft command message)

Broadcast 49h 10h 2 ECT\_DEG\_C (Engine Coolant Temp. in Deg. C)

Broadcast 93h var 2 ENGINE\_PAT\_STATUS (Anti-theft results for PCM)

Broadcast 6Bh 43h 7 REPORT\_OBDII\_CODES (Send CARB mil\_codes Only)

Broadcast 6Bh 47h 7 REPORT\_OBDII\_CONT\_RESULTS (Send Pending DTC's)

Broadcast 6Bh 42h zz REPORT\_OBDII\_FF\_PID (Send CARB PID Data)

Broadcast 6Bh 41h zz REPORT\_OBDII\_PID (Send CARB PID Data)

Broadcast 6Bh 44h 1 REPORT\_OBDII\_RESET (Send CARB Reset Complete)

Broadcast 6Bh 46h 7 REPORT\_OBDII\_TRIP\_RESULTS (Send Mode 06 Data)

Node-Node Fxh 54h 1 CONFIRM\_CODES\_CLEAR (Report of OBDII Reset)

Node-Node Fxh 73h 7 DIAGNOSTIC\_RESULTS (Send On-Demand Codes)

Node-Node Fxh 7Fh 6 GENERAL\_RESPONSE (Generic Accept or Reject)

Node-Node Fxh 53h 7 REPORT\_ALL\_CODES (Send all Set & Pending DTC's)

Node-Node Fxh 63h zz REPORT\_DMR\_DATA (Send single response DMR data)

Node-Node Fxh 43h 7 REPORT\_MIL\_CODES (Send CARB mil\_codes Only)

Node-Node Fxh 62h zz REPORT\_PID\_DATA (Send single response PID data)

Node-Node Fxh 6Ah zz REPORT\_RAPID\_PACKET (Send Packet data requestd)

----------------------------------------------------------------------------

where: xxh = J1979 request modes (01h, 02h, 03h, 04h, 06h, or 07h).

yy = Message length determined by request type (0 to 7 bytes).

var = Variable data - determined by message transmit routine.

zz = Message length determined by type of information reported.

Fxh = Node Address register of Offboard Diagnostic Unit (ODU).

other = Any other Node to Node message which is NOT listed above.

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SCP INTERFACES, SCP MESSAGE CONTROL - CDAN2

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INITIAL MESSAGE SET:

The transmission of IMS messages is controlled by the flag

SCP\_ENA\_IMS, which is set in the module SCP\_BKGND\_COMx.

Other logic blocks are also allowed to send these messages:

ECT\_DEG\_C

FUNCTION READ MESSAGE TABLE:

Genr

Func Message Name Description

------------------------------------------------------------------

29h vsbar\_kph (EEC Calculated VS in Kph)

------------------------------------------------------------------

DEFINITIONS

Registers:

- SCP\_ECT\_TMR = Free running timer used to record interval elapsed between

two consecutive ECT\_DEG\_C messages.

- FR\_97\_COUNT = Register indicating type of bus utilization for FR of SCP

ANTI\_THEFT\_STATUS message.

Bit Flags:

- KAM\_ERROR = Indicates Keep Alive RAM invalid.

- OBDII\_RESET = Flag which represents the receipt of an OBD-II scan tool

reset message.

- PAT\_FAULT = Flag indicating the SCP link between the PATS and PCM is bad.

- VSFMFLG = Vehicle speed sensor (FMEM) flag, 1 = sensor failed.

- SCP\_ENA\_IMS = SCP Initial Message Set enable flag.

- SEND\_ECT = Broadcast periodic ECT (deg. C) message on SCP; 1 -> active.

Calibration Constants:

- ECT\_TIME = Time threshold to broadcast ECT\_DEG\_C message.

- SEND\_ECT\_SW = Broadcast ECT message at fixed periodic rate; 1 -> enabled.

This constant should be calibrated to 1 only for vehicles with the EATC

(Electr. Automatic Temp. Control) module.

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SCP INTERFACES, SCP MESSAGE CONTROL - CDAN2

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PROCESS

STRATEGY MODULE: SCP\_MSG\_CONTROL\_V6\_COM1

; network\_ims

Execute the following logic once during network initialization.

Broadcast the Initial Message Set messages only ONCE.

(No re-queueing or SCP fault strategies are enabled).

SCP\_ENA\_IMS = 1 ------------------------| send(ECT\_DEG\_C)

(Initial Message Set enabled)

;reset\_scp\_data

Execute the following logic once per background loop.

Logic to reset diagnostic parameters due to Offboard Tool command.

OBDII\_RESET = 1 ------------------|

;full diagnostic reset requested |OR --| PAT\_FAULT := 0

| | FR\_97\_COUNT := 0

KAM\_ERROR = 1 --------------------|

;KAM reset was detected

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SCP INTERFACES, SCP MESSAGE CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CONFIGURE\_EBC

Functional Read Data Register's:

(Initialize function read registers to FF => invalid data)

FRDR1 = FFh

Function Read Message Lookup Table:

(Set up to recognize function read messages)

Generic Function Code Reference Message

--------------------------------------------------------------------

29h vsbar\_kph

--------------------------------------------------------------------

Functional Message Lookup Table:

(Set up to recognize incoming Functional messages)

Generic Function Code Reference Message

--------------------------------------------------------------------

6Ah PROCESS\_OBDII\_REQUEST

54h RX\_PT\_STAT\_RQST

93h REQUEST\_SECURITY\_STATUS

Other EBC Registers:

UIMR = FFh; (User Input Mask Register)

RCR = F9h; (Receiver Control Register)

ECR = 72h; (EBC Control Register)

UIMR : Mask out PIP and overvoltage interrupts (Hardware Default

- Software overwrite not necessary).

RCR : Mask out - RCV OK, RCV Error, RCV Overrun, Unable to ACK,

Network Activity and Network Fault Interrupts.

Disable - RCV Node-Node only and Loopback Modes.

ECR : Enable - Network Drivers A & B at 41.6 KBaud

and Never Sleep Mode.

Disable - Sleep Mode operation and Test Mode Key.

END: CONFIGURE\_EBC

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SCP INTERFACES, SCP MESSAGE CONTROL - CDAN2

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BEGIN: UPDATE\_FUNCTION\_READS

Provide Vehicle Speed (in Kph) in a Function Read.

VSFMFLG = 1 -----------------------| vsbar\_kph = FFh

(VS sensor failed) | load vsbar\_kph in FR register

|

| --- ELSE ---

|

| vsbar\_kph = min((1.60934 \* VSBAR),254)

| load vsbar\_kph in FR register

| (Range: 0 - 254 kph => 00 - FE hex)

| (Res: 1 kph per bit)

| (FF hex => Invalid vsbar\_kph data)

END: UPDATE\_FUNCTION\_READS

BEGIN: TRANSMIT\_VEHICLE\_MESSAGE

ECT\_DEG\_C broadcast command logic. Note that SEND\_ECT is set

via Status Request for the ECT\_DEG\_C message. ECT\_TIME is a

calibratable constant which should be set between 1-5 seconds.

SEND\_ECT = 1 -----------------|

;SR for ECT\_DEG\_C Broadcast |

|OR --|

SEND\_ECT\_SW = 1 --------------| |

;Fixed time broadcast enable |

|AND -| send(ECT\_DEG\_C)

| | SCP\_ECT\_TMR := 0

SCP\_ECT\_TMR >= ECT\_TIME ------------| | ;reset the timer

;At least ECT\_TIMR expired since

;the last ECT\_DEG\_C message transmit

;attempt

END: TRANSMIT\_VEHICLE\_MESSAGES

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SCP INTERFACES, EBC INITIALIZATION - CDAN2

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5.1.6 EBC INITIALIZATION (CDAJ0)

OVERVIEW

This module contains the initialization procedure for EEC/EBC power-up and

EBC software reset. Chip configuration is executed after all time delays

have elapsed.

DEFINITIONS

INPUTS

Registers:

- CIR = EBC Configuration Identifier Register (NOT DISPLAYABLE).

- NAR = EBC Node Address Register (NOT DISPLAYABLE).

OUTPUTS

Registers:

- ECR = EBC Control Register (NOT DISPLAYABLE).

- NAR = See above (NOT DISPLAYABLE).

Bit Flags:

- SCP\_UP = Flag to indicate the EBC chip has been successfully initialized.

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SCP INTERFACES, EBC INITIALIZATION - CDAN2

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PROCESS

STRATEGY MODULE: SCP\_INIT\_COM2

BEGIN: INITIALIZE\_EBC

;This logic block is called from the SCP\_BKGND module upon power up init.

;It may also be called from the SCP\_EXTINT module upon recognition of the

;appropriate interrupt bit being set in the EBC.

;It may also be called from the module which commands an EBC reset as a

;failsafe in case the chip should become "locked-up" during a transmit.

unconditionally ------------------------| ECR = 80h; (reset EBC)

| read CIR

CIR <> 02h -----------------------------| EXIT; (no action)

(wrong CIR value) |

| --- ELSE ---

|

| NAR = 10h

| read NAR

NAR <> 10h -----------------------------| EXIT; (no action)

(wrong NAR value) |

| --- ELSE ---

|

| Do: CONFIGURE\_EBC

| (in MSG\_CONTROL module)

|

| SCP\_UP = 1

END: INITIALIZE\_EBC

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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OVERVIEW

Note that the node to node communications strategy assumes that only one

Offboard Diagnostic Unit (ODU) will be connected to the network and

requesting diagnosic data at any given time.

5.1.7 SIGNIFICANT FEATURES OF SCP OBDII DIAGNOSTICS (CDAM0)

-------------------------------------------------

PIDs and DMR Data Retrieval & SAE Required Communications

A) Data retrieval; supported by either the Parameter Identifier (PID)

method, or via a Direct Memory Request (DMR). The PID is a unique,

two-byte, hex number assigned to a particular parameter. It is used with

parameters which are frequently referenced. A list of the PIDs supported

by this strategy is included in the SCP chapter. The DMR is a request for

the contents of an EEC memory address location.

When data is requested by DMR, a three byte reference is sent on SCP. The

Upper byte controls whether the address requested is ROM data (01h for

Bank 1 or 08h for Bank 8), or RAM data (00h). In any case, the response

message will include the contents of the requested address plus the

following three memory locations. PID and DMR data can ONLY be reported

as a single response. PID data can only be in the form of a byte, a word,

or a double-word, as referenced in the tables.

Support of the Emission-related messages required by the SAE Recommended

Practice "J1979 E/E Diagnostic Test Modes" includes: Single PID requests

for EEC performance data; PID requests for regulated Freeze Frame data;

Diagnostic Trouble Codes (DTCs) which illuminate the MIL; Clearing of

DTCs, and; Monitoring of the OBDII Oxygen sensor(s). These messages are

typically used by the OBDII generic Scan Tool via a Broadcast type

message, however some can be referenced physically from the SBDS tools.

NOTE THAT THE J1979 PIDS ARE NOT INTENDED FOR SERVICE BY ANY REPETITIVE

DATA TRANSMISSION SPECIFICATION. A breakdown of the EEC service of PID

and DMR data requests is presented on the following page.

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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SIGNIFICANT FEATURES OF THE SCP MODULE (continued)

------------------------------------------------------

DATA FORMATS FOR VARIOUS PID/DMR REQUEST & RESPONSE MESSAGES

OBDII SCAN TOOL ALL OTHER NODES

Data Type Must be Broadcast Broadcast or Node-Node

------------------------------------------------------------------------

J1979 PID data SINGLE REQ/RESP SINGLE REQ/RESP

(Only Low Byte (Low Byte of PID precedes (Two Byte PID number precedes

of PID req'd) data in returned message) data in returned message)

------------------------------------------------------------------------

SBDS PID data N/A SINGLE REQ/RESP

(Two Byte PID (Two Byte PID number precedes

no. required) data in returned message)

-OR-

REPETITIVE PACKET

(Only data returned in Packet)

------------------------------------------------------------------------

SBDS DMR data N/A SINGLE REQ/RESP

(Three Byte DMR (DMR memory address precedes FOUR

address required) contiguous bytes of data beginning

with requested address in returned

message)

-OR-

REPETITIVE PACKET

(Single byte of data returned in

Packeted data message)

------------------------------------------------------------------------

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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SIGNIFICANT FEATURES OF THE SCP MODULE (continued)

------------------------------------------------------

On-Demand Test Support

B) Support of On-Demand tests which are built into the EEC include:

the Engine Off sequence; the Engine Running sequence, and; the

Output Test Mode. These features will allow a quick powertrain

diagnosis of any emission and non-emission related problems, etc.

Part of the On-Demand test sequence is the retrieving of any DTCs

which may have been sent during the test.

The set trouble codes will remain in EEC memory until the next engine

warm-up, or until the next On-Demand test is initiated by the ODU.

However, these codes will only be transmitted once over SCP.

Further definition of the On-Demand state machine is presented in the

figure: ON-DEMAND TEST STATE MACHINE. In this figure, note that the

SCP messages are shown in UPPERCASE text. In some cases, to conserve

space, the message names were abbreviated.

The ODU will always follow the same general on-demand sequence...

ODU sends: EEC responds:

DIAGNOSTIC\_ROUTINE\_ENTRY

if entry conditions are met .. GENERAL\_RESPONSE <affirmative>

if not ....................... GENERAL\_RESPONSE <sequence error>

DIAGNOSTIC\_ROUTINE\_EXIT

<exit if complete>

if test completed normally ... GENERAL\_RESPONSE <normal w/results>

if test aborted .............. GENERAL\_RESPONSE <abnormal w/o results>

if test still running ........ GENERAL\_RESPONSE <busy repeat request>

-OR-

<abort test>

if test still running ........ GENERAL\_RESPONSE <abnormal w/o results>

if test not running .......... GENERAL\_RESPONSE <sequence error>

REQUEST\_PID\_ACCESS REPORT\_PID\_DATA

(number of DTC's requested) ... (OD\_CODE\_CNT returned)

REQUEST\_DIAG\_RESULTS

if test exited normally ...... DIAGNOSTIC\_RESULTS (send codes once only)

if not ....................... GENERAL\_RESPONSE <sequence error>

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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KEY: <- = incoming message

-> = outgoing message

ON-DEMAND TEST STATE MACHINE

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

.REQUEST\_DIAG\_RESULTS <- OR .power up OR

.DIAG\_ROUTINE\_EXIT +-------------0 .OBDII\_RESET=1

(abort) <- OR +-->|initial\_state|<--------- --------------

.DIAG\_ROUTINE\_EXIT | +-+----+------+ .RESULTS=0

(if complete) <- OR | | | .DEMAND\_MODE=0

.DIAG\_ROUTINE\_ENTRY <- +-----+ |

------------------------- |PUTMR>4 seconds

.GENERAL\_RESPONSE |

(seq error) -> | .DIAG\_ROUTINE\_EXIT <-

+----+ | +----+ ------------------

| | | | | .GENERAL\_RESPONSE ->

.REQ\_DIAG\_RESULTS<- OR | +-+-------V--------+-+ | (abnormal w/o results)

.[.test NOT ready & +->| TEST NOT RUNNING |<-+

.DIAG\_ROUTINE\_ENTRY] <- | no\_results\_avail |<------------------------+

----------------------- 1----A-----A--+------+ .REQ\_DIAG\_RESULTS <- |

.GENERAL\_RESPONSE | | | --------------------- |

(seq error) -> | | | .DIAGNOSTIC\_RESULTS -> |

| | | .RESULTS=0 |

| | | |

| | | .test ready & |

+-------------------------------+ | | .DIAG\_ROUTINE\_ENTRY <- |

|.DIAG\_ROUTINE\_EXIT | | ---------------------- |

| (abort; not OTM) <- | | .GENERAL\_RESPONSE |

| ------------------- | | (affirmative) -> |

|.GENERAL\_RESPONSE -> .test NOT ready| | .enable self test |

| (abnrml w/o rslts) ---------------| | .RESULTS=0 |

|.disable test .disable test | | .DEMAND\_MODE=1 |

|.DEMAND\_MODE=0 .DEMAND\_MODE=0 | | |

+---------------------------------+ | | |

| | | |

.DIAG\_ROUTINE\_ENTRY<- OR +-----+ | | | +-----+ .DIAG\_ROUTINE\_EXIT |

.DIAG\_ROUTINE\_EXIT | | | | | | | (if complete) <- |

(wrong test) <- OR | +-+-+---+--V--+-+ | -------------- |

.REQ\_DIAG\_RESULTS <- +-->| test\_running |<--+ .GENERAL\_RESPONSE |

--------------------- 2-+------+------+ (busy repeat req) -> |

.GENERAL\_RESPONSE | | |

(sequence error) -> | | |

| |.test\_MON=1 |

.DIAG\_ROUTINE\_EXIT | |-------------- |

(exit or abort OTM) <- | |.disable test |

------------------------ | |.RESULTS=1 |

.GENERAL\_RESPONSE -> | |.DEMAND\_MODE=0 |

(normal w/results) +-----V------V-------+ |

.disable test | TEST NOT RUNNING |--------------------------+

.DEMAND\_MODE=0 | results\_avail |------------------+

.RESULTS=1 3----A----+--------A-+ |

| | | |

.[.test NOT ready & +----+ +--------------------+

.DIAG\_ROUTINE\_ENTRY] <- OR .DIAG\_ROUTINE\_EXIT <-

.REQ\_DIAG\_RESULTS (wrong test) <- ------------------

------------------------------- .GENERAL\_RESPONSE

.GENERAL\_RESPONSE (sequence error) -> (normal exit with results) ->

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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Diagnostic Trouble Code Reporting

C) Retrieval of DTCs other than emission-related codes is supported.

However, the EEC will not report more than one list of codes at any one

point in time.

ODU Heartbeat Message

D) The TESTER\_PRESENT message is relied upon as a time-out feature,

indicating that the ODU has gone off-line. If the ODU timer ever reaches

a calibratable time delay during a diagnostic process, certain offboard

communications will be terminated. The typical update rate for this

message is every 3 to 5 seconds. NOTE: If the EEC has been placed in the

Security Access state (as part of Output Substitution), the

SECURITY\_REQUEST message which is used to transmit the 'KEY' can take the

place of the 'heartbeat' requirement. Both the TESTER\_PRESENT and a valid

ODU 'KEY' transmission will clear the ODU\_UP\_TMR timer.

Rapid Data Transfer

E) A method of reporting a combination of PID and DMR data in the same

message (called Rapid Data Transfer) is supported through the use of

definable Rapid Packets. A Packet is a message which is defined by the

ODU through a dynamic process described below. The process begins by the

ODU requesting to define a Rapid Packet. Since only one portion of a

rapid packet can be defined at a time, several DEFINE\_RAPID\_PACKET

messages are required to describe the contents of a full

REPORT\_RAPID\_PACKET message.

Each definition message identifies the position of a specific parameter

within the data packet. There are five byte positions dedicated to

conveying parameter information in the report message.

Parameters in the packet definition message may be identified by PID

number or DMR. This allows a data packet to include mixed parameter

definition types. Definition by PID Offset is NOT supported. ROM

parameters cannot be defined by DMR - only RAM parameters are allowed.

The DEFINE\_RAPID\_PACKET message is variable in length. The reported

message REPORT\_RAPID\_PACKET is fixed at seven (7) data bytes.

The following guidelines are set for the definition and transmission of

data with rapid packets on the SCP network:

1) UP TO FIFTEEN PACKETS ARE AVAILABLE FOR DEFINITION/TRANSMISSION.

The packet definition messages define packets, to be referenced as

an EEC RAM array. This array is to be part of a 200 Byte ODU SBDS

RAM area which is also available for program download/execution.

The RAM array is referenced as SCP\_PACKET[i,j] (where i = packet

number 1-15, and j = data position 1-5 for each packet). A TOTAL OF

75 BYTES OF DATA ARE AVAILABLE THROUGH RAPID PACKETS.

2) Each packet response message contains a unique SEVEN byte string

consisting of a pre-defined mode number byte (6A hex), a packet

number byte (01h to 0Fh), plus 5 bytes of data (or 00h) as defined

via the packet definition process. A request for an undefined

packet will result in a 00h filled response message.

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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SIGNIFICANT FEATURES OF THE SCP MODULE (continued)

------------------------------------------------------

Rapid Data Transfer (continued)

3) Data within a packet will be sent in the exact order in which it

was specified. In the event the ODU requests data beyond 5 bytes in

a given packet, the EEC will truncate the data to 5 bytes. This

means that the data will NOT be wrapped to another packet.

4) A Single rate is available to the user to send packets. This

rate is FIXED in E-EEC memory. In order to maintain the kind of

packet to be sent, a symbolic 'queue' is utilized in this chapter.

The second data byte (scp\_data\_2) of the Packet Request Message

defines the rate at which to send that group of packets. A rate of

00h will temporarily disable repetitive transmission for a group of

packets. A rate of 01h or 02h will result in a GENERAL\_RESPONSE

message stating that the requested update rate is not supported. A

rate of 04h will result in the requested packets to be transmitted

at a Type 'A' update rate.

Note: For backward compatiblity, requests for rate 03h and 04h will

both be supported by the Type 'A' response.

5) Type 'A' rate reporting will cycle through the list of requested

packets, transmitting two packets every 10 +/- 2 milliseconds.

There may exist packets which have been defined, but not requested

for repetitive transmission. The E-EEC will only transmit those

packets which are requested via the REQUEST\_RAPID\_PACKET message.

6) To stop a single Packet from transmitting, the

REQUEST\_RAPID\_PACKET message is sent for that Packet with a

transmission rate of 00h. The REQUEST\_ALL\_DATA\_STOP message is

required in order to stop all Packet repetitive data transmissions.

SCP Network Bandwidth Considerations

F) The EESE group has indicated that the SCP network traffic should not

exceed 40% of the databus bandwidth during diagnostic communications. It

is left to the OFFBOARD UNIT to see that the SCP databus is not overloaded

and that the vehicle performance is not affected by the diagnostic tests.

Bus loading beyond 40% bandwidth may cause increasing message latency.

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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SIGNIFICANT FEATURES OF THE SCP MODULE (continued)

------------------------------------------------------

Downloading and Executing a RAM Program

G) A facility to download data and diagnostic routines to EEC RAM is

provided to improve vehicle serviceability. The routine will allow

download to RAM registers ONLY. There are currently no boundary checks to

limit the download to the 200 Byte SBDS RAM area; however, such a feature

could be incorporated into future releases of this strategy.

The download sequence is designed around a finite state machine which

requires a distinct order of execution to successfully store a program to

EEC RAM and execute it. If this execution sequence is not met, a

GENERAL\_RESPONSE message will be sent informing the user of the error.

The EEC will have two types of download program execution which must be

specified with the message requesting the program execution; one maintains

the normal background routine executions sequence, while the other spawns

a separate SBDS background sequence. The latter consists primarily of the

SCP interfacing software and the downloaded program itself. This type of

program can ONLY be executed while the engine is in CRANK or UNDERSPEED

Modes.

The process of downloading and executing RAM programs is shown in the

DOWNLOAD & EXECUTE STATE MACHINE, but generally follows this sequence:

(Initialize SCP\_DWNLD\_ST to zero, state=0)

ODU sends: EEC responds:

DOWNLOAD\_ROUTINE\_ENTRY GENERAL\_RESPONSE (set state=1)

(START ADDRESS & Byte COUNT) (Good data & PUTMR>4: affirmative)

DOWNLOAD\_BLOCK\_DATA No response required (state=2)

(repeat as necessary)

DOWNLOAD\_ROUTINE\_EXIT GENERAL\_RESPONSE (set state=3)

(when data is complete) (normal exit if COUNT = 0)

(abnormal exit if COUNT <> 0)

EXECUTE\_ROUTINE GENERAL\_RESPONSE (state=3)

(xqt at address and with (affirmative)

background execute sequence) begin execution at address

Routine termination via Key No response required.

Off or via program.

IN ORDER TO MAINTAIN EXECUTION OF A DOWNLOADED ROUTINE,

THE OFFBOARD TESTER MUST EITHER SERVICE THE ODU\_UP\_TMR OR

PERIODICALLY SEND THE TESTER\_PRESENT MESSAGE (3-5 sec).

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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DOWNLOAD & EXECUTE STATE MACHINE

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

KEY: <- = incoming message

-> = outgoing message

+-----+

.DWNLD\_BLOCK\_DATA <- OR | |

.DWNLD\_ROUTINE\_EXIT <- OR | +-+--------------------+

.EXECUTE\_ROUTINE <- +-->| download\_not\_ready |<------- .power up

------------------- | State = 0 |

.GENERAL\_RESPONSE +---A--+---------------+

(sequence error) -> | | .PUTMR>4 seconds AND

| | .DOWNLOAD\_ROUTINE\_ENTRY <-

| | .Start Address

.DOWNLOAD\_ROUTINE\_EXIT <- | | .Byte Count

------------------------- | | --------------------

.GENERAL\_RESPONSE | | .GENERAL\_RESPONSE

(affirmative) -> | | (affirmative) ->

| |

| |

.DWNLD\_ROUTINE\_ENTRY <- OR | |

.EXECUTE\_ROUTINE <- +-------+--V---------+

-------------------- | download\_entered |

.GENERAL\_RESPONSE +-->| State = 1 |

(sequence error) -> | +-+--------+---------+

| | | .DOWNLOAD\_BLOCK\_DATA <-

+-----+ | ----------------------

| .data is downloaded

.DOWNLOAD\_BLOCK\_DATA <- |

---------------------- +-----+ | +-----+ .EXECUTE\_ROUTINE <- OR

.data is downloaded | | | | | .DWNLD\_ROUT\_ENTRY <-

| +--+------V------+-+ | ---------------------

+->| downloading\_data |<--+ .GENERAL\_RESPONSE

| State = 2 | (sequence error) ->

+---------+--------+

|

.DWNLD\_BLOCK\_DATA <- OR | .DOWNLOAD\_ROUTINE\_EXIT <-

.DWNLD\_ROUTINE\_EXIT <- | -------------------------

------------------- | .GENERAL\_RESPONSE

.GENERAL\_RESPONSE +-----+ | (affirmative) ->

(sequence error) -> | | |

| +-+---------V--------+

.EXECUTE\_ROUTINE <- +-->| execute\_ready |

------------------- +-->| State = 3 |

.GENERAL\_RESPONSE | +-+------A--+--------+

(affirmative) -> | | | |

+-----+ | | .DOWNLOAD\_ROUTINE\_ENTRY <-

| | .Start Address

.DOWNLOAD\_ROUTINE\_EXIT <- | | .Byte Count

--------------------------- | | -------------------------

.GENERAL\_RESPONSE | | .GENERAL\_RESPONSE

(affirmative) -> | | (affirmative) ->

+--------+--V--------+

.DWNLD\_ROUT\_ENTRY <- OR | download\_&\_execute |

.EXECUTE\_ROUTINE <- +-->| State = 4 |<--+ .DOWNLOAD\_BLOCK\_DATA <-

------------------- | +-+----------------+-+ | ----------------------

.GENERAL\_RESPONSE | | | | .data is downloaded

(sequence error) -> +-----+ +-----+

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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SIGNIFICANT FEATURES OF THE SCP MODULE (continued)

------------------------------------------------------

Output Substitution (Output State) Control

H) This capability allows the ODU to verify proper operation of external

output components and circuitry by isolation techiques. Direct control of

output devices can be achieved with this feature. Since substitution may

cause the EEC to operate in a manner which is unsuitable for "down-the-road"

operation, a security access routine must be successfully processed before

substitution is allowed. Additionally, the "Tester Present" message is also

required to ensure the the EEC is returned to normal before returning the

vehicle to the customer. This mode is for use by Ford authorized SBDS and

End-Of-Line service technicians only. To ensure a substitution request is

properly handled (and the request is granted or denied), it is a basic

assumption that the service technician will wait for a response from one

request before sending another request for the same channel.

There is a four layer security scheme in place to prevent inadvertent

substitution. It is extremely important that the substitution of values in

the control strategy never occurs unless the vehicle is in the service bay

and being worked on by the service technician. The security scheme has been

designed to ensure this. The implementation in the strategy has been

designed to prevent activation by any means other than through the SCP

interface with an authorized ODU.

The first layer requires an ODU to transmit a 'heartbeat' message

periodically. This tells the strategy an ODU is currently on the network and

actively communicating. NOTE: This can either be accomplished via the

TESTER\_PRESENT message, or (when in the Security Access state - See Below) a

transmission of the valid 'KEY' value via the SECURITY\_REQUEST message.

The second layer requires the ODU to request a seed (randomly generated)

value from the EEC and succesfully transform it via a proprietary

transformation algorithm. The ODU then returns the transformed value. If it

matches the internally calculated value, this layer's requirements have been

met. This ensures only authorized ODUs gain access to the OSC mode.

The third layer requires the ODU to transmit an enable mask and requested

substitution value for the channel it wishes to override. The enable mask

must match the predetermined enable mask that is coded into the EEC. This

allows for unlocking of each individual channel number in the OSC table

seperately, thus minimizing the risk that other channels get overridden when

not requested.

The final layer verifies, each background loop when the parameter is written

to, that the vehicle is in an operational state that allows the override of

the requested channel(s) and that the override value is within some

guidelines. If the override value is acceptable and the enable mask is

correct the channel's normal value will be overridden and will remain in that

state until one of the security layers is breached or the ODU changes the

value. This layer ensures that the ODU will not damage the vehicle or place

the vehicle in an unsuitable operating state.

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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Pictorially the security scheme looks something like the following:

|.ODU present

+----V---------------------+

| |

| |.key is correct |

|+---V--------------------+|

|| ||

|| |.enable mask O.K. ||

||+--V-------------------+||

||| |||

||| |.override currently|||

||| | allowed |||

||| +V--------------+ |||

||| | OSC enabled | |||

||| +---------------+ |||

||+----------------------+||

|+------------------------+|

+--------------------------+

Portions of the Output State Control feature are located in the OBDII

chapter, under the heading OBDII\_OSC\_COMx. All details concerning the

communications interface for OSC are described in this module.

The messages used to enable and control the PCM through Output State Control

are listed, in order, below. In general, this is the process used to unlock

and control the outputs of the Powertrain Control Module. However, the

process below does not necessarily cover all of the message combinations.

MESSAGING PROCESS FOR OUTPUT STATE CONTROL

1) TESTER\_PRESENT must have been issued within the last ODU\_TIMEOUT (3-5)

seconds. This requirement continues throughout the OSC process. If

the ODU 'times-out', then the OSC is halted and the PCM returns to

its normal operating mode.

2) SECURITY\_REQUEST must have been issued with an 01h identifier to

request the SEED.

3) The PCM must have a non-zero 'clock' byte from which the SEED is

generated. If not, then the ODU is informed that the PCM is 'busy'

and that it should 'repeat its request'. This is transmitted via the

GENERAL\_RESPONSE. If the 'clock' is non-zero, then the SEED is

transmitted to the ODU via SECURITY\_RESPONSE.

4) The ODU must transmit a calculated KEY value, per the proprietary

algorithm shown in this document, via the SECURITY\_REQUEST message,

with an 02h identifier in the second byte.

5) The ODU key must match the PCM-calculated eec\_key value. The message

GENERAL\_RESPONSE is used to either confirm 'access granted' or

indicate 'access denied - device secured'.

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MESSAGING PROCESS FOR OUTPUT STATE CONTROL (cont'd)

6) If 'access granted', then the ODU must transmit an OSC channel 'enable

mask' for each channel it whishes to manipulate. The channel must be

supported by the PCM and the mask must be equivalent to the ROM-coded

mask byte within the PCM. The mask is transmitted via the

EXECUTE\_ROUTINE message, with a command word of 0047h.

7) The PCM again uses GENERAL\_RESPONSE to indicate success or failure of

the EXECUTE\_ROUTINE request.

8) The OSC must then utilize the PARAMETER\_SUBSTITUTION message to

control the unlocked output channel. Once again, the channel must be

supported by the PCM. In addition, the value must be within the

bounds specified in the OBDII\_OSC\_COMx strategy chapter, or else the

PCM will clip the commanded value to the internally-specified max/min

limit. The ODU WILL NOT be notified of this clip.

9) The PCM uses GENERAL\_RESPONSE to indicate success or failure of

PARAMETER\_SUBSTITUTION requests.

10) The ODU can disable OSC for a given channel by transmitting the

PARAMETER\_SUBSTITUTION without a substitute value. It can exit OSC by

merely ceasing to transmit the TESTER\_PRESENT, or by issuing an

incorrect KEY value, via SECURITY\_REQUEST.

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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DEFINITIONS

Registers:

- CODES\_COUNT = Count of all codes with PxxxFAULT = , or PxxxSTATE > 0.

- DLOAD\_EXEC\_KEY = Command Key byte to enable execution of a download

program.

- DLOAD\_PROG\_STRT = Address at which to begin execution of a download

program.

- KAMQA = KAM Qualification test register 1.

- NUM\_CODES = Count of all MIL-codes (with PxxxFAULT = 1).

- OD\_CODE\_CNT = Count of all On-demand codes (with PxxxCNT = 0).

- ODU\_UP\_TMR = Timer used to indicate the Offboard Diagnostic Unit is

on-line. (incrementing timer, msec).

- ODU\_KEY = Key transmitted to the EEC from an ODU as part of the SCP

Security Access process.

- OSC\_ENAx = Output State Control Enable Mask, where 'x' = channel number.

- OSC\_SEED = Randomly generated Seed value transmitted to the ODU by the

EEC as part of the SCP Security Access process.

- OSC\_STATE = Output State Control state variable.

- OSC\_VALUEx = Output State Control substitution value for a given 'x'

channel.

- OUTPUT\_MODE = Level of EEC outputs to affect (in Output Test Mode only).

- PUTMR = Time since last power up (seconds).

- PxxxSTATE = State register for any given diagnostic trouble code.

- PxxxCNT = Warm-up counter register for any given diagnostic trouble code.

- SCP\_DIAG\_ST = State register for the On-demand test scheduler.

- SCP\_DWNLD\_ST = State register for the Download and Execute scheduler.

- SCP\_PACKET[] = Array of [1..15,1..5] data locations to maintain the

latest Rapid Data Packet message DATA BYTES to be sent on SCP.

- SCP\_TST\_REQ = Last On-demand test requested from ODU.

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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Bit Flags:

- A\_RATE\_ENA = Flag set when SCP Packets are requested at Type 'A' rate.

- CRKFLG = CRANK FLAG (1 = In Crank mode).

- DEMAND\_MODE = Flag set when an On-Demand selt test mode is active.

- OBDII\_RESET = Flag used to indicate the receipt of an SCP diagnostic

reset message of any type.

- ODU\_UP\_STATE = Flag set when Offboard Unit is actively communicating with

the EEEC over SCP; 1 -> on-line and communicating.

- PxxxFAULT = Fault bit for any given diagnostic trouble code.

- RESULTS = Flag set when an On-Demand test has executed successfully.

- SCPEO\_START = Signal to start the engine off self test.

- SCPEO\_EXIT = Signal to abort the engine off self test.

- SCPER\_START = Signal to start the engine running self test.

- SCPER\_EXIT = Signal to abort the engine running self test.

- SCPOTM\_START = Signal to start output test mode diagnostic procedure.

- SCPOTM\_EXIT = Signal to abort the output test mode diagnostic procedure.

- UNDSP = Underspeed flag; 1 -> Underspeed.

Calibration Constants:

- ODU\_TIMEOUT = Time-out value for certain offboard diagnostic routines.

- OSC\_MASK = Mask byte which ODU must match in order to unlock a given OSC

channel for parameter substitution (part of Output State Control).

OTHER

- scp\_data\_n = Data byte in SCP message (n = 1 through 7).

- scp\_target = SCP message Target Specifier byte for Broadcast messages.

- scp\_pri\_type = SCP message Priority/Type byte for transmit messages.

- scp\_src\_nar = Source Node Address Register from received Node-Node

message.

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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PROCESS

STRATEGY MODULE: SCP\_OBDII\_DIAG\_COM1

The following assignments define key parameter logicals which are referenced

throughout this chapter. It is not necessarily intended to be executable.

BEGIN: parameter\_definitions

unconditionally ------------------------| dwnld\_not\_ready = 0

(Definitions used for SCP\_DWNLD\_ST | dwnld\_entered = 1

documentation purposes only) | dwnld\_data = 2

| execute\_ready = 3

| dwnld\_&\_execute = 4

|

(Definitions used for SCP\_DIAG\_ST | initial\_state = 0

documentation purposes only) | no\_results\_avail = 1

| test\_running = 2

| results\_avail = 3

|

(Definitions for OSC) | osc\_initial\_state := 0

| osc\_seed\_sent := 1

| key\_received := 2

END: parameter\_definitions

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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PROCESS\_OBDII\_REQUEST

Message Type: Broadcast Receive.

Purpose of Message: Request specific J1979 OBDII-related action to be taken

This message is used to broadcast a diagnostic request of J1979 Mode 01

(get PID data), Mode 02 (get Freeze Frame PID data), Mode 03 (get the

set MIL-code DTCs), Mode 04 (Clear all emissions related information),

Mode 06 (request on-board monitoring test results for non-continuously

monitored systems), and Mode 07 (request on-board monitoring test results

for continuously monitored systems).

Data Flow: From ODU (ex. scan tool).

Message as retreived from the Receive Buffer:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (J1979 Mode) = xxh

scp\_data\_2 (optional J1979 data) = xxh

scp\_data\_3 (optional J1979 data) = xxh

Receive Message Routine (executed only upon reception of message):

scp\_data\_1 = 01 ------------------------| pid\_lo = scp\_data\_2

(send response message < 100ms after | (lo byte of PID,pid\_hi=00h)

receiving PROCESS\_OBDII\_REQUEST) | (If pid is not found: EXIT)

(Single Request/Single Response Only) | send(REPORT\_OBDII\_PID)

(Get PID request) |

| --- ELSE ---

|

scp\_data\_1 = 02 ------------------------| ff\_pid\_lo = scp\_data\_2

(send response message < 100ms after | (lo byte of PID,ff\_pid\_hi=00h)

receiving PROCESS\_OBDII\_REQUEST) | (If pid is not found: EXIT)

(Single Request/Single Response Only) | send(REPORT\_OBDII\_FF\_PID)

(Get Freeze Frame data) |

| --- ELSE ---

|

scp\_data\_1 = 03 ------------------------| send(REPORT\_OBDII\_CODES)

(send response message < 100ms after | (send all codes in the set of

receiving PROCESS\_OBDII\_REQUEST) | mil\_codes with PxxxFAULT=1)

(Get mil\_code data) |

| --- ELSE ---

|

scp\_data\_1 = 04 ------------------------| OBDII\_RESET = 1

(send response message < 100ms after | (Executive Resets All DTC's)

receiving PROCESS\_OBDII\_REQUEST) | send(REPORT\_OBDII\_RESET)

|

| --- ELSE ---

|

scp\_data\_1 = 06 ------------------------| test\_id = scp\_data\_2

(send response message < 100ms after | Do: report\_test\_data

receiving PROCESS\_OBDII\_REQUEST) | ; Request Test Results

|

| --- ELSE ---

(continued on next page)

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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PROCESS\_OBDII\_REQUEST

(continued from previous page)

|

scp\_data\_1 = 07 ------------------------| send (REPORT\_OBDII\_CONT\_RESULTS)

(send response message < 100ms after | (send all codes in the set of

receiving PROCESS\_OBDII\_REQUEST) | mil\_codes with

(Send Pending Code Data) | PxxxSTATE>0 and PxxxFAULT=0)

BEGIN: report\_test\_data

The purpose of this test mode is to allow access to the results of on-board

diagnostic monitoring tests of specific components/systems performed

during normal vehicle operation.

Requests are made via test IDs. A test ID identifies a specific test result.

The manufacturer is responsible for defining test IDs and component IDs.

Only one test limit is included in a response message, and the limit can

be either a minimum or a maximum. If a test has both a minimum and a maximum

to report, two reporting messages will be sent for the request. Also, if

more than one component performs the same test, multiple messages will be

sent to report the test results for each component.

Test IDs are in the range 00h to FFh. These are divided into 8 sets

of 32 Test IDs. Because of the large number of tests, and components for

which this could be used to report test results, test IDs are not

standardized. Furthermore, there is a requirement to be able to report

which test IDs do exist in any given block of 32 IDs.

In effect, there are two possible reporting formats. The first, as

mentioned above, requires a message to be returned that reports the

supported test IDs out of a block of 32 into a 4 byte message response.

The responses for this message are bitmapped into calibratable parameters.

The second type reports the test value, test limit, test limit type, and

component ID for a specific Test ID. Multiple messages of this type will

be sent if conditions warrant, as described above.

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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PROCESS\_OBDII\_REQUEST

The following chart illustrates the message formats for messages received

and transmitted for Mode 06 reporting.

SCP MODE 06 MESSAGE DATA BYTES

|==================================================|

| scp\_data\_n (Hex) |

|--------------------------------------------------|

| #1 | #2 | #3 | #4 | #5 | #6 | #7 |

|==================================================|

| Request Test Results (EEC Receives) |

|--------------------------------------------------|

| 06 | Test | |

| | ID | |

|==================================================|

|==================================================|

| Report Test ID Support (EEC Sends) |

| (Test IDs 00h, 20h, 40h, 60h, 80h, A0h, C0h, E0h)|

|--------------------------------------------------|

| 46 | Test | FF | Support for the next 32 |

| | ID | | Test IDs following the |

| | | | requested ID. |

|==================================================|

| Reort Test Results (EEC Sends) |

|--------------------------------------------------|

| 46 | Test | Test Limit | test value | test limit |

| | ID | type and |-------------------------|

| | | component | MSB | LSB | MSB | LSB |

| | | ID |-------------------------|

|==================================================|

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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PROCESS\_OBDII\_REQUEST

See the Response Table in SCP\_MODE06\_MAP\_xx for reply message

content.

Note that the number of messages sent in response to a given

Test ID is equal to the number of row entries in the Response

Table that match the requested Test ID.

unconditionally for each --------| send (REPORT\_OBDII\_TRIP\_RESULTS,46h,

matching Test ID | test\_id,scp\_data\_3,

entry in the SCP MODE 06 | scp\_data\_4,scp\_data\_5,

TEST ID MAP Response Table | scp\_data\_6,scp\_data\_7)

END: report\_test\_data

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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DEFINE\_RAPID\_PACKET

Message Type: Node to Node Receive.

Purpose of Message: Request to set up diagnostic rapid data transfer packet

which is used for quick transmission of EEC data on SCP

Data Flow: From Offboard Diagnostic Unit (ODU).

Data Description: Several DEFINE\_RAPID\_PACKET messages are required to

define the contents of a 'fully packed' REPORT\_RAPID\_PACKET message. Each

definition message identifies the position of a specific parameter within the

data packet. The are five byte positions dedicated to conveying parameter

information in the REPORT\_RAPID\_PACKET message. The positions are referred

to as locations 1 thru 5; where position 1 is 'scp\_data\_2' of the message.

Parameters in the packet definition message may be identified by PID number

or DMR address. This allows a data packet to include mixed parameter

definition types. As can be seen in the message below, two bytes are

required for a PID identifier, and three bytes are required for a DMR

identifier. Definition by PID offset is NOT supported.

The normal response to each DEFINE\_RAPID\_PACKET message is the

CONFIRM\_RAPID\_PACKET message.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Define Rapid Packet) = 2Ch

scp\_data\_2 (Rapid Data Packet num) = pkt\_num

scp\_data\_3 (Type/Position/Length) = tpl\_data

scp\_data\_4 (Offset/DMR/PID spec) = odp\_spec

OPTIONAL >>> scp\_data\_5 (DMR/PID specification) = dp\_spec

OPTIONAL >>> scp\_data\_6 (DMR specification) = d\_spec

Other Specifications:

The construct SCP\_PACKET[packet number, position in packet] is used below for

referencing rapid packet formation.

All packet definition structures created via this message are to be stored in

the 200 byte area designated for SBDS/EOL useage.

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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DEFINE\_RAPID\_PACKET

Receive Message Routine (only executed upon message reception):

unconditionally -----------------------| type = bits 7,6 of tpl\_data

| posit = bits 5,4,3 of tpl\_data

| length = bits 2,1,0 of tpl\_data

pkt\_num = 00h -------------------|

|

pkt\_num > 0Fh -------------------|

|

type > 02h ----------------------|

|

posit > 05h ---------------------|OR --| send(GENERAL\_RESPONSE: 7Fh,2Ch,

| | scp\_data\_2,scp\_data\_3,

length = 00h --------------------| | scp\_data\_4,12h)

| | (sub-func not supported,

length > 04h --------------------| | invalid format)

| |

posit + length > 6 --------------| |

| |

type = 01 -----------------| | |

|AND -| |

PID not supported in map --| |

| --- ELSE ---

|

posit = 00h ---------------------------| SCP\_PACKET[pkt\_num,1] = 00h

(clear postns 1..5 in pkt\_num) | SCP\_PACKET[pkt\_num,2] = 00h

| SCP\_PACKET[pkt\_num,3] = 00h

| SCP\_PACKET[pkt\_num,4] = 00h

| SCP\_PACKET[pkt\_num,5] = 00h

| send(GENERAL\_RESPONSE: 7Fh,2Ch,

| pkt\_num,tpl\_data,odp\_spec,00h)

| (confirm packet was defined)

|

| --- ELSE ---

|

type = 02h ----------------------------| ad\_rqst = scp\_data\_5,scp\_data\_6

(define up to 4 bytes RAM data by DMR)| (ad\_rqst is a RAM address)

| Do: load\_scp\_packet

|

| --- ELSE ---

(continued on next page)

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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DEFINE\_RAPID\_PACKET

(continued from previous page)

|

type = 01h -----------------------------| pidxxxx = scp\_data\_4,scp\_data\_5

(define up to 4 bytes by PID) | SCP\_PACKET[pkt\_num,posit] =

| (pidxxxx data)

| (1 to 4 Bytes of PID data

| requested)

| send(GENERAL\_RESPONSE: 7Fh,2Ch,

| pkt\_num,tpl\_data,odp\_spec,00h)

| (confirm packet was defined)

|

| --- ELSE ---

|

| send(GENERAL\_RESPONSE: 7Fh,2Ch,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,12h)

| (invalid format)

BEGIN: load\_scp\_packet

length = 01h --------------| SCP\_PACKET[pkt\_num,posit] = (pointer to ad\_rqst)

(define 1 byte) | send(GENERAL\_RESPONSE: 7Fh,2Ch,

| pkt\_num,tpl\_data,odp\_spec,00h)

| (confirm packet was defined)

|

| --- ELSE ---

|

length = 02h --------------| SCP\_PACKET[pkt\_num,posit] = (pointer to ad\_rqst)

(define 2 contiguous bytes)| SCP\_PACKET[pkt\_num,posit+1] = (ad\_rqst+1 pntr)

| send(GENERAL\_RESPONSE: 7Fh,2Ch,

| pkt\_num,tpl\_data,odp\_spec,00h)

| (confirm packet was defined)

|

| --- ELSE ---

|

length = 03h --------------| SCP\_PACKET[pkt\_num,posit] = (pointer to ad\_rqst)

(define 3 contiguous bytes)| SCP\_PACKET[pkt\_num,posit+1] = (ad\_rqst+1 pntr)

| SCP\_PACKET[pkt\_num,posit+2] = (ad\_rqst+2 pntr)

| send(GENERAL\_RESPONSE: 7Fh,2Ch,

| pkt\_num,tpl\_data,odp\_spec,00h)

| (confirm packet was defined)

|

| --- ELSE ---

|

length = 04h --------------| SCP\_PACKET[pkt\_num,posit] = (pointer to ad\_rqst)

(define 4 contiguous bytes)| SCP\_PACKET[pkt\_num,posit+1] = (ad\_rqst+1 pntr)

| SCP\_PACKET[pkt\_num,posit+2] = (ad\_rqst+2 pntr)

| SCP\_PACKET[pkt\_num,posit+3] = (ad\_rqst+3 pntr)

| send(GENERAL\_RESPONSE: 7Fh,2Ch,

| pkt\_num,tpl\_data,odp\_spec,00h)

| (confirm packet was defined)

END: load\_scp\_packet

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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DIAGNOSTIC\_ROUTINE\_ENTRY

Message Type: Node to Node Receive.

Purpose of Message: Request to enable on-demand self test strategies.

Data Flow: When an ODU sends this message to the EEC, one of three Self Test

enable flags are set. The on-demand strategy determines whether or not Self

Test can be executed. If the Self Test can be fully executed, the EEC will

send the GENERAL\_RESPONSE message indicating a "normal exit with results".

If for any reason the Self Test was not completed, or aborted, the EEC will

send GENERAL\_RESPONSE to indicate this to the ODU.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Diag. Routine Entry) = 31h

scp\_data\_2 (Specific Diag Routine) = xxh

Receive Message Routine (only executed upon message reception):

SCP\_DIAG\_ST = initial\_state ------|

(=0) |OR --| send(GENERAL\_RESPONSE: 7Fh,31h,

SCP\_DIAG\_ST = test\_running -------| | scp\_data\_2,00h,00h,22h)

(not ready for OD testing) (=2) | (sequence error)

(test already in progress) |

| --- ELSE ---

|

scp\_data\_2 = 81h -----------------------| SCP\_TST\_REQ = scp\_data\_2

(Engine Off test requested) | SCPEO\_START = 1

| (Enable Engine Off Test)

|

| --- ELSE ---

|

scp\_data\_2 = 82h -----------------------| SCP\_TST\_REQ = scp\_data\_2

(Engine Running test requested) | SCPER\_START = 1

| (Enable Engine Running Test)

|

| --- ELSE ---

|

scp\_data\_2 = 84h -----------------------| SCP\_TST\_REQ = scp\_data\_2

(Output Test Mode requested) | SCPOTM\_START = 1

| OUTPUT\_MODE = 00h

| (Enable Output Test Mode)

|

| --- ELSE ---

|

| SCP\_TST\_REQ = 00h

| send(GENERAL\_RESPONSE: 7Fh,31h

| scp\_data\_2,00h,00h,12h)

| (sub-function not supported)

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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DIAGNOSTIC\_ROUTINE\_EXIT

Message Type: Node to Node Receive.

Purpose of Message: Request to exit from on-demand self test.

Data Flow: When an ODU sends this message to the EEC, one of three Self Test

disable flags can be set. The following strategy determines the current

state of the diagnostic executive via SCP\_DIAG\_ST register and takes the

appropriate action. If the ODU breaks the on-demand routine sequence, a

"sequence error" will be sent. If an 'exit if complete' is requested for

the routine currently executing (with the exception of the Output Test Mode),

the EEC will respond with "busy - repeat request". Otherwise, the routine

will set the appropriate disable flag, for the diagnostic executive to abort

its test and send the appropriate GENERAL\_RESPONSE message confirming the

abort. The EEC will wait for the ODU to request the test results.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Diag. Routine Entry) = 32h

scp\_data\_2 (Specific Diag Routine) = xxh

scp\_data\_3 (Type of EXIT requested)= xxh

Receive Message Routine (only executed upon message reception):

SCP\_TST\_REQ <> scp\_data\_2 --------|

|

SCP\_TST\_REQ = 00h ----------------|OR --| send(GENERAL\_RESPONSE: 7Fh,32h,

(referencing wrong test) | | scp\_data\_2,scp\_data\_3,00h,22h)

| | (sequence error)

SCP\_DIAG\_ST = initial state ------| |

(not ready for test: state=0) |

| --- ELSE ---

|

SCP\_DIAG\_ST = results\_avail ------------| send(GENERAL\_RESPONSE: 7Fh,32h,

(test completed successfully) (=3) | scp\_data\_2,scp\_data\_3,00h,61h)

| (normal exit with results)

|

| --- ELSE ---

|

SCP\_DIAG\_ST = no\_results\_avail ---------| send(GENERAL\_RESPONSE: 7Fh,32h,

(test was aborted/never ran) (=1) | scp\_data\_2,scp\_data\_3,00h,64h)

| (abnormal exit without results)

|

| --- ELSE ---

|

scp\_data\_2 = 84h -----------------------| OUTPUT\_MODE = 00h

(requesting end of OTM tests) | SCPOTM\_EXIT = 1

| (Disable Output Test Mode)

|

| --- ELSE ---

(continued on next page)

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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DIAGNOSTIC\_ROUTINE\_EXIT

(continued from previous page)

scp\_data\_3 = 00h -----------------------| send(GENERAL\_RESPONSE: 7Fh,32h,

(query test status via the | scp\_data\_2,scp\_data\_3,00h,21h)

'exit if complete' request | (busy - repeat request)

ie. "ARE YOU DONE YET?") |

| --- ELSE ---

|

scp\_data\_3 = 01h -----------------------| Do: abort\_routine

(abort unconditionally requested) |

| --- ELSE ---

|

| send(GENERAL\_RESPONSE: 7Fh,32h,

| scp\_data\_2,scp\_data\_3,00h,12h)

| (sub-function not supported)

BEGIN: abort\_routine

scp\_data\_2 = 81h -----------------------| SCPEO\_EXIT = 1

(requested abort of EO test) | (Disable Engine Off Test)

|

| --- ELSE ---

|

scp\_data\_2 = 82h -----------------------| SCPER\_EXIT = 1

(requested abort of ER test) | (Disable Engine Running Test)

END: abort\_routine

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

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DOWNLOAD\_ROUTINE\_ENTRY

Message Type: Node to Node Receive.

Purpose of Message: The First Step in the Download Sequence which requests

that the EEC enter a program download receive mode.

Block transfer formats other than 80 are not supported.

Format 80 means "no handshaking required".

Data Flow: From Offboard Diagnostic Unit (ODU).

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Dwnld Routine Entry) = 34h

scp\_data\_2 (Block Transfer Format) = xxh

scp\_data\_3 (Hi Byte Total Byte Cnt)= xxh

scp\_data\_4 (Lo Byte Total Byte Cnt)= xxh

scp\_data\_5 (Hi Byte Start Address) = xxh

scp\_data\_6 (Mid Byte Start Address)= xxh

scp\_data\_7 (Lo Byte Start Address) = xxh

Receive Message Routine (only executed upon message reception):

unconditionally ------------------------| total\_bytes = scp\_data\_3,scp\_data\_4

| start\_adrs = scp\_data\_6,scp\_data\_7

scp\_data\_2 <> 80h ----------------------| send(GENERAL\_RESPONSE: 7Fh,34h,

(format other than 80 requested) | scp\_data\_2,scp\_data\_3,

| scp\_data\_4,12h)

| (invalid format)

|

| --- ELSE ---

PUTMR > 4 seconds ----------------| |

|AND -| SCP\_DWNLD\_ST = dwnld\_entered (=1)

SCP\_DWNLD\_ST = dwnld\_not\_ready ---| | (save total\_bytes count and

(ready for first download request; =0) | start\_adrs for use with the

| DOWNLOAD\_BLOCK\_DATA messages)

| (begin download at start\_adrs)

| send(GENERAL\_RESPONSE: 7Fh,34h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,00h)

| (affirmative)

|

| --- ELSE ---

(continued on following page)

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DOWNLOAD\_ROUTINE\_ENTRY

(continued from previous page)

|

SCP\_DWNLD\_ST = execute\_ready -----------| SCP\_DWNLD\_ST = dwnld\_&\_execute(=4)

(already entered download) (=3) | (save total\_bytes count and

| start\_adrs for use with the

| DOWNLOAD\_BLOCK\_DATA messages)

| (begin download at start\_adrs)

| send(GENERAL\_RESPONSE: 7Fh,34h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,00h)

| (affirmative)

|

| --- ELSE ---

|

| send(GENERAL\_RESPONSE: 7Fh,34h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,22h)

| (conditions not correct)

5-52

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DOWNLOAD\_BLOCK\_DATA

Message Type: Node to Node Receive.

Purpose of Message: The Second step in downloading a program; transmits

the actual data to be stored in EEC RAM.

Data Flow: From Offboard Diagnostic Unit (ODU) to EEC.

FIXED LENGTH MESSAGE

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Block Data Transfer) = 36h

scp\_data\_2 (data\_byte) = xxh

scp\_data\_3 (data\_byte or 00h) = xxh

scp\_data\_4 (data\_byte or 00h) = xxh

scp\_data\_5 (data\_byte or 00h) = xxh

scp\_data\_6 (data\_byte or 00h) = xxh

scp\_data\_7 (data\_byte or 00h) = xxh

Receive Message Routine (only executed upon message reception):

SCP\_DWNLD\_ST = dwnld\_entered -----|

(State Machine at State = 1) |OR --| SCP\_DWNLD\_ST = dwnld\_data

| | (Set State Machine to State 2)

SCP\_DWNLD\_ST = dwnld\_data --------| | (Start loading at 'start\_adrs' as

(State Machine at State = 2) | defined in DOWNLOAD\_ROUTINE\_ENTRY

| until 'total\_bytes' as defined in

| same message have been saved.)

|

| --- ELSE ---

|

SCP\_DWNLD\_ST = dwnld\_&\_execute ---------| SCP\_DWNLD\_ST = dwnld\_&\_execute

(State Machine at State = 4) | (Set State Machine to State 4)

| (Start loading at 'start\_adrs' as

| defined in DOWNLOAD\_ROUTINE\_ENTRY

| until 'total\_bytes' as defined in

| same message have been saved.)

|

| --- ELSE ---

|

| send(GENERAL\_RESPONSE: 7Fh,36h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,22h)

| (conditions not correct)

5-53

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DOWNLOAD\_ROUTINE\_EXIT

Message Type: Node to Node Receive.

Purpose of Message: Third step in Download Sequence. This message

requests that the EEC exit the download receive mode.

Data Flow: From Offboard Diagnostic Unit (ODU).

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Dwnld Routine Exit) = 37h

scp\_data\_2 (Block Transfer Format) = xxh

Receive Message Routine (only executed upon message reception):

SCP\_DWNLD\_ST = dwnld\_&\_execute ---|

(State Machine is in State = 4) |OR --| send(GENERAL\_RESPONSE: 7Fh,37h,

| | scp\_data\_2,00h,00h,00h)

SCP\_DWNLD\_ST = dwnld\_data --------| | (affirmative)

(State Machine is in State = 2) | SCP\_DWNLD\_ST = execute\_ready

| (Set State Machine at State=3)

|

| --- ELSE ---

|

SCP\_DWNLD\_ST = dwnld\_entered -----------| send(GENERAL\_RESPONSE: 7Fh,37h,

(State Machine is at State = 1) | scp\_data\_2,00h,00h,00h)

| (affirmative)

| SCP\_DWNLD\_ST = dwnld\_not\_ready

| (Set State Machine at State=0)

|

| --- ELSE ---

|

| send(GENERAL\_RESPONSE: 7Fh,37h,

| scp\_data\_2,00h,00h,22h)

| (conditions not correct)

5-54

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EXECUTE\_ROUTINE

Message Type: Node to Node Receive.

Purpose of Message: Fourth step in the Download & Execute process,

requesting that the EEC execute a specified routine

(which is downloaded or internal to the EEC).

- OR -

Second step in the Output Test Mode sequence,

requesting that the EEC change the state of a set

of pre-defined outputs.

- OR -

Third step in the Output Substitution Mode sequence,

requesting that the EEC open up a variable to be

manipulated via OSC. The EEC will assign the mask

value to a table which is examined each background

loop as part of the OSC security scheme.

- OR -

Request the reset of EEC KAM (Keep Alive Memory).

Data Flow: From Offboard Diagnostic Unit (ODU).

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Execute Diag Command) = B1h

scp\_data\_2 (Hi Byte Diag Command) = xxh

scp\_data\_3 (Lo Byte Diag Command) = xxh

scp\_data\_4 (Optional Data Byte) = xxh

scp\_data\_5 (Optional Data Byte) = xxh

Receive Message Routine (only executed upon message reception):

unconditionally ------------------------| command = scp\_data\_2,scp\_data\_3

;assign names to message | xqt\_adrs = scp\_data\_4,scp\_data\_5

;bytes as needed in logic below | channel = scp\_data\_4 - 128

| ; Convert channel to decimal

| ; since PCM uses 80h -> FFh only.

| mask = scp\_data\_5

SCP\_DWNLD\_ST = execute\_ready -----|

(State Machine in State=3) |AND -| send(GENERAL\_RESPONSE: 7Fh,B1h,

| | scp\_data\_2,scp\_data\_3,

command = 8002h ------------------| | scp\_data\_4,00h)

(execute downloaded routine at a | (affirmative response)

2-byte address with the normal | DLOAD\_PROG\_STRT = xqt\_adrs

EEC strategy running) | DLOAD\_EXEC\_KEY = command

| (Enable execution of the routine

| as part of the NORMAL background

| sequence - actual decision to

| jump to the routine is detailed

| in the SCP\_BKGND\_COMx logic)

|

| --- ELSE ---

(continued on next page)

5-55

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EXECUTE\_ROUTINE

(continued from previous page)

SCP\_DWNLD\_ST = execute\_ready -----| |

(State Machine at State=3) | |

|AND -| send(GENERAL\_RESPONSE: 7Fh,B1h,

UNDSP = 1 ------------------| | | scp\_data\_2,scp\_data\_3,

|OR --| | scp\_data\_4,00h)

CRKFLG = 1 -----------------| | | (affirmative response)

| | DLOAD\_PROG\_STRT = xqt\_adr

command = 8102h ------------------| | DLOAD\_EXEC\_KEY = command

(execute downloaded routine at | (enable execution of the routine

a 2-byte address which will | as part of the SBDS background

take control of the EEC) | sequence - actual decision to

| jump to the routine is detailed

| in the SCP\_BKGND\_COMx logic)

|

| --- ELSE ---

command = 0025h ------------------| |

(Execute an OTM output change) | |

| |

SCP\_DIAG\_ST = test\_running -------| |

(State Machine is in State=2) |AND -| OUTPUT\_MODE = scp\_data\_4

| | (pass value to OTM logic)

SCP\_TST\_REQ = 84h ----------------| |

(OTM test was last requested) |

| --- ELSE ---

|

command = 0047h ------------------| |

(Request an OSC mask enablement) |AND -| Do: transform\_seed

| | ;assigns eec\_key temp register

OSC\_STATE = key\_received ---------| | ;reference SECURITY\_REQUEST msg.

(State Machine is in State=2) | | ;ODU\_KEY checked on each request

| |

ODU\_UP\_TMR < ODU\_TIMEOUT ---------| | Do: process\_osc\_mask

;Test tool is present | | ;allow or disallow OSC mask

| |

Channel scp\_data\_2 is | |

found in OSC Table ---------------| |

;OSC Table support documented in | ; Do not store eec\_key in RAM.

;the module OBDII\_OSC\_COMx. |

| --- ELSE ---

|

command = 8010h ------------------| |

(Request to execute KAM reset) |AND -| KAMQA = 0

| | ; Overwrite the KAM qualification

CRKFLG = 1 -----------------------| | ; pattern A to force the KAM

(Engine is in crank mode) | ; reset

|

| send(GENERAL\_RESPONSE: 7Fh,B1h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,00h)

| (affirmative response)

|

| --- ELSE ---

(continued on next page)

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EXECUTE\_ROUTINE

(continued from previous page)

|

| send(GENERAL\_RESPONSE: 7Fh,B1h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,22h)

| (conditions not correct)

BEGIN: process\_osc\_mask

Determine whether to allow/disallow mask overwrite.

(Security level must be verified.)

mask = OSC\_MASK ------------------|

(ODU mask matches EEC mask) |

|AND -| OSC\_ENA[channel] = mask

eec\_key <> 0 ---------------------| | (pass value to OSC logic)

| |

eec\_key = ODU\_KEY ----------------| | send(GENERAL\_RESPONSE: 7Fh,B1h,

(security level verified) | scp\_data\_2,scp\_data\_3

| scp\_data\_4,00h)

| (affirmative response)

|

| --- ELSE ---

|

mask <> OSC\_MASK -----------------------| send(GENERAL\_RESPONSE: 7Fh,B1h,

(OSC masks do not match) | scp\_data\_2,scp\_data\_3

| scp\_data\_4,31h)

| (request out of range)

|

| --- ELSE ---

|

| OSC\_STATE = osc\_initial\_state

| ;Illegal access determined,

| ;Reset OSC state machine.

|

| send(GENERAL\_RESPONSE: 7Fh,B1h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,33h)

| (access denied - device secured)

END: process\_osc\_mask

5-57

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MODE\_NOT\_SUPPORTED

Message Type: Node to Node Receive.

Purpose of Message: Unknown. Message requested does not correspond with

any existing EEC supported modes.

Data Flow: From Offboard Diagnostic Unit (ODU) to EEC.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Any Unsupported Mode) = xxh

scp\_data\_2 (Optional data byte) = xxh

scp\_data\_3 (Optional data byte) = xxh

scp\_data\_4 (Optional data byte) = xxh

scp\_data\_5 (Optional data byte) = xxh

scp\_data\_6 (Optional data byte) = xxh

scp\_data\_7 (Optional data byte) = xxh

Other Specifications:

THIS MESSAGE REPRESENTS ANY NODE TO NODE REQUEST WHICH DOES NOT MATCH

AN EXISTING EEC MODE. THE LIST OF SUPPORTED MODES IS FOUND IN THE

OVERVIEW FOR THIS MODULE.

Receive Message Routine (only executed upon message reception):

unconditionally ------------------------| send(GENERAL\_RESPONSE: 7Fh,

| scp\_data\_1,scp\_data\_2,

| scp\_data\_3,scp\_data\_4,11h)

5-58

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PARAMETER\_SUBSTITUTION

Message Type: Node to Node Receive.

Purpose of Message: Allows technician to manipulate direct EEC outputs.

This message requires proper security access via the seed/key system

discussed in the overview section of this module as well as the module

OBDII\_OSC\_COMx.

Data Flow: From Offboard Diagnostic Unit (ODU) to EEC.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Substitute by Data ID) = 30h

scp\_data\_2 (OSC Channel to Subs) = xxh

scp\_data\_3 (High Byte Subs Value) = xxh

scp\_data\_4 (Low Byte Subs Value) = xxh

Other Specifications:

When OSC scaling references a flag or byte, the least significant bit/byte

of the substitute word shall be used to control the channel, respectively.

Receive Message Routine (only executed upon message reception):

unconditionally --------------------------| channel = scp\_data\_2 - 128

;Note that scp\_data\_2 is offset | ;Convert channel to Ford range

;by 128 from OSC\_TABLE list. | ;Ford uses 80h = 0 and FFh = 127

Channel scp\_data\_2 is found in OSC Table -| value = scp\_data\_3,scp\_data\_4

;OSC Table support documented in | ;See OBDII\_OSC\_COMx for scaling

;the module OBDII\_OSC\_COMx. |

| --- ELSE ---

|

| send(GENERAL\_RESPONSE: 7Fh,30h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,31h)

| (request out of range)

|

| EXIT routine

5-59

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OSC\_STATE = key\_received -----------|

(State Machine is in State=2) |

|AND -| Do: transform\_seed

| | ;Assigns eec\_key temp register

ODU\_UP\_TMR < ODU\_TIMEOUT -----------| | ;Reference SECURITY\_REQUEST msg.

;Test tool is present | ;ODU\_KEY checked on each request

|

| Do: process\_osc\_subs

| ;Allow or disallow substitution.

| ;Do not store eec\_key in RAM.

|

| --- ELSE ---

|

| send(GENERAL\_RESPONSE: 7Fh,30h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,22h)

| (conditions not correct)

5-60

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: process\_osc\_subs

Determine whether to allow/disallow output parameter overwrite.

(Security level must be verified.)

eec\_key = 0 ----------------------|

|OR --| OSC\_STATE = osc\_initial\_state

eec\_key <> ODU\_KEY ---------------| | ;Illegal access determined,

;illegal security access | ;Reset OSC state machine.

|

| send(GENERAL\_RESPONSE: 7Fh,30h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,33h)

| (access denied - device secured)

|

| --- ELSE ---

|

if scp\_data\_3 is present ---------------| OSC\_VALUE[channel] = value

| ; Update substitution value.

| ; Reference the OSC\_TABLE for

| ; scaling information on each

| ; channel (in OBDII\_OSC\_COMx).

| SUBST\_REQ[channel] = 1

| send(GENERAL\_RESPONSE: 7Fh,30h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,00h)

| (affirmative)

| ; This affirmative response MUST

| ; be deleted when OSC effort for

| ; URD 11738 is complete.

|

| --- ELSE ---

|

| Increment OSC\_ENA[channel]

| ; Disable substitution

| ; for this channel only.

| ; Allow value to roll to zero.

|

| send(GENERAL\_RESPONSE: 7Fh,30h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,00h)

| (affirmative)

END: process\_osc\_subs

5-61

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REQUEST\_ALL\_CODES

Message Type: Node to Node Receive.

Purpose of Message: Request for all of the Diagnostic Trouble Codes

which are 'set' or 'pending' in KAM.

Data Flow: From Offboard Diagnostic Unit (ODU) to EEC.

Data Description: If the CODES\_COUNT register is greater than zero, the list

of all\_codes are searched. Any mil\_codes with the FAULT bit set, or ones

with the STATE register greater than zero are sent over the SCP network.

In addition, any non\_mil\_codes with a FUALT bit set are also sent.

The mil\_codes will be transmitted first, followed immediately by the

non\_mil\_codes. Only the FINAL message can be packed with 00hex.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Request all codes mode)= 13h

Other Specifications:

ONLY ONE SET OF CODES ARE TO BE REQUESTED OR TRANSMITTED AT ANY ONE TIME.

Receive Message Routine (only executed upon message reception):

CODES\_COUNT <> 0 -----------------------| send(REPORT\_ALL\_CODES)

| (send all codes in the set of

| mil\_codes with PxxxFAULT = 1 or

| PxxxSTATE > 0)

| (send all codes in the set of

| non\_mil\_codes with PxxxFAULT = 1)

|

| --- ELSE ---

|

CODES\_COUNT = 0 ------------------------| send(GENERAL\_RESPONSE: 7Fh,13h,00h,

| 00h,00h,62h)

| (normal exit without results)

5-62

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REQUEST\_ALL\_DATA\_STOP

Message Type: Node to Node Receive.

Purpose of Message: Request to discontinue sending all repetitive data.

Data Flow: From Offboard Diagnostic Unit (ODU) to EEC.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Request all codes mode)= 25h

Receive Message Routine (only executed upon message reception):

unconditionally ------------------------| A\_RATE\_ENA = 0

| send(GENERAL\_RESPONSE: 7Fh,25h,00h,

| 00h,00h,00h)

| (affirmative)

5-63

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REQUEST\_CLEAR\_CODES

Message Type: Node to Node Receive.

Purpose of Message: Request to clear all of the Diagnostic Trouble Codes

which are 'set' or 'pending' in KAM.

Data Flow: From Offboard Diagnostic Unit (ODU) to EEC.

Data Description: Upon receiving this message, the reset flag (OBDII\_RESET)

is set, which is recognized and acted upon by the diagnostic executive.

Although this message allows for individual clearing of DTC's, the EEC

will execute a COMPLETE reset of ALL codes whenever any type of code

reset is requested.

The message is variable in length.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Request to clear codes)= 14h

scp\_data\_2 (High byte Code # - opt)= xxh

scp\_data\_3 (Low byte Code # - opt) = xxh

Receive Message Routine (only executed upon message reception):

if scp\_data\_2 or scp\_data\_3 have data --| send(GENERAL\_RESPONSE: 7Fh,14h,

| scp\_data\_2,scp\_data\_3,00h,12h)

| (individual clearing of codes

| is not supported)

|

| --- ELSE ---

|

| OBDII\_RESET = 1

| (Set flag to clear all codes)

| send(CONFIRM\_CODES\_CLEAR)

5-64

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REQUEST\_DIAG\_RESULTS

Message Type: Node to Node Receive.

Purpose of Message: Request to report results of on-demand self test.

Data Flow: From the ODU to the EEC.

Other Specifications: The ODU can only request results of the on-demand test

after completion of that on-demand sequence (as referenced by SCP\_TST\_REQ).

The ODU cannot ask for results of a test which it did not execute. When the

EEC receives this request, it cycles through all codes looking for 'set'

codes, indicated by a zeroed 'warm-up' counter. Upon finding some codes

'set', the codes are transmitted via DIAGNOSTIC\_RESULTS.

If the EEC is powered down, or another test is requested prior to requesting

codes from a previous test, the initial results are erased. Codes may be

obtained only once via this message.

ONLY ONE SET OF CODES ARE TO BE REQUESTED OR TRANSMITTED AT ANY ONE TIME.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Diag. Routine Results) = 33h

scp\_data\_2 (Specific Diag Routine) = xxh

Receive Message Routine (only executed upon message reception):

SCP\_DIAG\_ST = results\_avail ------|

(State Machine is at State=3) |

|

SCP\_TST\_REQ = scp\_data\_2 ---------|AND -| send(DIAGNOSTIC\_RESULTS)

(Correct test requested) | | (send all codes in the set of

| | all\_codes with PxxxCNT = 0)

OD\_CODE\_CNT <> 0 -----------------| | RESULTS = 0

(Codes were set for the test) |

| --- ELSE ---

SCP\_DIAG\_ST = results\_avail ------| |

(State Machine is at State=3) | |

| |

SCP\_TST\_REQ = scp\_data\_2 ---------|AND -| send(DIAGNOSTIC\_RESULTS: 73h,00h,

(Correct test requested) | | 00h,00h,00h,00h,00h)

| | (send NULL code set)

OD\_CODE\_CNT = 0 ------------------| | RESULTS = 0

(No codes were set for the test) |

| --- ELSE ---

|

| send(GENERAL\_RESPONSE: 7Fh,33h,

| scp\_data\_2,00h,00h,22h)

| (sequence error)

5-65

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REQUEST\_DMR\_ACCESS

Message Type: Node to Node Receive.

Purpose of Message: Request EEC data to be transmitted over the SCP network

by Direct Memory Request (DMR).

Data Flow: From ODU (ex. scan tool) to the PCM.

Data Description: Data can ONLY be a single request/single response.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (DMR Data Access Mode) = 23h

scp\_data\_2 (High Byte Address) = xxh

scp\_data\_3 (Middle Byte Address) = xxh

scp\_data\_4 (Low Byte Address) = xxh

Receive Message Routine (executed only upon reception of message):

unconditionally ------------------------| dmr\_type = scp\_data\_2

| dmr\_rqst = scp\_data\_3,scp\_data\_4

dmr\_type = 01h -------------------------| send(REPORT\_DMR\_DATA)

| (Send single response consisting

| of four bytes of ROM Bank1 data

| starting at address: dmr\_rqst)

|

| --- ELSE ---

|

dmr\_type = 08h -------------------------| send(REPORT\_DMR\_DATA)

| (Send single response consisting

| of four bytes of ROM Bank8 data

| starting at address: dmr\_rqst)

|

| --- ELSE ---

|

dmr\_type = 00h -------------------------| send(REPORT\_DMR\_DATA)

| (Send single response consisting

| of four bytes of RAM data

| starting at address: dmr\_rqst)

|

| --- ELSE ---

|

| send(GENERAL\_RESPONSE: 7Fh,23h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,12h)

| (invalid format)

5-66

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REQUEST\_MIL\_CODES

Message Type: Node to Node Receive.

Purpose of Message: Message requesting same data as the J1979 Mode 03

message (all set mil\_code DTC's).

Data Flow: From Offboard Diagnostic Unit (ODU) to EEC.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Request mil\_codes mode)= 03h

Other Specifications:

ONLY ONE SET OF CODES ARE TO BE REQUESTED OR TRANSMITTED AT ANY ONE TIME.

Receive Message Routine (only executed upon message reception):

NUM\_CODES <> 0 -------------------------| send(REPORT\_MIL\_CODES)

| (send all codes in the set of

| mil\_codes with PxxxFAULT=1)

|

| --- ELSE ---

|

NUM\_CODES = 0 --------------------------| send(GENERAL\_RESPONSE: 7Fh,03h,00h,

| 00h,00h,62h)

| (normal exit without results)

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REQUEST\_PID\_ACCESS

Message Type: Node to Node Receive.

Purpose of Message: Request EEC data to be transmitted over the SCP network

by Parameter Identifier (PID).

Data Flow: From ODU (ex. scan tool) to the PCM.

Data Description: Data can ONLY be a single request/single response.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (PID Data Access Mode) = 22h

scp\_data\_2 (High Byte PID number) = pid\_hi

scp\_data\_3 (Low Byte PID number) = pid\_lo

Receive Message Routine (executed only upon reception of message):

unconditionally ------------------------| pid\_rqst = scp\_data\_2,scp\_data\_3

pid\_rqst not found in map --------------| send(GENERAL\_RESPONSE: 7Fh,22h,

(bad PID number requested) | scp\_data\_2,scp\_data\_3,00h,12h)

| (invalid format)

|

| --- ELSE ---

|

| send(REPORT\_PID\_DATA)

| (send single response of pid\_rqst

| as defined in SCP\_PID\_MAP\_COMx)

5-68

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REQUEST\_RAPID\_PACKET

Message Type: Node to Node Receive.

Purpose of Message: Request EEC Rapid Data Tranfer packet data to be

transmitted over the SCP network at an optional rate.

Data Flow: From ODU (ex. scan tool) to the PCM.

Data Description: SEE THE CHAPTER OVERVIEW FOR GUIDELINES OF DEFINITION AND

TRANSMISSION OF DATA WITH RAPID PACKETS ON THE SCP NETWORK.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Packet Request Mode) = 2Ah

scp\_data\_2 (Data Packet Rate) = xxh

scp\_data\_3 (1st Packet Number) = xxh

OPTIONAL >>> scp\_data\_4 (2nd Packet Number) = xxh

OPTIONAL >>> scp\_data\_5 (3rd Packet Number) = xxh

OPTIONAL >>> scp\_data\_6 (4th Packet Number) = xxh

OPTIONAL >>> scp\_data\_7 (5th Packet Number) = xxh

Response Message: REPORT\_RAPID\_PACKET

Receive Message Routine (executed only upon reception of message):

unconditionally ------------------------| pkt\_a = scp\_data\_3

| pkt\_b = scp\_data\_4

| pkt\_c = scp\_data\_5

| pkt\_d = scp\_data\_6

| pkt\_e = scp\_data\_7

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REQUEST\_RAPID\_PACKET

scp\_data\_2 = 01h -----------------|

|

scp\_data\_2 = 02h -----------------|

|

scp\_data\_2 > 04h -----------------|

|

scp\_data\_3 > 0Fh -----------------|

|

scp\_data\_4 > 0Fh -----------------|

|

scp\_data\_5 > 0Fh -----------------|

|

scp\_data\_6 > 0Fh -----------------|OR --| send(GENERAL\_RESPONSE: 7Fh,2Ah,

| | scp\_data\_2,scp\_data\_3,

scp\_data\_7 > 0Fh -----------------| | scp\_data\_4,12h)

| | (invalid format)

scp\_data\_3 = 00h -----------------| |

| |

scp\_data\_4 = 00h -----------------| |

| |

scp\_data\_5 = 00h -----------------| |

| |

scp\_data\_6 = 00h -----------------| |

| |

scp\_data\_7 = 00h -----------------| |

| --- ELSE ---

|

scp\_data\_2 >= 03h ----------------------| Enable pkt\_a at Type 'A' rate

(update the 'A' queue to include | Enable pkt\_b at Type 'A' rate

these packets) | Enable pkt\_c at Type 'A' rate

| Enable pkt\_d at Type 'A' rate

| Enable pkt\_e at Type 'A' rate

| (enable the transmission of

| each packet requested at

| the Type 'A' data rate)

| A\_RATE\_ENA = 1

|

| --- ELSE ---

|

scp\_data\_2 = 00h -----------------------| Disable the transmission of pkt\_a

| Disable the transmission of pkt\_b

| Disable the transmission of pkt\_c

| Disable the transmission of pkt\_d

| Disable the transmission of pkt\_e

| (disable the transmission of

| each packet requested)

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SECURITY\_REQUEST

Message Type: Node to Node Receive.

Purpose of Message: To restrict access and prevent unauthorized intrusion

into the EEC. The security access method described in this strategy book

satisfies the requirements for tamper protection specified in SAE J2186. The

process is split into two steps: 1) Request and obtain an algorithm 'seed'

value, and 2) Submit processed 'key' code in order to obtain security access.

Data Flow: From ODU (ex. scan tool) to the PCM.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Security Access Request) = 27h

scp\_data\_2 (Seed/Key Indicator) = xxh (01h or 02h)

scp\_data\_3 (High byte KEY) = xxh (If scp\_data\_2=02h)

scp\_data\_4 (Low byte KEY) = xxh (If scp\_data\_2=02h)

Receive Message Routine (only executed upon message reception):

OSC\_STATE = osc\_initial\_state ----|

(Not in the substitute state) |

(State Machine is in State=0) |

|AND -| send(GENERAL\_RESPONSE: 7Fh,27h,

scp\_data\_2 = 01h -----------------| | scp\_data\_2,scp\_data\_3,

(Request for Access Seed value) | | scp\_data\_4,21h)

| | ;Busy - repeat request

All bytes of 'clock' are zero ----| |

;OSC\_SEED cannot be equal to zero | ODU\_UP\_TMR = 0

| ;Accept that tester is 'present'

|

| EXIT this routine.

|

| --- ELSE ---

OSC\_STATE = osc\_initial\_state ----| |

(State Machine is in State=0) |AND -| OSC\_SEED = (least significant,

(Not in the substitute state) | | non-zero byte of 'clock')

| | ;Use as random number for OSC\_SEED

scp\_data\_2 = 01h -----------------| |

(Request for Access Seed value) | OSC\_STATE = osc\_seed\_sent

| ;Set State Machine to State=1

|

| ODU\_UP\_TMR = 0

| ;Accept that tester is 'present'

|

| send(SECURITY\_RESPONSE: 67h,01h,

| 00h,OSC\_SEED)

| ;Provide seed for ODU algorithm

|

| --- ELSE ---

(continued on next page)

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SECURITY\_REQUEST

(continued from previous page)

OSC\_STATE = osc\_seed\_sent --------| |

(State Machine is in State=1) |AND -| ODU\_KEY = scp\_data\_3,scp\_data\_4

(Just supplied new Seed value) | | ;Assign KEY word from ODU.

| |

scp\_data\_2 = 02h -----------------| | Do: transform\_seed

(Submit Security Key value) | ;Assigns eec\_key temp register.

|

| Do: check\_key

| ;Allow/disallow security access.

| ;Do not store eec\_key in RAM.

|

| --- ELSE ---

|

| send(GENERAL\_RESPONSE: 7Fh,27h,

| scp\_data\_2,scp\_data\_3,

| scp\_data\_4,22h)

| ;Sequence error

BEGIN: transform\_seed

;PRIVATE process used to transform the seed value to produce the key

;to unlock the output substitution control. The same process must be

;installed in the ODU to provide the key.

;The transform function and algorithm are shown below:

|

65535 + \*

| \*

| \*

| \*

k | \*

e | \*

y | \*

| \* \*

| \* \* \*

| \* \* \*

| \* \* \*

| \* \* \*

0 \*----------------------------\*--------+--------->

0 255 seed

unconditionally --------| eec\_key := abs(2\*OSC\_SEED\*\*2 - 253\*OSC\_SEED)

END: transform\_seed

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SECURITY\_REQUEST

BEGIN: check\_key

PRIVATE process to determine if ODU key matches EEC calculated key.

eec\_key <> 0 ---------------|

|AND -| OSC\_STATE = key\_received

eec\_key = ODU\_KEY ----------| | ; substitution allowed

; valid KEY was received |

| send(GENERAL\_RESPONSE: 7Fh, 27h,

| scp\_data\_2, scp\_data\_3,

| scp\_data\_4,34h)

| ; access allowed

|

| ODU\_UP\_TMR = 0

| ; Accept that tester is 'present'

|

| --- ELSE ---

|

| OSC\_STATE = osc\_initial\_state

| ; Reset state machine

|

| send(GENERAL\_RESPONSE: 7Fh, 27h,

| scp\_data\_2, scp\_data\_3,

| scp\_data\_4,33h)

| ; access denied - device secured

END: check\_key

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TESTER\_PRESENT

Message Type: Node to Node Receive.

Purpose of Message: Heartbeat message indicating that ODU is currently

on-line and communicating with the EEC.

If the EEC has been put in an 'unlocked' state

(e.g. parameter substitution), then this message

is used to prompt a check of the validity of that

state. If the state is invalid, then reset the

security access state machine.

Data Flow: From Offboard Diagnostic Unit (ODU) to EEC.

Message Specification:

scp\_src\_nar (ODU Node Address) = Fxh

scp\_data\_1 (Tester Present code) = 3Fh

Receive Message Routine (only executed upon message reception):

unconditionally ------------------------| ODU\_UP\_TMR = 0

| (Reset ODU timeout counter)

| ODU\_UP\_STATE = 1

| send(GENERAL\_RESPONSE: 7Fh, 3Fh,

| 00h, 00h, 00h, 00h)

| (affirmative)

OSC\_STATE = key\_received ---------------| Do: transform\_seed

; if currently unlocked... | ; Ensure access is legal.

(State Machine is in State=2) | ; The 'transform' process located

| ; in SECURITY\_REQUEST algorithm.

| ; Process returns 'eec\_key'.

|

| Do: check\_legal\_access

| ;Do not store eec\_key in RAM.

BEGIN: check\_legal\_access

PRIVATE process to ensure that security access has not been back-doored.

eec\_key <> ODU\_KEY ---------------|

|OR --| OSC\_STATE = osc\_initial\_state

ODU\_KEY = 0 ----------------------| | ; Reset State Machine.

| ; Do not allow security access.

END: check\_legal\_access

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REPORT\_OBDII\_CODES

Message Type: Broadcast Transmit.

Purpose of Message: This message is sent in response to receipt of scan

tool message PROCESS\_OBDII\_REQUEST, with a Mode 03 request.

Data Flow: From PCM to SCP Network.

THIS MESSAGE MUST BE SENT ON THE SCP NETWORK WITHIN 100 MSEC OF

RECEIVING THE "PROCESS\_OBDII\_REQUEST" MESSAGE.

USE OF THE 'list' CONCEPT IS MERELY FOR DOCUMENTATION

PURPOSES AND IN NO WAY IMPLIES AN IMPLEMENTATION.

Message Specification:

scp\_pri\_type = 41h

scp\_target (Target Specifier) = 6Bh

scp\_data\_1 (Report OBDII DTC's) = 43h

scp\_data\_2 (high byte code 1) = list\_of\_codes

scp\_data\_3 (low byte code 1) = list\_of\_codes

scp\_data\_4 (high byte code 2 or 00)= list\_of\_codes

scp\_data\_5 (low byte code 2 or 00) = list\_of\_codes

scp\_data\_6 (high byte code 3 or 00)= list\_of\_codes

scp\_data\_7 (low byte code 3 or 00) = list\_of\_codes

Other Specifications:

Data Format:

list\_of\_codes : (code\_hi = hi byte of 1st code

code\_lo = lo byte of 1st code

code\_hi = hi byte of 2nd code (or 00h)

code\_lo = lo byte of 2nd code (or 00h)

:

:

code\_hi = hi byte of n'th code (or 00h)

code\_lo = lo byte of n'th code (or 00h))

The 4 digit codes are sent in BCD format. They occupy 2 data bytes

each, with the upper nibble of the upper byte encoded to indicate either

legislated codes, or Ford specific codes as specified in SAE spec J1979.

The codes are packed 3 to a message, with the hi byte first.

If there are less than 3 codes, the message is filled with zeros so

that a fixed length message is transmitted (data bytes 2-7 filled).

Requesting Message: PROCESS\_OBDII\_REQUEST

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REPORT\_OBDII\_CONT\_RESULTS

Message Type: Broadcast Transmit.

Purpose of Message: This message is sent in response to receipt of scan

tool message PROCESS\_OBDII\_REQUEST, with a Mode 07 request.

Data Flow: From PCM to SCP Network.

THIS MESSAGE MUST BE SENT ON THE SCP NETWORK WITHIN 100 MSEC OF

RECEIVING THE "PROCESS\_OBDII\_REQUEST" MESSAGE.

USE OF THE 'list' CONCEPT IS MERELY FOR DOCUMENTATION

PURPOSES AND IN NO WAY IMPLIES AN IMPLEMENTATION.

Message Specification:

The requirement for codes to be sent in response to mode 07 is

the state to be greater than zero, and the fault flag equal zero, ie.

send all codes in the set of mil\_codes with PxxxSTATE>0 and PxxxFAULT=0

scp\_pri\_type = 41h

scp\_target (Target Specifier) = 6Bh

scp\_data\_1 (Report OBDII DTC's) = 47h

scp\_data\_2 (high byte code 1) = list\_of\_codes

scp\_data\_3 (low byte code 1) = list\_of\_codes

scp\_data\_4 (high byte code 2 or 00)= list\_of\_codes

scp\_data\_5 (low byte code 2 or 00) = list\_of\_codes

scp\_data\_6 (high byte code 3 or 00)= list\_of\_codes

scp\_data\_7 (low byte code 3 or 00) = list\_of\_codes

Other Specifications:

Data Format:

list\_of\_codes : (code\_hi = hi byte of 1st code

code\_lo = lo byte of 1st code

code\_hi = hi byte of 2nd code (or 00h)

code\_lo = lo byte of 2nd code (or 00h)

:

:

code\_hi = hi byte of n'th code (or 00h)

code\_lo = lo byte of n'th code (or 00h))

The 4 digit codes are sent in BCD format. They occupy 2 data bytes

each, with the upper nibble of the upper byte encoded to indicate either

legislated codes, or Ford specific codes as specified in SAE spec J1979.

The codes are packed 3 to a message, with the hi byte first.

If there are less than 3 codes, the message is filled with zeros so

that a fixed length message is transmitted (data bytes 2-7 filled).

Requesting Message: PROCESS\_OBDII\_REQUEST

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REPORT\_OBDII\_FF\_PID

Message Type: Broadcast Transmit.

Purpose of Message: This message is sent in response to receipt of scan

tool message PROCESS\_OBDII\_REQUEST, with a Mode 02 request.

Data Flow: From PCM to SCP Network.

THIS MESSAGE MUST BE SENT ON THE SCP NETWORK WITHIN 100 MSEC OF

RECEIVING THE "PROCESS\_OBDII\_REQUEST" MESSAGE.

Data Description: The EEC will transmit the appropriate Freeze Frame PID

data, as defined in the SAE specification J1979. EXAMPLE: An OBDII

FF PID request of the trouble code which cause the CARB required freeze

frame data storage (J1979 Mode 02, PID 02) will prompt the response of

the following:

A priority/type byte which complies with the J1979 spec (41h); A GENERIC

function code identifying the message as a J1979 Response (6Bh);

A SPECIFIC function code identifying the message as a PID response (42h);

The PID number which was requested via Scan Tool (02h); the freeze frame

number associated with the trouble code (which will be 00h, by default);

and the two byte trouble code which resides in pid\_def(j1979\_02\_02).

The J1979 PID values and scaling are described with "pid\_def()"

constructs throughout the strategy.

The SCP Freeze Frame PID table is contained in the module:

SCP\_PID\_MAP\_COMx.

Message Specification:

scp\_pri\_type = 41h

scp\_target (J1979 response byte) = 6Bh

scp\_data\_1 (PID Report Funct Code) = 42h

scp\_data\_2 (PID number returned) = ff\_pid\_lo

scp\_data\_3 (J1979 frame number) = 00h

scp\_data\_4 (J1979 PID data) = yyh

scp\_data\_5 (optional PID data) = yyh

scp\_data\_6 (optional PID data) = yyh

scp\_data\_7 (optional PID data) = yyh

Where:

ff\_pid\_lo = FF PID number (scp\_data\_2 from PROCESS\_OBDII\_REQUEST).

yyh = Freeze Frame PID data per SAE specification J1979.

Other Specifications:

IF FF PID IS NOT SUPPORTED in SCP\_PID\_MAP\_COMx, DO NOT SEND RESPONSE.

Requesting Message: PROCESS\_OBDII\_REQUEST

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REPORT\_OBDII\_TRIP\_RESULTS

Message Type: Broadcast Transmit.

Purpose of Message: This message is sent in response to receipt of

scan tool message PROCESS\_OBDII\_REQUEST, with a Mode 06 request.

It provides on-board monitoring test results for non-continuously

monitored systems.

The Response Table in SCP\_MODE06\_MAP\_xx details exactly what data

should be used for each data byte in the response message(s), for

a given Test ID.

Data Flow: From PCM to SCP Network.

THIS MESSAGE MUST BE SENT ON THE SCP NETWORK WITHIN 100 MSEC OF

RECEIVING THE "PROCESS\_OBDII\_REQUEST" MESSAGE.

Message Specification:

scp\_pri\_type = 41h

scp\_target (J1979 Targ Spec) = 6Bh

scp\_data\_1 (Data Mode) = 46h

scp\_data\_2 (Returned scp\_data\_2) = test\_id

scp\_data\_3 (Returned scp\_data\_3) = FFh or Test Limit Type

and Component ID

scp\_data\_4 = test support bitmap 1 or

test value MSB

scp\_data\_5 = test support bitmap 2 or

test value LSB

scp\_data\_6 = test support bitmap 3 or

test result MSB

scp\_data\_7 = test support bitmap 4 or

test result LSB

Other Specifications:

IF TEST ID IS NOT SUPPORTED, DO NOT SEND RESPONSE.

Requesting Message: PROCESS\_OBDII\_REQUEST

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REPORT\_OBDII\_PID

Message Type: Broadcast Transmit.

Purpose of Message: This message is sent in response to receipt of scan

tool message PROCESS\_OBDII\_REQUEST, with a Mode 01 request.

Data Flow: From PCM to SCP Network.

THIS MESSAGE MUST BE SENT ON THE SCP NETWORK WITHIN 100 MSEC OF

RECEIVING THE "PROCESS\_OBDII\_REQUEST" MESSAGE.

Data Description: The EEC will transmit the appropriate PID data, as defined

in the SAE specification J1979. EXAMPLE: An OBDII PID request of MIL

status (J1979 Mode 01, PID 01) will prompt the response of the following:

A priority/type byte which complies with the J1979 spec (41h); A GENERIC

function code identifying the message as a J1979 Response (6Bh);

A SPECIFIC function code identifying the message as a PID response (41h);

The PID number which was requested via Scan Tool (01h), and; four bytes

of information, as described in the send message command, which are:

j1979\_01\_011, j1979\_01\_012, j1979\_01\_013 and j1979\_01\_014. The J1979

PID values and scaling are described with "pid\_def()" constructs

throughout the strategy.

The SCP PID table is contained in the module: SCP\_PID\_MAP\_COMx.

Message Specification:

scp\_pri\_type = 41h

scp\_target (J1979 response byte) = 6Bh

scp\_data\_1 (PID Report Funct Code) = 41h

scp\_data\_2 (PID number returned) = pid\_lo

scp\_data\_3 (J1979 data) = yyh

scp\_data\_4 (optional PID data) = yyh

scp\_data\_5 (optional PID data) = yyh

scp\_data\_6 (optional PID data) = yyh

Where:

pid\_lo = PID number (scp\_data\_2 from PROCESS\_OBDII\_REQUEST).

yyh = PID data per SAE specification J1979.

Other Specifications:

IF PID IS NOT SUPPORTED in SCP\_PID\_MAP\_COMx, DO NOT SEND RESPONSE.

Requesting Message: PROCESS\_OBDII\_REQUEST

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REPORT\_OBDII\_RESET

Message Type: Broadcast Transmit.

Purpose of Message: This message is sent in response to receipt of

scan tool message PROCESS\_OBDII\_REQUEST, with a Mode 04 request.

Data Flow: From PCM to SCP Network.

THIS MESSAGE MUST BE SENT ON THE SCP NETWORK WITHIN 100 MSEC OF

RECEIVING THE "PROCESS\_OBDII\_REQUEST" MESSAGE.

Message Specification:

scp\_pri\_type = 41h

scp\_target (Target Specifier) = 6Bh

scp\_data\_1 (Code for OBDII Reset) = 44h

Other Specifications:

Requesting Message: PROCESS\_OBDII\_REQUEST

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONFIRM\_CODES\_CLEAR

Message Type: Node to Node Transmit.

Purpose of Message: This message is sent in response to the request message

REQUEST\_CLEAR\_CODES to indicate that a code reset has

been completed by the EEC.

Data Flow: From EEC to ODU. The scp\_target address, is defined

by the scp\_src\_nar byte contained in the requesting message.

Message Specification:

scp\_pri\_type = C4h

scp\_target (ODU Node Address) = Fxh

scp\_data\_1 (Confirm codes cleared) = 54h

Requesting Message: REQUEST\_CLEAR\_CODES

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DIAGNOSTIC\_RESULTS

Message Type: Node to Node Transmit.

Purpose of Message: This message is sent in response to receipt of the

message REQUEST\_DIAG\_RESULTS. It is used to report any codes which may

have been set during the most recent On-Demand test sequence.

Data Flow: From EEC to ODU. The scp\_target address, is defined

by the scp\_src\_nar byte contained in the requesting message.

USE OF THE 'list' CONCEPT IS MERELY FOR DOCUMENTATION

PURPOSES AND IN NO WAY IMPLIES AN IMPLEMENTATION.

Message Specification:

scp\_pri\_type = C4h

scp\_target (ODU Node Address) = Fxh

scp\_data\_1 (Report stored codes) = 73h

scp\_data\_2 (high byte code 1) = list\_of\_codes

scp\_data\_3 (low byte code 1) = list\_of\_codes

scp\_data\_4 (high byte code 2 or 00)= list\_of\_codes

scp\_data\_5 (low byte code 2 or 00) = list\_of\_codes

scp\_data\_6 (high byte code 3 or 00)= list\_of\_codes

scp\_data\_7 (low byte code 3 or 00) = list\_of\_codes

Other Specifications:

Data Format:

list\_of\_codes : (code\_hi = hi byte of 1st code

code\_lo = lo byte of 1st code

code\_hi = hi byte of 2nd code (or 00h)

code\_lo = lo byte of 2nd code (or 00h)

:

:

code\_hi = hi byte of n'th code (or 00h)

code\_lo = lo byte of n'th code (or 00h))

The 4 digit codes are sent in BCD format. They occupy 2 data bytes

each, with the upper nibble of the upper byte encoded to indicate either

legislated codes, or Ford specific codes as specified in SAE spec J1979.

The codes are packed 3 to a message, with the hi byte first.

If there are less than 3 codes, the message is filled with zeros so

that a fixed length message is transmitted (data bytes 2-7 filled).

Requesting Message: REQUEST\_DIAG\_RESULTS

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

GENERAL\_RESPONSE

Message Type: Node to Node Transmit.

Purpose of Message: This Node to Node message is sent in response to many

Node to Node requests to indicate various types of EEC response.

Data Flow: From EEC to ODU. The scp\_target address, is defined

by the scp\_src\_nar byte contained in the requesting message.

Data Description: It is suggested that the EEC maintain the requesting

message data (scp\_data\_1 to scp\_data\_4, where applicable) for

possible use with this message as shown below. In most instances,

however,the strategy which sends this message will specify the values

to load into the GENERAL\_RESPONSE message scp\_data\_2 to scp\_data\_6.

Message Specification:

scp\_pri\_type = C4h

scp\_target (ODU Node Address) = Fxh

scp\_data\_1 (Generic Response mode) = 7Fh

scp\_data\_2 (Mode of request msg.) = xxh

scp\_data\_3 (Argument #1 of request)= xxh (or 00h)

scp\_data\_4 (Argument #2 of request)= xxh (or 00h)

scp\_data\_5 (Argument #3 of request)= xxh (or 00h)

scp\_data\_6 (General Response Code) = xxh

Other Specifications:

There are 255 possible values of scp\_data\_6. Some of these are shown here:

00h General Affimative

10h General Reject

11h Mode not Supported

12h Invalid Format - Sub-funtion not supported

21h Busy - Repeat request

22h Conditions not correct - Sequence error

23h Routine not complete

31h Request out of range

33h Access denied - device secured

61h Normal Exit with results

62h Normal Exit without results

63h Abnormal Exit with results

64h Abnormal Exit without results

5-83

SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REPORT\_ALL\_CODES

Message Type: Node to Node Transmit.

Purpose of Message: This message is sent in response to receipt of the

message REQUEST\_ALL\_CODES. It is used to report ALL Pending and Set

mil\_codes and all no\_mil\_codes set in EEC KAM.

Data Flow: From EEC to ODU. The scp\_target address, is defined

by the scp\_src\_nar byte contained in the requesting message.

USE OF THE 'list' CONCEPT IS MERELY FOR DOCUMENTATION

PURPOSES AND IN NO WAY IMPLIES AN IMPLEMENTATION.

Message Specification:

scp\_pri\_type = C4h

scp\_target (ODU Node Address) = Fxh

scp\_data\_1 (Report stored codes) = 53h

scp\_data\_2 (high byte code 1) = list\_of\_codes

scp\_data\_3 (low byte code 1) = list\_of\_codes

scp\_data\_4 (high byte code 2 or 00)= list\_of\_codes

scp\_data\_5 (low byte code 2 or 00) = list\_of\_codes

scp\_data\_6 (high byte code 3 or 00)= list\_of\_codes

scp\_data\_7 (low byte code 3 or 00) = list\_of\_codes

Other Specifications:

Data Format:

list\_of\_codes : (code\_hi = hi byte of 1st code

code\_lo = lo byte of 1st code

code\_hi = hi byte of 2nd code (or 00h)

code\_lo = lo byte of 2nd code (or 00h)

:

:

code\_hi = hi byte of n'th code (or 00h)

code\_lo = lo byte of n'th code (or 00h))

The 4 digit codes are sent in BCD format. They occupy 2 data bytes

each, with the upper nibble of the upper byte encoded to indicate either

legislated codes, or Ford specific codes as specified in SAE spec J1979.

The codes are packed 3 to a message, with the hi byte first.

If there are less than 3 codes, the message is filled with zeros so

that a fixed length message is transmitted (data bytes 2-7 filled).

Requesting Message: REQUEST\_ALL\_CODES

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REPORT\_DMR\_DATA

Message Type: Node to Node Transmit.

Purpose of Message: This message is sent in response to receipt of the

message REQUEST\_DMR\_ACCESS.

Data Flow: From EEC to ODU. The scp\_target address, is defined

by the scp\_src\_nar byte contained in the requesting message.

Data Description: The EEC will transmit the appropriate DMR data, plus three

bytes of contiguous addresses following the requested address.

EXAMPLE: REQUEST\_DMR\_ACCESS is received with the following byte string

from scp\_data\_2 on: 00h,0Bh,10h. An upper byte of 00h, indicates a

request for RAM data (a request of 01h or 08h would be for ROM data).

And since the scp\_data\_6 byte was not included, the request is for a

single response only. The following response is sent:

A priority/type byte (C4h); the ODU address which issued the request

(Fxh); the SCP-FORD specificied response mode number in scp\_data\_1

(63h); the Middle Byte of the referenced DMR in scp\_data\_2 (xxh); the

Low Byte of the referenced DMR in scp\_data\_3 (xxh), and; the

corresponding DMR values in RAM registers 0B10, 0B11, 0B12, & 0B13,

in scp\_data\_4 through scp\_data\_7. The message is ALWAYS a fixed length.

Message Specification:

scp\_pri\_type = C4h

scp\_target (ODU Node Address) = Fxh

scp\_data\_1 (Report DMR data mode) = 63h

scp\_data\_2 (Returned DMR mid addrs)= dmr\_mid

scp\_data\_3 (Returned DMR low addrs)= dmr\_lo

scp\_data\_4 (dmr\_rqst address data) = yyh

scp\_data\_5 (dmr\_rqst+1 addrs data) = yyh

scp\_data\_6 (dmr\_rqst+2 addrs data) = yyh

scp\_data\_7 (dmr\_rqst+3 addrs data) = yyh

Where:

dmr\_rqst = Direct Memory address requested (dmr\_mid,dmr\_lo)

dmr\_mid = DMR middle byte (scp\_data\_3 from requesting msg).

dmr\_lo = DMR low byte (scp\_data\_4 from requesting msg).

yyh = Contiguous RAM data following address dmr\_rqst.

Requesting Message: REQUEST\_DMR\_ACCESS

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REPORT\_MIL\_CODES

Message Type: Node to Node Transmit.

Purpose of Message: This message is sent in response to receipt of the

message REQUEST\_MIL\_CODES.

Data Flow: From EEC to ODU. The scp\_target address, is defined

by the scp\_src\_nar byte contained in the requesting message.

USE OF THE 'list' CONCEPT IS MERELY FOR DOCUMENTATION

PURPOSES AND IN NO WAY IMPLIES AN IMPLEMENTATION.

Message Specification:

scp\_pri\_type = C4h

scp\_target (ODU Node Address) = Fxh

scp\_data\_1 (Report OBDII codes) = 43h

scp\_data\_2 (high byte code 1) = list\_of\_codes

scp\_data\_3 (low byte code 1) = list\_of\_codes

scp\_data\_4 (high byte code 2 or 00)= list\_of\_codes

scp\_data\_5 (low byte code 2 or 00) = list\_of\_codes

scp\_data\_6 (high byte code 3 or 00)= list\_of\_codes

scp\_data\_7 (low byte code 3 or 00) = list\_of\_codes

Other Specifications:

Data Format:

list\_of\_codes : (code\_hi = hi byte of 1st code

code\_lo = lo byte of 1st code

code\_hi = hi byte of 2nd code (or 00h)

code\_lo = lo byte of 2nd code (or 00h)

:

:

code\_hi = hi byte of n'th code (or 00h)

code\_lo = lo byte of n'th code (or 00h))

The 4 digit codes are sent in BCD format. They occupy 2 data bytes

each, with the upper nibble of the upper byte encoded to indicate either

legislated codes, or Ford specific codes as specified in SAE spec J1979.

The codes are packed 3 to a message, with the hi byte first.

If there are less than 3 codes, the message is filled with zeros so

that a fixed length message is transmitted (data bytes 2-7 filled).

Requesting Message: REQUEST\_MIL\_CODES

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REPORT\_PID\_DATA

Message Type: Node to Node Transmit.

Purpose of Message: This message is sent in response to receipt of the

message REQUEST\_PID\_ACCESS.

Data Flow: From EEC to ODU. The scp\_target address, is defined

by the scp\_src\_nar byte contained in the requesting message.

Data Description: The EEC will transmit the appropriate PID data, as defined

in the module SCP\_PID\_MAP\_COMx.

Message Specification:

scp\_pri\_type = C4h

scp\_target (ODU Node Address) = Fxh

scp\_data\_1 (Report PID data mode) = 62h

scp\_data\_2 (Returned PID number) = pid\_hi

scp\_data\_3 (Returned PID number) = pid\_lo

scp\_data\_4 (PID data) = yyh

scp\_data\_5 (optional PID data) = yyh

scp\_data\_6 (optional PID data) = yyh

scp\_data\_7 (optional PID data) = yyh

Where:

pid\_hi = PID number high byte (scp\_data\_2 from requesting msg).

pid\_lo = PID number low byte (scp\_data\_3 from requesting msg).

yyh = Data per the PID table in SCP\_PID\_MAP\_COMx.

Other Specifications:

IF PID is NOT SUPPORTED in PID MAP, send GENERAL\_RESPONSE message as

defined in the requesting message. The data will always be of the

forms: byte, word, or double-word. They can point to ROM or RAM data.

Requesting Message: REQUEST\_PID\_ACCESS

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REPORT\_RAPID\_PACKET

Message Type: Node to Node Transmit.

Purpose of Message: This message is sent in response to receipt of the

message REQUEST\_RAPID\_PACKET.

Data Flow: From EEC to ODU. The scp\_target address, is defined

by the scp\_src\_nar byte contained in the requesting message.

Data Description: The EEC will transmit the appropriate packet's data, as

defined dynamically through the message DEFINE\_RAPID\_PACKET and

initiated via REQUEST\_RAPID\_PACKET. Only the Type 'A' rate is supported.

To manage which packets are actually enabled for transmission, a transmit

"queue" is symbolically referenced which maintains the status of each

rapid packet message. A packet can also be removed from the "queue" by

using the REQUEST\_RAPID\_PACKET message (with a 00h in scp\_data\_2).

USE OF THE queue CONCEPT IS MERELY FOR DOCUMENTATION

PURPOSES AND IN NO WAY IMPLIES AN IMPLEMENTATION.

Message Specification:

scp\_pri\_type = C4h

scp\_target (ODU Node Address) = Fxh

scp\_data\_1 (Report Packet mode) = 6Ah

scp\_data\_2 (Packet Number 01..0Fh) = pkt\_num

scp\_data\_3 (1st Byte of pkt data) = yyh

scp\_data\_4 (2nd Byte of pkt data) = yyh

scp\_data\_5 (3rd Byte of pkt data) = yyh

scp\_data\_6 (4th Byte of pkt data) = yyh

scp\_data\_7 (5th Byte of pkt data) = yyh

Other Specifications:

NOTE THAT THE J1979 PIDS ARE NOT INTENDED FOR SERVICE BY

ANY REPETITIVE DATA TRANSMISSION SPECIFICATION.

PACKETED MESSAGES ARE ALWAYS A FIXED LENGTH OF SEVEN DATA BYTES.

Any undefined packet (or portion of a packet) is to be zero filled.

Requesting Message: REQUEST\_RAPID\_PACKET

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SCP INTERFACES, OBDII DIAGNOSTIC MESSAGE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SECURITY\_RESPONSE

Message Type: Node to Node Transmit.

Purpose of Message: This Node to Node message is sent in response to the

Node to Node request for access to secured routines within the EEC.

Data Description:

The second data byte contains an identifier which informs the ODU how to

interperet the remaining message contents. A 01h indicates the EEC is

responding with the OSC\_SEED value, as requested by the ODU. Scp\_data\_3 and

scp\_data\_4 contain the high/low bytes of the security access algorithm

OSC\_SEED value (NOTE that since the EEC's algorithm requires only a byte

input, scp\_data\_3 will be packed with 00h). A "send(SECURITY\_RESPONSE)"

message command is used in this case.

If scp\_data\_2 from the SECURITY\_REQUEST message is 02h, the strategy issues

the "send(GENERAL\_RESPONSE)" message command. A 02h indicates the EEC has

processed the ODU's KEY value and made a decision to allow or disallow the

requested security access.

SECURITY\_RESPONSE IS A FIXED LENGTH MESSAGE.

Data Flow: From EEC to ODU. The scp\_target address, is defined

by the scp\_src\_nar byte contained in the requesting message.

Message Specification:

scp\_pri\_type = C4h

scp\_target (ODU Node Address) = Fxh

scp\_data\_1 (Security Response mode)= 67h

scp\_data\_2 (Response Type Byte) = 01h

scp\_data\_3 (Variable data byte) = xxh

scp\_data\_4 (Variable data byte) = xxh

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SCP INTERFACES, OUTPUT STATE CONTROL RESPONSE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

5.1.8 SCP OUTPUT STATE CONTROL MESSAGE RESPONSE HANDLING (CDAM0)

OVERVIEW

OSC\_RESPONSE is responsible for sending Output State Control related

GENERAL\_RESPONSE messages to the SCP network. This routine accepts the OSC

channel number and the hexadecimal response code as arguments, and uses them

to look up the appropriate data to send with the GENERAL\_RESPONSE. This

routine is designed to generically handle all SCP general responses

associated with OSC that were sent from non-SCP modules.

DEFINITIONS

Registers:

- OSC\_VALUEnn = Output State Control substitution value for channel nn.

- SUBST\_REQnn = Substitution Requested flag for channel nn.

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SCP INTERFACES, OUTPUT STATE CONTROL RESPONSE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SCP\_OSC\_RESPONSE\_COM1

BEGIN: OSC\_RESPONSE( channel, resp\_code )

channel is word type -----------| send (GENERAL\_RESPONSE: 7Fh, 30h, channel,

| high byte of OSC\_VALUE[channel],

| low byte of OSC\_VALUE[channel],

| resp\_code)

| ; OSC\_VALUE is a word

|

| --- ELSE ---

|

channel is byte type -----------| send (GENERAL\_RESPONSE: 7Fh, 30h, channel,

| 00h, OSC\_VALUE[channel], resp\_code)

| ; OSC\_VALUE is a byte

|

| --- ELSE ---

|

channel is bit type ----| |

|AND ---| send (GENERAL\_RESPONSE: 7Fh, 30h, channel,

OSC\_VALUE[channel] = 0 -| | 00h, 00h, resp\_code)

| ; OSC\_VALUE is a bit

|

| --- ELSE ---

|

channel is bit type ----| |

|AND ---| send (GENERAL\_RESPONSE: 7Fh, 30h, channel,

OSC\_VALUE[channel] = 1 -| | 00h, 01h, resp\_code)

| ; OSC\_VALUE is a bit

unconditionally ----------------| SUBST\_REQ[channel] = 0

| ; Clear flag that indicates a new

| ; substitution has been requested for

| ; the selected channel

END: OSC\_RESPONSE

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SCP INTERFACES, RECEIVE STATUS REQUEST MESSAGE - CDAN2

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5.1.9 RX\_PT\_STAT\_RQST MESSAGE (CDAN0)

OVERVIEW

This SCP module is used by various modules in the multiplexed data bus for

requesting Powertrain-specific information by transmitting the corresponding

Status Request message.

There are three types of status requests available in the SCP network (Body,

Chassis, and Powertrain). The PCM is expected to receive and respond to

Powertrain-specific status request messages alone.

The data sent in the message is the actual target specifier of the required

SCP message (accompanied by any secondary specifier as necessary). The node

which recognizes this message must examine its list of transmit message

target specifier (/secondary ID) bytes to determine if it is responsible for

transmitting the requested information. If a match occurs, the message is

transmitted by that node and the requesting node receives the data.

DEFINITIONS

INPUTS

Registers:

- scp\_data\_n = Data byte in SCP message (n = 1 through 7).

- SCP\_ECT\_TMR = Free running timer used to record time elapsed between two

consecutive ECT\_DEG\_C messages

OUTPUTS

Registers:

- SEND\_ECT = Flag to enable the conditional transmission of the ECT (deg.

C) as a result of a Status Request message.

========================================================================

Message Representation:

TARG SOURCE

PRI/TYP SPEC NAR DATA1 DATA2

------- ---- ------ ----- -----

61h 54h ??h var var

CONTROL

RECEIVE CONDITIONS FLAGS

----------------------------- -------

Unknown. none

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SCP INTERFACES, RECEIVE STATUS REQUEST MESSAGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

========================================================================

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SCP INTERFACES, RECEIVE STATUS REQUEST MESSAGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SCP\_RX\_PT\_STAT\_RQST\_COM3

RX\_PT\_STAT\_RQST

Message Type: Broadcast Receive.

Data Flow: From SCP network to EEEC.

Receive Buffer Data Bytes:

Sending Node Address = ??h (not used in strategy)

scp\_data\_1 (Primary ID of req'd msg) = xxh (mandatory)

scp\_data\_2 (Sec ID of req'd msg) = xxh (or 00h as required)

Receive Message Execution (only when this message is received):

scp\_data\_1 = 49h -----------------|

|AND -| send(ECT\_DEG\_C)

scp\_data\_2 = 10h -----------------| | SCP\_ECT\_TMR := 0

| reset the free-running tmr

| SEND\_ECT := 1

| ; enable periodic transmit

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SCP INTERFACES, ECT\_DEG\_C MESSAGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

5.1.10 ECT\_DEG\_C MESSAGE (CDAM0)

OVERVIEW

This SCP message sends the Engine Coolant Temperature (ECT) from the EEEC to

the Electronic Automatic Temperature Control (EATC) or to any other node with

the same functional address. The message is sent per the conditions detailed

in the SCP\_MSG\_CONTROL\_xx\_COMx module (where xx is the specific strategy

utilizing this message). The data carried by this message must meet SAE

standard content requirements.

DEFINITIONS

Registers:

- ECT = Engine Coolant Temperature in Degrees F.

Bit Flags:

- CFMFLG = ECT failure mode flag. 1 -> failure mode set.

Other

- scp\_data\_n = Data byte in SCP message (n = 1 through 7).

- scp\_gen\_func = SCP message primary identifier for functional messages.

- scp\_pri\_type = SCP message Priority/Type byte.

========================================================================

Message Representation:

TARG SOURCE

PRI/TYP SPEC NAR DATA1 DATA2

------- ---- ------ ----- -----

61h 49h 10h 10h var

TRANSMIT CONDITIONS & MESSAGE CONTROL

--------------------------------------

SCP\_MSG\_CONTROL\_... module

========================================================================

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SCP INTERFACES, ECT\_DEG\_C MESSAGE - CDAN2

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PROCESS

STRATEGY MODULE: SCP\_ECT\_DEG\_C\_COM1

ECT\_DEG\_C

Message Type: Broadcast Transmit.

Data Flow: From PCM to SCP Network as defined in SCP\_MSG\_CONTROL module.

Message Specification:

scp\_pri\_type = 61h

scp\_gen\_func (primary msg ID) = 49h

scp\_data\_1 (Secondary ID of ECT msg) = 10h

scp\_data\_2 (ECT value for SCP in deg.C) = scpect\_c

Message Transmit Routine:

Execute only upon send command for this message.

Change CFMFLG flag to SAE standard.

CFMFLG = 1 -----------------------------| scpect\_c = FFh

| ;ECT failure mode flag set

|

| --- ELSE ---

|

| scpect\_c = ((ECT - 32) \* 5/9) + 40

| (ECT in deg C with 40 deg offset)

|

| (Range: -40 - 214 deg C

| => 00 - FE hex)

| (Res: 1 deg C per bit)

| (FF hex => Invalid scpect\_c data)

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ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

5.1.11 PASSIVE ANTI-THEFT (CDAK0)

OVERVIEW

+----------------------------+

| ANTI\_THEFT |

+----------------------------+

| . definitions |

| . anti\_theft\_reset |

| . anti\_theft\_init |

| . anti\_theft\_input |

| . anti\_theft\_state\_control |

| . anti\_theft\_timer\_control |

| . anti\_theft\_controller |

| . pat\_fault\_detection |

| . store\_a\_code() |

+----------------------------+

The Anti-theft strategy is used to disable the engine when an offboard device

(typically the PATS module or LCM) determines a theft condition exists. The

PCM performs a function read message directed at the offboard device. If the

resulting information indicates a theft condition is present, the anti-theft

strategy will output the FLG\_THFT\_FCO to the fuel control strategy. When

set, this flags directs the fuel control strategy to discontinue fuel

delivery to the engine. The communications between the PCM and offboard

device are carried out over the SCP vehicle network.

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ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

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The anti-theft strategy is based on the parameter THEFT\_STATE which is to be

maintained in KAM. This parameter tells us which state the anti-theft system

is in at all times. The allowable states the system can be in are:

1. DISABLE - This state is one in which the anti-theft strategy has been

disabled. This can be entered either by calibrating out the system or when

an SCP fault occurs after initial vehicle start. The second path is to

prevent stranding the vehicle operator when a system or component failure

occurs after the vehicle has successfully passed all the criteria to start

the car once. It is assumed that a valid key and starting sequence has been

used to get the engine started, so it does not make sense to prevent engine

start if the SCP network goes down later. In the disable state, the vehicle

is allowed to start normally.

2. START\_ENGINE - This state is one in which the anti-theft strategy has

been successfully exercised and all security criteria have been met so that

the engine is allowed to continue starting. The normal mode of entry into

this state is by obtaining the 'ok' response from the function read message

that the PCM performs during the starting sequence. The START\_ENGINE state

can also be entered from the DISABLE state if the calibration switch

SW\_ANTI\_THFT is set and the SCP network is functioning properly

(PAT\_FAULT=0).

3. STOP\_ENGINE - This state is one in which the anti-theft strategy has

detected a breach in one of the security criteria. The fuel delivery will be

stopped and the engine will not be allowed to start. This state is entered

in one of two ways. The first is if the result of the function read results

in a 'theft' response. The second is if a 'no\_response' or 'wait' results

from the function read (i.e., the PATS module never responded to the function

read message or told us to wait because they were not ready yet.) and the PCM

has been in run mode for more than 1 second. This second path has a one

second time limit to ensure the vehicle has had very little time to move

under it's own power prior to the engine fuel delivery being cut-out.

4. DELAY - This state is entered on KAM reset and RAM initialization if

currently not in the DISABLE state. The strategy waits in this state until

the SCP network is up and capable of supporting the initial function read

message. This is based on SCP\_DT2. When this time has passed, the first

function read message takes place and the DELAY state is exited.

5. RETRY - If the first function read after a KAM or RAM reset results in a

'no\_response' or 'wait' response from the PATS module, the RETRY state is

entered. This state will be exited when the next function read message is

performed or the PCM has been in run mode for more than one second or if KAM

or RAM initialization takes place again.

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ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

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The following diagram shows the input/output relationship of the anti-theft

strategy:

SCP BASED ANTI-THEFT STRATEGY

-----------------------------

+---------------+

time -------------->| |--------> FLG\_THFT\_FCO

SW\_ANTI\_THFT ------>| ANTI-THEFT |--------> FR\_PAT\_DATA

UNDSP ------------->| CONTROL |--------> P1260(theft, wait)

SCP\_TMR ----------->| STRATEGY |--------> U1451(no response)

KAM\_ERROR --------->| |

+---------------+

|Local data: |

|. THEFT\_STATUS |

|. THEFT\_STATE |

|. PAT\_FAULT |

|. THEFT\_TMR |

|. SCP\_PATS\_TMR |

|. FR\_PAT\_DATA |

+---------------+

The strategy is structured per the following diagram:

+------------+ +-------------------+

| background | | RAM initialization|

+------+-----+ +---------+---------+

| |

+-----------+-----------+ +--------+--------+

| anti\_theft\_controller | | anti\_theft\_init |

+-----------+-----------+ +-----------------+

|

+-------------+----+--------+------------+-----------------+

| | | | |

+---+---+ +-------+-------+ +---+---+ +------+--------+ +------+-----------+

| reset | | timer\_control | | input | | state\_control | | pat\_fault\_detect |

+-------+ +---------------+ +-------+ +------+--------+ +------------------+

|

+-----+--------+

| store\_a\_code |

+--------------+

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ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

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A finite state machine will be used to graphically represent how the strategy

functions.

Below is a description of how a finite state machine functions.

A finite state machine is a way to graphically illustrate the functioning of

a system or process that can be in a set of DISCRETE states. The diagram

shows how and when transitions can occur between the states.

+----------------------+

| |

| STATE X |<-------------------

| | condition

+-----+----------A-----+ ---------

| | action

| |

condition | | condition

--------- | | ---------

action | | action

| |

| |

| |

+-----V----------+-----+

| |

| STATE Y |

| |

+----------------------+

CONVENTIONS:

· BOXES represent STATES of the system.

· ARROWS represent TRANSITIONS between states.

· CONDITIONS will CAUSE a transition to be taken.

· ACTIONS are done WHEN a transition is taken.

RULES:

· The system can be in only one state at a time.

· The system remains in a given state until an event

occurs to cause a transition.

· No other transitions than those shown can be taken.

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ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

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FINITE STATE REPRESENTATION

---------------------------

SW\_ANTI\_THFT=0

--------------

FLG\_THFT\_FCO=0 +---+SCP\_PATS\_TMR>=PATS\_RETRY

THEFT\_STATUS=no\_resp | |---------------

THEFT\_TMR=0 | |FR\_PAT\_DATA=0

from SCP\_PATS\_TMR=0 +-------+-+ |send(ANTI\_THEFT\_STATUS)

any ----------------------------------->| DISABLE\*|<+SCP\_PATS\_TMR=0

state +--+----A-+

PAT\_FAULT=0 & | |

SW\_ANTI\_THFT=1 | | PAT\_FAULT=1

-------------- | | --------------

FLG\_THFT\_FCO=0 | | FLG\_THFT\_FCO=0

send(ENGINE\_PAT\_STATUS) | | send(ENGINE\_PAT\_STATUS)

| |

+-V----+-+ SCP\_PATS\_TMR>=

| START |-+ PATS\_RETRY

+----------------------->| ENGINE\*| |---------------

| THEFT\_STATUS=OK & +-+-A--A-+ |FR\_PAT\_DATA=0

| pu\_time > SCP\_DT2 | | | |send(ANTI\_THEFT\_STATUS)

| ----------------- | | +---+SCP\_PATS\_TMR=0

| FLG\_THFT\_FCO=0 | |

SCP\_TMR>=SCP\_DT2 | send(ENGINE\_PAT\_STATUS) | | THEFT\_TMR < 1 second &

---------------- | | | THEFT\_STATUS=OK

FR\_PAT\_DATA=0 | +------------------------+ | -----------------

send(ANTI\_ | | power up | FLG\_THFT\_FCO=0

THEFT\_STATUS) | | -------------- | send(ENGINE\_PAT\_STATUS)

+-------+ | | THEFT\_STATUS=NO\_RESP |

| | | | FLG\_THFT\_FCO=0 |

+---->+-+-+-V-+ +---+---+

------------>| DELAY |------------------->| RETRY |-+SCP\_TMR>=SCP\_DT2

KAM reset +-A-+-A-+ [THEFT\_STATUS=WAIT +-+-+-A-+ |----------------

-------------- | | | or NO\_RESP]& | | | |FR\_PAT\_DATA=0

FLG\_THFT\_FCO=0 | | | pu\_time > SCP\_DT2 | | +---+send(ANTI\_THEFT\_STATUS)

THEFT\_STATUS= | | | ------------------ | |

no\_resp | | | FLG\_THFT\_FCO=0 | |

PAT\_FAULT=0 | | | | |

THEFT\_TMR=0 | | +------------------------+ |

SCP\_PATS\_TMR=0 | | power up |

| | -------------- | THEFT\_STATUS=THEFT OR

| | THEFT\_STATUS=NO\_RESP | [[THEFT\_STATUS=WAIT

| | FLG\_THFT\_FCO=0 | or NO\_RESP] &

| | | THEFT\_TMR >= 1 second]

| +--------------------------+ | ------------------

| THEFT\_STATUS=THEFT & | | FLG\_THFT\_FCO=1

| pu\_time > SCP\_DT2 | | store\_a\_code(THEFT\_STATUS)

| -------------------- | | send(ENGINE\_PAT\_STATUS)

| FLG\_THFT\_FCO=1 | |

| store\_code(P1260) | |

| send(ENGINE\_PAT\_STATUS) | |

| +-V-V----+

+--------------------------| STOP |

power up | ENGINE |

-------------- +--------+

THEFT\_STATUS=NO\_RESP

FLG\_THFT\_FCO=0

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ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

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Where:

1. SCP\_DT2 represents the time to wait prior to first function read message.

2. THEFT\_STATUS is the returned data from the anti-theft function read

message.

3. The finite state machine is discrete, updated once per background pass or

during RAM initialization or during KAM initialization.

4. SCP\_PATS\_TMR is free running up counter in these states, otherwise it is

held at zero.

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ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

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DEFINITIONS

INPUTS

Registers:

- FRECR = Commanded EBC Control Register (ECR) state for a Function Read

SCP message transmit command.

- FR\_97\_COUNT = State encoded register indicating which type of SCP bus

utilization is enabled for Function Read ANTI\_THEFT\_STATUS (target 97h).

State 0: Invalid State (message not yet sent).

1: Differentially Ended (+ & -).

2: Single Ended - (Bus A).

3: Single Ended + (Bus B).

- KAM\_ERROR = Indicates keep alive RAM invalid.

- SCP\_PATS\_TMR = Control timer to send Anti-theft message in engine\_start

state.

- THEFT\_STATE = SCP Anti-theft finite state machine control register.

- THEFT\_STATUS = State encoded byte for anti-theft status determination,

obtained from function read message ANTI\_THEFT\_STATUS.

- THEFT\_TMR = Control timer to disable engine as a result of Anti-theft.

Bit Flags:

- PAT\_FAULT = Communication fault indicated between PCM and Anti-theft

module; 1 -> fault, 0 -> no fault.

- FLG\_THFT\_FCO = Flag signaling when fuel is being cut out due to anti

theft system action; 1 -> cutting out fuel.

- FR\_PAT\_DATA = Anti-theft data available flag; 1 -> data available from

SCP.

- UNDSP = Underspeed flag; 1 -> in underspeed mode.

Calibration Constants:

- PATS\_RETRY = Time delay to re-verify the SCP connection between the PCM &

the PATS module, seconds.

- SCP\_DT2 = Time delay to begin transmitting SCP status request messages.

- SW\_ANTI\_THFT = Software switch to enable/disable the EEC controlled

vehicle anti theft strategy; 1 -> enable.

5-103

ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- ECR = EBC Control Register (NOT DISPLAYABLE).

- FRECR = See above.

- FR\_97\_COUNT = See above.

- SCP\_PATS\_TMR = See above.

- THEFT\_STATE = See above.

- THEFT\_STATUS = See above.

- THEFT\_TMR = See above.

Bit Flags:

- FLG\_THFT\_FCO = See above.

- FR\_PAT\_DATA = See above.

- PAT\_FAULT = See above.

OTHER

- P1260 = Engine disabled due to detected vehicle theft.

- U1451 = Engine disabled due to lack of response from the anti-theft

module.

5-104

ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ANTI\_THEFT\_COM4

BEGIN: definitions

;define parameters used to make the strategy more readable. This is not to

;explicitly executed.

unconditionally ------------------------| delay := 0

| disable := 1

| start\_engine := 2

| retry := 3

| stop\_engine := 4

| no\_resp := 80h

| ok := 7Fh

| wait := 01h

| theft := 00h

| true := 1

| false := 0

END: definitions

BEGIN: anti\_theft\_init

;The following logic is to executed during RAM initialization.

SW\_ANTI\_THFT = 0 -----------------------| THEFT\_STATE := disable

;Anti-theft calibrated out | FLG\_THFT\_FCO := false

| THEFT\_STATUS := no\_resp

| THEFT\_TMR := 0

| SCP\_PATS\_TMR := 0

|

| --- ELSE ---

THEFT\_STATE = start\_engine -------| |

| |

THEFT\_STATE = retry --------------|OR --| THEFT\_STATE := delay

| | THEFT\_STATUS := no\_resp

THEFT\_STATE = stop\_engine --------| | FLG\_THFT\_FCO := false

| THEFT\_TMR := 0

| SCP\_PATS\_TMR := 0

END: anti\_theft\_init

5-105

ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: anti\_theft\_controller

;execute the following once per background to control the anti-theft

;strategy.

SW\_ANTI\_THFT = 0 -----------------------| THEFT\_STATE := disable

;Anti-theft calibrated out | FLG\_THFT\_FCO := false

| THEFT\_STATUS := no\_resp

| THEFT\_TMR := 0

| SCP\_PATS\_TMR := 0

|

| --- ELSE ---

|

| Do: anti\_theft\_reset

| Do: anti\_theft\_timer\_control

| Do: anti\_theft\_state\_control

| Do: anti\_theft\_input

| Do: pat\_fault\_detection

END: anti\_theft\_controller

5-106

ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: anti\_theft\_reset

;Logic that handles the KAM reset values of the anti-theft strategy.

KAM\_ERROR = 1 --------------------------| THEFT\_STATE := delay

| FLG\_THFT\_FCO := false

| THEFT\_STATUS := no\_resp

| PAT\_FAULT := false

| THEFT\_TMR := 0

| SCP\_PATS\_TMR := 0

END: anti\_theft\_reset

BEGIN: anti\_theft\_timer\_control

;Logic process used to control THEFT\_TMR, a high resolution timer for

;anti-theft strategy, and the fault detection message pacing timer,

;SCP\_PATS\_TMR.

UNDSP = 1 ------------------------------| THEFT\_TMR := 0

THEFT\_STATE <> start\_engine ------|

|AND -| SCP\_PATS\_TMR := 0

THEFT\_STATE <> disable -----------|

END: anti\_theft\_timer\_control

BEGIN: store\_a\_code(status)

;Logic process used to interface to the diagnostic executive.

status = theft -------------------|

|OR --| store\_code(P1260)

status = wait --------------------| |

| --- ELSE ---

|

status = no\_resp -----------------------| store\_code(U1451)

END: store\_a\_code(status)

5-107

ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: anti\_theft\_state\_control

;Logic that specifies operation of the FSM shown in the overview.

PAT\_FAULT = 1 --------------------|

|AND -| THEFT\_STATE := disable

THEFT\_STATE = start\_engine -------| | FLG\_THFT\_FCO := false

| send(ENGINE\_PAT\_STATUS;

| 81h, THEFT\_STATUS)

| ; Engine enabled - PATS disabled

|

| --- ELSE ---

THEFT\_STATUS = ok ----------| |

|AND -| |

THEFT\_STATE = delay --------| | |

| |

THEFT\_TMR < 1 second -------| | |

| | |

THEFT\_STATUS = ok ----------|AND -|OR --| THEFT\_STATE := start\_engine

| | | FLG\_THFT\_FCO := false

THEFT\_STATE = retry --------| | | send(ENGINE\_PAT\_STATUS;

| | 81h, THEFT\_STATUS)

PAT\_FAULT = 0 --------------| | | ; Engine enabled

|AND -| |

THEFT\_STATE = disable ------| |

| --- ELSE ---

THEFT\_STATUS = wait --------| |

|OR --| |

THEFT\_STATUS = no\_resp -----| | |

| | ; Retry PATS function read

SCP\_TMR > SCP\_DT2 ----------------|AND -| THEFT\_STATE := retry

| | FLG\_THFT\_FCO := false

THEFT\_STATE = delay --------------| |

| --- ELSE ---

THEFT\_STATUS = theft -------| |

| |

THEFT\_STATE = delay --| |AND -| |

|OR --| | |

THEFT\_STATE = retry --| | |

|OR --| THEFT\_STATE := stop\_engine

THEFT\_STATUS = wait --| | | FLG\_THFT\_FCO := true

|OR --| | | store\_a\_code(THEFT\_STATUS)

THEFT\_STATUS=no\_resp -| | | | send(ENGINE\_PAT\_STATUS;

|AND -| | 01h, THEFT\_STATUS)

THEFT\_TMR >= 1 second ------| | ; Engine disabled

|

THEFT\_STATE = retry --------|

END: anti\_theft\_state\_control

5-108

ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: anti\_theft\_input

;Logic process to obtain the THEFT\_STATUS value via SCP from the PATS/LCM.

;To be executed once per background loop.

SCP\_TMR >= SCP\_DT2 ---------------|

|AND -| FR\_PAT\_DATA := 0

THEFT\_STATE = delay --------| | | send(ANTI\_THEFT\_STATUS)

|OR --| | ; Load Transmit Queue

THEFT\_STATE = retry --------|

END: anti\_theft\_input

5-109

ANTI-THEFT, PASSIVE ANTI-THEFT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: pat\_fault\_detection

Logic process used to test the network connection between the PCM and the

PATS/LCM anti-theft module - ONLY execute if in link verification states.

NOTE: The Function Read retry process continues until either three attempts

are made, or until the message is properly acknowledged by the target Node.

If no acknowledge is received after a set number of attempts, then the

message is considered faulted and the appropriate FMEM action is enabled.

THEFT\_STATE <> start\_engine ------|

|AND -| Exit (No Action)

THEFT\_STATE <> disable -----------| |

;Not in SCP link verification mode |

| --- ELSE ---

|

FR\_97\_COUNT <> 1 -----------------| | ; Queue up first Link

;First attempt not been queued | | ; Verification message.

| |

FRECR = 0 ------------------------|AND -| FR\_PAT\_DATA := 0

;First attempt not been sent | | FR\_97\_COUNT := 1

| | send(ANTI\_THEFT\_STATUS)

SCP\_PATS\_TMR >= PATS\_RETRY -------| | ; Load Transmit Queue

;Waited enough time to retry link |

| SCP\_PATS\_TMR := 0

|

| --- ELSE ---

FR\_97\_COUNT = 1 ------------| |

;First attempt was queued | |

| |

FRECR = 72h ----------------|AND -| |

;First attempt was sent | | |

| | |

FR\_PAT\_DATA = 0 ------------| | |

;Not yet seen good 'ack' |OR --| ; Attempt to obtain good

| | ; Acknowledge byte from

FR\_97\_COUNT = 2 ------------| | | ; Anti-Theft node FR register.

;Second attempt was queued | | |

| | | Increment FR\_97\_COUNT

FRECR = 52h ----------------|AND -| | send(ANTI\_THEFT\_STATUS)

;Second attempt was sent | | ; Load Transmit Queue

| |

FR\_PAT\_DATA = 0 ------------| | SCP\_PATS\_TMR := 0

;Not yet seen good 'ack' |

| --- ELSE ---

FR\_97\_COUNT = 3 ------------------| |

;Third attempt was queued | | ; Detected link fault.

| |

FRECR = 32h ----------------------|AND -| PAT\_FAULT := true

Third attempt was sent | | store\_code(U1451)

| |

FR\_PAT\_DATA = 0 ------------------| | ; Set up for next link retry

;Still not seen good 'ack' | FRECR := 0

END: pat\_fault\_detection

5-110

SCP INTERFACES, ANTI\_THEFT\_STATUS MESSAGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

5.1.12 ANTI\_THEFT\_STATUS Message (CDAK0)

OVERVIEW

Purpose of Message:

This Function Read message is sent from the EEEC to determine the status of

the Anti-theft system. The message is sent per the conditions detailed in

the ANTI\_THEFT section. Successful receipt of the Function Read message will

also indicate to the strategy that the SCP link is alive between the PCM and

the Anti-theft control module.

DEFINITIONS

OUTPUTS

Registers:

- FRECR = Commanded EBC Control Register (ECR) state for a Function Read

SCP message transmit command.

- FR\_97\_COUNT = Register indicating type of bus utilization for FR of

ANTI\_THEFT\_STATUS (target 97h) message.

- ECR = EBC Control Register (NOT DISPLAYABLE).

- THEFT\_STATUS = State encoded byte for anti-theft status determination,

obtained from function read message ANTI\_THEFT\_STATUS.

Bit Flags:

- FR\_PAT\_DATA = Anti-theft data available flag.

- PAT\_FAULT = Fault flag indicating a communications problem exists between

the PCM and the Anti-theft module.

========================================================================

Message Representation:

TARG SOURCE

PRI/TYP SPEC NAR ack

------- ---- ------ -----

43h 97h 10h var

TRANSMIT CONDITIONS & MESSAGE CONTROL

--------------------------------------

ANTI\_THEFT\_COMx

========================================================================

5-111

SCP INTERFACES, ANTI\_THEFT\_STATUS MESSAGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SCP\_ANTI\_THEFT\_STATUS\_COM1

ANTI\_THEFT\_STATUS

Message Type: Function Read Transmit

Data Flow: From PCM to network, responsible node returns a data byte

back to the PCM containing theft status.

Message Specification:

PCM sends: scp\_pri\_type = 43h

scp\_gen\_func (primary msg ID) = 97h

node responds: scp\_frdr\_dat (theft status reply)= xxh

Acknowledgment Handler (execute upon reception of returned data byte ONLY):

scp\_frdr\_dat = 00h ---------------|

(THEFT indicated) |

|

scp\_frdr\_dat = 01h ---------------|OR --| THEFT\_STATUS := scp\_frdr\_dat

(WAIT indicated) | | FR\_PAT\_DATA := 1

| | PAT\_FAULT := 0

scp\_frdr\_dat = 7Fh ---------------| | ECR := 72h

(OK indicated) | FRECR := 00h

| FR\_97\_COUNT := 0

|

| --- ELSE ---

|

| ECR := 72h

| FRECR := 00h

| FR\_97\_COUNT := 0

| No change to THEFT\_STATUS

| No change to FR\_PAT\_DATA

| No change to PAT\_FAULT

5-112

SCP INTERFACES, ENGINE\_PAT\_STATUS MESSAGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

5.1.13 ENGINE\_PAT\_STATUS Message (CDAK0)

OVERVIEW

Purpose of Message:

This Broadcast message is sent to provide results of the PCM's Anti-theft

logic (engine ENabled due to PATS, engine DISabled due to PATS, or PATs Logic

disabled due to communications problem). The receiving node uses this data

to either set or clear a Fault Indication light on the dashboard. The

message is sent per the conditions detailed in the ANTI\_THEFT chapter.

The variable data bytes provided in this message are defined in the send()

construct which issues the transmit command.

DEFINITIONS

INPUTS

Registers:

- THEFT\_STATUS = State encoded byte for anti-theft status determination,

obtained from function read message ANTI\_THEFT\_STATUS.

========================================================================

Message Representation:

TARG SOURCE SEC

PRI/TYP SPEC NAR ID data

------- ---- ------ ---- ----

61h 93h 10h var var

TRANSMIT CONDITIONS & MESSAGE CONTROL

--------------------------------------

ANTI\_THEFT\_COMx

========================================================================

5-113

SCP INTERFACES, ENGINE\_PAT\_STATUS MESSAGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SCP\_ENGINE\_PAT\_STATUS\_COM1

ENGINE\_PAT\_STATUS

Message Type: Broadcast Transmit

Data Flow: From PCM to network.

Message Specification:

scp\_pri\_type = 61h

scp\_gen\_func (primary msg ID) = 93h

scp\_data\_1 (secondary msg ID) = xxh

scp\_data\_2 (THEFT\_STATUS echo) = xxh

5-114

SCP INTERFACES, ENGINE PAT DATA STATUS REQUEST MESSAGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

5.1.14 REQUEST\_SECURITY\_STATUS (CDAK0)

OVERVIEW

This SCP message can be used by various modules (on multi-node vehicles) to

request a broadcast of the message transmitted by the PCM immediately

following a decision to either start the vehicle or disable it as part of a

detected theft countermeasure. Even though this message is quite specific,

SAE rules dictate that a Secondary ID be evaluated to determine what message

is actually being requested for broadcast.

DEFINITIONS

INPUTS

Registers:

- scp\_data\_n = Data byte in SCP message (n = 1 through 7).

========================================================================

Message Representation:

TARG SOURCE

PRI/TYP SPEC NAR DATA1

------- ---- ------ -----

61h 93h ??h var

CONTROL

RECEIVE CONDITIONS FLAGS

----------------------------- -------

Unknown. none

========================================================================

5-115

SCP INTERFACES, ENGINE PAT DATA STATUS REQUEST MESSAGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SCP\_REQUEST\_SECURITY\_STATUS\_COM1

REQUEST\_SECURITY\_STATUS

Message Type: Broadcast Receive.

Data Flow: From SCP network to EEEC.

Receive Buffer Data Bytes:

Sending Node Address = ??h (not used in strategy)

scp\_data\_1 (Sec ID of req'd msg) = xxh

Receive Message Execution (only when this message is received):

scp\_data\_1 = C1h -----------------------| send(ENGINE\_PAT\_STATUS)

5-116

SCP INTERFACES, SCP OBDII MODE 06 REPORTING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

5.2 SCP OBDII SAE-J1979 MODE 06 SUPPORT MAP (CDAN0)

OVERVIEW

This strategy specific module identifies the test results and test limits

required for replying to an OBDII Mode 06 request for data. Mode 06 is fully

documented in SAE J1979. The Response Table included here is used in

conjunction with the logic in SCP\_OBDII\_DIAG\_COMn to reply to a

PROCESS\_OBDII\_REQUEST message.

DEFINITIONS

Registers:

- CMIS1FIL = Misfire test cylinder 1 rolling average fault filter.

- CMIS2FIL = Misfire test cylinder 2 rolling average fault filter.

- CMIS3FIL = Misfire test cylinder 3 rolling average fault filter.

- CMIS4FIL = Misfire test cylinder 4 rolling average fault filter.

- CMIS5FIL = Misfire test cylinder 5 rolling average fault filter.

- CMIS6FIL = Misfire test cylinder 6 rolling average fault filter.

- CMIS7FIL = Misfire test cylinder 7 rolling average fault filter.

- CMIS8FIL = Misfire test cylinder 8 rolling average fault filter.

- DELPR\_FLW = Filtered DELPR during test for mode 06 reporting, in H2O.

- DELPR\_HOSE = Filtered DELPR during test for mode 06 reporting, in H2O.

- EGO1\_RF\_AVE = Rear to front EGO1 average switch ratio.

- EGO2\_RF\_AVE = Rear to front EGO2 average switch ratio.

- EGRDC\_FLW = Filtered EGRDC during test for mode 06 reporting.

- EPTBAR\_OPN = Filtered EPTBAR during test mode 06 reporting.

- EPT\_OPN\_MAX = EPTZER\_OFF + EPT\_VOPN\_IDL stored failure condition for mode

06.

- FAO\_SCP\_AVG1 = The average value of the integral value of R\_BIAS1 for

mode 06.

- FAO\_SCP\_AVG2 = The average value of the integral value of R\_BIAS2 for

mode 06.

- MIN\_DELPR\_FL = Filtered MIN\_delpr during test for mode 06 reporting, in

H2O.

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SCP INTERFACES, SCP OBDII MODE 06 REPORTING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PGM\_BLD\_DLTK = Purge monitor bleed pressure allowed before test is

failed, from FN\_PGM\_BLEED(PGM\_P0\_WPEK), KAM version.

- PGM\_P0\_BEGK = Value of PGM\_PS0\_BEGP stored to KAM for SCP reporting.

- PGM\_P2\_DLTPK = Value of PGM\_PS2\_DLTP stored to KAM for SCP reporting.

- PGM\_P4\_DELPK = Value of PGM\_PS4\_DELP stored to KAM for SCP reporting.

- PGM\_P4\_DLTPK = Value of PGM\_PS4\_DLTP stored to KAM for SCP reporting.

- SAIR\_TMRK1 = KAM snapshot of SAIR\_LN\_TMR at completion of upstream

thermactor flow test.

- SAIR\_TMRK2 = KAM snapshot of SAIR\_LN\_TMR at completion of downstream

thermactor flow test.

- TOTMISFIL = Overall misfire fault rolling average fault filter .

- V\_MIS\_TSTCNT = Register containing number of misfire test testable

events.

- VEGO\_AMP11 = Amplitude (volts) of difference between rich and lean for

bank1, fore HEGO.

- VEGO\_AMP21 = Amplitude (volts) of difference between rich and lean for

bank2, fore HEGO.

- VEGO11\_FIL2 = Second order filtered value of bank1 upstream HEGO voltage.

- VEGO12\_FIL2 = Second order filtered value of bank1 downstream HEGO

voltage.

- VEGO21\_FIL2 = Second order filtered value of bank2 upstream HEGO voltage.

Calibration Constants:

- DELPR\_THRES1 = Threshold on DELPR to check for downstream vacuum hose

off.

- DELPR\_THRES3 = Threshold on DELPR to check for upstream vacuum hose off.

- DS\_SWTPOINT = Downstream HEGO switch point.

- EGO1\_FL\_RAT = Value at which Bank 1 catalyst is considered failed.

- EGO2\_FL\_RAT = Value at which Bank 2 catalyst is considered failed.

- LEAN\_AMP\_M = U.S. EGO voltage amplitude to signal a failure when area

ratio is not shifted rich or lean (median).

- MISLEVEL1000 = Percent misfire threshold for emissions.

- PGM\_PS0\_LO = Low tank pressure value of phase zero deadband.

- PGM\_PS0\_HI = High tank pressure value of phase zero deadband.

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SCP INTERFACES, SCP OBDII MODE 06 REPORTING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PGM\_PS4\_DP = Maximum allowable delta presure in phase four to allow purge

monitor test.

- RBIAS\_EGO\_MX = Maximum allowable value of R\_BIAS.

- RBIAS\_EGO\_MN = Minimum allowable value of R\_BIAS.

- SAIR\_EGO\_LVL = Voltage on EGO sensor indicating lean/rich boundry.

- SAIR\_LN\_TM = Total amount of time that both egos must be lean to pass

thermactor flow test.

- SAIR\_LN\_TM2 = Total amount of time that downstream ego must be lean to

pass thermactor flow test.

- TESTIDMAP\_1 = Bitmapped word containing supported Test IDs in the range

01h - 10h.

- TESTIDMAP\_2 = Bitmapped word containing supported Test IDs in the range

11h - 20h.

- TESTIDMAP\_3 = Bitmapped word containing supported Test IDs in the range

21h - 30h.

- TESTIDMAP\_4 = Bitmapped word containing supported Test IDs in the range

31h - 40h.

- TESTIDMAP\_5 = Bitmapped word containing supported Test IDs in the range

41h - 50h.

- TESTIDMAP\_6 = Bitmapped word containing supported Test IDs in the range

51h - 60h.

- US\_SWTPOINT = Upstream HEGO switch point.

- V\_EGRDC\_MAX = Minimum EVR duty cycle for running insufficient flow test.

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SCP INTERFACES, SCP OBDII MODE 06 REPORTING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SCP\_MODE06\_MAP\_NAAO\_COM1

BEGIN: SCP\_MODE06\_MAP

The following response table shows the parameters that must be

returned to meet the mode 06 reporting requirements. Both test

support and test result reporting are handled through this chart.

Note that the number of messages sent in response to a given

Test ID is equal to the number of row entries in the following

table whose Test ID matches the requested Test ID.

The reply message this data is used for is REPORT\_OBDII\_TRIP\_RESULTS,

detailed in the SCP\_OBDII\_DIAG\_COMn module. This table is for use

with NAAO strategy logic.

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SCP INTERFACES, SCP OBDII MODE 06 REPORTING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SCP MODE 06 TEST ID MAP

|---------------------------------------------------------------------------|

| Test |Test Limit | |

| ID |Type and | PARAMETER NAME |

|(hex) |Component ID|Parameter MSB|Parameter LSB|Parameter MSB|Parameter LSB|

|------|------------|-------------|-------------|-------------|-------------|

| |scp\_data\_3 | scp\_data\_4 | scp\_data\_5 | scp\_data\_6 | scp\_data\_7 |

|------|------------|-------------|-------------|-------------|-------------|

| 00 | FF | TESTIDMAP\_1 | TESTIDMAP\_2 |

| 01 | 91 | VEGO\_AMP11 | LEAN\_AMP\_M |

| 01 | A1 | VEGO\_AMP21 | LEAN\_AMP\_M |

| 02 | 91 | FAO\_SCP\_AVG1 | RBIAS\_EGO\_MN |

| 02 | 11 | FAO\_SCP\_AVG1 | RBIAS\_EGO\_MX |

| 02 | A1 | FAO\_SCP\_AVG2 | RBIAS\_EGO\_MN |

| 02 | 21 | FAO\_SCP\_AVG2 | RBIAS\_EGO\_MX |

| 03 | 81 | US\_SWTPOINT | 0000h |

| 03 | 82 | DS\_SWTPOINT | 0000h |

| 10 | 11 | EGO1\_RF\_AVE | EGO1\_FL\_RAT |

| 10 | 21 | EGO2\_RF\_AVE | EGO2\_FL\_RAT |

| 20 | FF | TESTIDMAP\_3 | TESTIDMAP\_4 |

| 21 | 80 | PGM\_P0\_BEGK | PGM\_PS0\_LO |

| 21 | 00 | PGM\_P0\_BEGK | PGM\_PS0\_HI |

| 22 | 00 | PGM\_P2\_DLTPK | PGM\_BLD\_DLTK |

| 23 | 00 | PGM\_P4\_DELPK | PGM\_PS4\_DP |

| 24 | 00 | PGM\_P4\_DLTPK | PGM\_BLD\_DLTK |

| 30 | 11 | VEGO11\_FIL2 | SAIR\_EGO\_LVL |

| 30 | 21 | VEGO21\_FIL2 | SAIR\_EGO\_LVL |

| 30 | 12 | VEGO12\_FIL2 | SAIR\_EGO\_LVL |

| 31 | 80 | SAIR\_TMRK1 | SAIR\_LN\_TM |

| 31 | 81 | SAIR\_TMRK2 | SAIR\_LN\_TM2 |

| 40 | FF | TESTIDMAP\_5 | TESTIDMAP\_6 |

| 41 | 91 | DELPR\_HOSE | DELPR\_THRES3 |

| 41 | 12 | DELPR\_HOSE | DELPR\_THRES1 |

| 45 | 20 | EPTBAR\_OPN | EPT\_OPN\_MAX |

| 4A | B0 | DELPR\_FLW | MIN\_DELPR\_FL |

| 4B | 30 | EGRDC\_FLW | V\_EGRDC\_MAX |

| 50 | 00 | TOTMISFIL | MISLEVEL1000 |

| 51 | 01 | CMIS1FIL | MISLEVEL1000 |

| 51 | 02 | CMIS2FIL | MISLEVEL1000 |

| 51 | 03 | CMIS3FIL | MISLEVEL1000 |

| 51 | 04 | CMIS4FIL | MISLEVEL1000 |

| 51 | 05 | CMIS5FIL | MISLEVEL1000 |

| 51 | 06 | CMIS6FIL | MISLEVEL1000 |

| 51 | 07 | CMIS7FIL | MISLEVEL1000 |

| 51 | 08 | CMIS8FIL | MISLEVEL1000 |

| 52 | 00 | V\_MIS\_TSTCNT | 0000h |

|------|------------|---------------------------|---------------------------|

Note: All Mode 06 parameters that are not a full word in length MUST be

loaded in the LSB of the parameter field, and zero loaded in the MSB of

the parameter field.

END: SCP\_MODE06\_MAP

5-121

SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

5.3 SCP PID LIST (CDAN0)

OVERVIEW

SCP Parameter ID Map Definitions

The tables below outline the SCP Parameter Identifiers (PIDs) which are

supported by the EEEC. A PID is a four digit (two byte) numerical

representation which is used to quickly reference a particular standardized

EEEC parameter; such that if the number is requested by an offboard device,

the EEEC will respond with the value of the parameter which is mapped to that

number. PIDs can reference EEEC RAM, KAM, or ROM parameters. All PID

numbers have been standardized so that the same list of PIDs can be used

across all FORD vehicle lines (which utilize SCP communications). The list

of PIDs which are supported by this strategy is presented in three tables

which follow this overview.

The first two tables support PID's which are legislated by the specification;

"SAE RECOMMENDED PRACTICE J1979 (E/E DIAGNOSTIC TEST MODES)". These tables

are referenced only when reporting J1979 emissions-related diagnostic data.

The first table represents the latest RAM calculation of the J1979 data,

while the second table represents a snapshot of data taken at the occurrence

of an OBDII system monitor failure (as specified in the CARB regulations).

The second table is the KAM Freeze Frame PID map as legislated in J1979.

The J1979 parameters are typically requested by the OBDII Scan Tool, but are

also available (for single request, single response) for request by other

devices via the SCP network. The OBDII Scan Tool can ONLY reference PID data

from the J1979 PID tables (the first two PID tables).

The OBDII Scan Tool is a generic device (ie. manufacturer independent) which

requires the parameter information requested to be in a specific format. It

is also capable of obtaining and clearing any emmission-related Diagnostic

Trouble Codes which may be stored in KAM, as well as obtaining results from

the vehicle oxygen sensor monitor tests.

The third table supports the manufacturer specific PID set which is included

with this vehicle application. The third PID list is the ONLY list which can

be referenced when requesting ANY repetitive data diagnostics. This list

CANNOT be referenced with an OBDII Generic SCAN TOOL.

The PID table columns are defined as follows: the PID number; the defined

parameter (or pid\_definition) which is referenced by the PID number; the

output resolution in engineering units per count; the output scaling in

binary point, and; the data type (byte, word, signed, or unsigned).

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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DEFINITIONS

OBDII J1979 Parameter Definitions

The following parameters are necessary to comply with the OBDII requirements

as stated in the SAE J1979 specification. The EEEC must respond to the Scan

Tool within 100 msec of receiving a request. Parameter information may

consist of one or more bytes of binary, hex, or bitmap data as specified per

parameter. Examples include engine load as a percent or oxygen sensor as a

voltage. The parameters may be variable or constant. They may represent the

most recent calculation of that parameter (j1979\_01\_xx) or a snapshot in time

(j1979\_02\_xx) as required by the J1979 mandated Freeze Frame.

j1979\_01\_00 This four byte parameter consists of a bitmap of the PIDS

supported by this system. This shall be a calibrated constant

parameter such that bit 7 (MSB) of the first byte (1st byte

sent in response to the request) corresponds to PID 1 and

bit 0 (LSB) of the first byte corresponds to PID 8. The

next byte identifies PIDS 9 through 16. The last will

identify PIDS 25 through 32. If the bit is a one then the

PID is supported. If it is a zero, the PID is not supported.

An example of the bitmap written in hex is 'FF FE C0 00'. In

this example PIDs 1 through 15, 17, and 18 are supported.

j1979\_01\_011 This single byte parameter contains the number of emission

trouble codes stored. This variable is an integer which can

range from zero to 128 in the lower six bits of the byte.

It shall represent the current number of emission codes

identified by the monitor processes which are required by

CARB for OBDII. The high order bit (7) is set to a one if

the MIL light is commanded on by this module or set to a

zero if it is not commanded on by this module. This KAM

parameter shall be initialized to zero upon KAM reset.

j1979\_01\_012 This single byte parameter consists of a bitmap of the

continuous monitoring tests supported by the system. This

shall be a calibrated constant as follows: bits 7 through 3

are not assigned, bit 2 refers to the components test, bit 1

refers to the fuel test, and bit 0 refers to the misfire

monitor test. If the bit is a zero the test is not supported.

j1979\_01\_013 This single byte parameter consists of a bitmap of the

emission evaluation tests supported by the system. (These

are the tests which are run once per trip.) This byte

shall be a calibrated constant as follows: bit 7 (MSB) refers

to the EGR system, bit 6 is the oxygen sensor heater, bit 5 is

the oxygen sensor, bit 4 is the A/C refrigerant, bit 3 is the

secondary AIR system, bit 2 is the evaporative purge system,

bit 1 is heated catalyst, and bit 0 is the catalyst. If the

bit is a zero then the test is not supported.

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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J1979 Regulated PID Definitions (continued)

j1979\_01\_014 This single byte parameter consists of a bitmap of the

emission evaluation tests status for those tests supported by

the system. ( These are the tests which are run once per

trip. ) This byte shall be updated as appropriate. The

bit assignments correspond to j1979\_01\_013. If the

tests are not supported there, then the corresponding bits

here have no function. The assignments are: bit 7 (MSB) refers

to the EGR system test completion, bit 6 is the oxygen sensor

heater test completion, bit 5 is the oxygen sensor test

completion, bit 4 is the A/C refrigerant test completion, bit

3 is the secondary AIR system test completion, bit 2 is the

evaporative purge system test completion, bit 1 is heated

catalyst test completion, and bit 0 is the catalyst test

completion. If a bit is a one then the test has not been

completed. (See j1979\_01\_013.) This parameter shall

be initialized to FF hex and maintained in KAM.

j1979\_01\_031 This single byte parameter consists of a bitmap of the current

BANK 1 fuel control status. This RAM variable is defined

as follows: bit 7 through 5 are reserved and undefined, bit 4

is set to one when fuel control is closed loop but a fault

exists with at least one oxygen sensor ( Fuel control may be

using a single oxygen sensor.) It is reset when this

condition no longer exists. Bit 3 is set to one when fuel

control is open loop due to a detected system fault. It is

reset when this condition no longer exists. Bit 2 is set when

fuel control is open loop because of driving conditions. It

is reset when this condition does not exist. Bit 1 is set

when fuel control is closed loop and oxygen sensor(s) are

being used for feedback. It is reset when this condition does

not exist. Bit 0 is set when fuel control is open loop and

has not satisfied the conditions to go closed loop. These

bits only apply to BANK 1 (contains cylinder 1). Note that

only one bit may be set at any point in time. This parameter

shall be initialized to one upon power-up of the EEC module.

j1979\_01\_04 This single byte variable contains the current load on the

engine expressed as a percent where 00h corresponds to

zero percent and FFh corresponds to 100 percent of maximum

load of the engine. In other words, one count represents

1/255 percent of maximum load. This RAM parameter shall be

initialized to zero. The J1979 definition of load is:

CURRENT AIRFLOW SEA LEVEL ATMOSPHERIC PRES.

CLV = ------------------- X --------------------------- X100

PEAK AIRFLOW @ SEA BAROMETRIC PRESSURE

Note that wide open throttle is 100%.

j1979\_01\_05 This single byte variable contains the current engine coolant

temperature, expressed in Degrees C (plus 40). A value of 00h

corresponds to -40 Degrees C and a value of FFh corresponds to

215 Degrees C. This RAM parameter shall be initialized to 00h

The value reported must reflect the current value of the

sensor input and not a substituted value.

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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J1979 Regulated PID Definitions (continued)

j1979\_01\_06 This single byte variable contains the current BANK 1 fuel

trim adjustment from stochiometry which is considered SHORT

TERM. It is expressed as a percent of range. A value of 00h

corresponds to a LAMBSE1 of infinity (or 100% lean). A value

of FFh corresponds to a LAMBSE1 of 0.50196 (or 99.22% rich).

A value of 80h corresponds to a LAMBSE1 of 1 (or at stoich).

This RAM parameter shall be initialized to zero.

j1979\_01\_07 This single byte variable contains the current BANK 1 fuel

trim adjustment from stochiometry which is considered LONG

TERM. It is expressed as a percent of range. A value of 00h

corresponds to a KAMRF1 of zero (or 100% lean). A value

of FFh corresponds to a KAMRF1 of 1.9922 (or 99.22% rich).

A value of 80h corresponds to a KAMRF1 of 1 (or at stoich).

This RAM parameter shall be initialized to zero.

j1979\_01\_08 This single byte variable contains the current BANK 2 fuel

trim adjustment from stochiometry which is considered SHORT

TERM. It is expressed as a percent of range. A value of 00h

corresponds to a LAMBSE2 of infinity (or 100% lean). A value

of FFh corresponds to a LAMBSE2 of 0.50196 (or 99.22% rich).

A value of 80h corresponds to a LAMBSE2 of 1 (or at stoich).

This RAM parameter shall be initialized to zero.

j1979\_01\_09 This single byte variable contains the current BANK 2 fuel

trim adjustment from stochiometry which are considered LONG

TERM. It is expressed as a percent of range. A value of 00h

corresponds to a KAMRF2 of zero (or 100% lean). A value

of FFh corresponds to a KAMRF2 of 1.9922 (or 99.22% rich).

A value of 80h corresponds to a KAMRF2 of 1 (or at stoich).

This RAM parameter shall be initialized to zero.

j1979\_01\_0C This double byte variable contains the current engine speed

in units of one quarter RPM. The range is from zero to

16,383.75. This RAM parameter shall be initialized to zero.

j1979\_01\_0D This single byte variable contains the current vehicle

speed in kilometers per hour. The range is from zero to

255 KPH. This RAM parameter shall be initialized to zero.

j1979\_01\_0E This single byte variable contains the current ignition

timing for the number one cylinder. The range will be from

-64.0 to +63.5 and 128 counts corresponds to 0 degrees crank.

Thus, 0 counts corresponds to -64.0 and 255 to +63.5 degrees.

One count equals one half degree crank. This RAM parameter

shall be initialized to 148 counts (10 degrees).

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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J1979 Regulated PID Definitions (continued)

j1979\_01\_0F This single byte variable contains the current inlet AIR

temperature of the engine expressed in Degrees C (plus 40).

A value of 00h corresponds to -40 Degrees C and a value of FFh

corresponds to 215 Degrees C. This RAM parameter shall be

initialized to zero. The value reported must reflect the

current value of the sensor input, not a substituted value.

j1979\_01\_10 This double byte variable contains the current mass AIR

flow in hundredths of grams per second. One count equals .01

gm/sec. The range is from zero to 655.35 gm/sec. This RAM

parameter shall be initialized to zero. The value reported

must reflect the current value of the sensor input and not

a substituted value.

j1979\_01\_11 This single byte variable contains the current absolute

throttle position as a percent. A value of 00h corresponds to

absolute minimum position (zero% of range) and a value of FFh

is 100 percent of maximum throttle position range. This RAM

parameter shall be initialized to 128. The value reported

must reflect the current value of the sensor input and not a

substituted value.

j1979\_01\_12 This single byte contains a bitmap of the commanded secondary

AIR system. This RAM variable is defined as follows: Bits 3

through 7 are reserved and should be set to zero, bit 2 is

zero for active operation and one for vented to atmosphere,

bit 1 is one for downstream of the first catalytic converter

inlet operation and zero is not, bit 0 is one for upstream of

first catalytic converter operation and zero is not. These

three bits (0-2) can only have one bit set to a one at a time.

This byte shall indicate the current status of the secondary

AIR, not an FMEM substituted value.

j1979\_01\_13 This single byte contains a bitmap of the oxygen sensor

locations. This ROM calibration parameter is defined as:

Bits 7 and 3 are unused, bit 6 is bank 2 sensor 3, bit 5 is

bank 2 sensor 2, bit 4 is bank 2 sensor 1, bit 2 is bank 1

sensor 3, bit 1 is bank 1 sensor 2, and bit 0 is bank 1

sensor 1. A one indicates a sensor is present at that

LOCAtion. A zero indicates not present. The value for four

sensors would be 51 decimal.

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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J1979 Regulated PID Definitions (continued)

j1979\_01\_14 This single byte RAM variable contains the current oxygen

sensor voltage for BANK ONE, SENSOR ONE. The range is from

zero to 1.275 volts. One count corresponds to .005 volts.

(This scaling presumes a one volt full scale sensor.)

j1979\_01\_151 This single byte RAM variable contains the current oxygen

sensor voltage for BANK ONE, SENSOR TWO. The range is from

zero to 1.275 volts. One count corresponds to .005 volts.

(This scaling presumes a one volt full scale sensor.)

j1979\_01\_152 This single byte RAM variable represents the SHORT TERM fuel

trim associated with the oxygen sensor: BANK ONE, SENSOR TWO.

Current strategies do not support this feature in the fuel

calculations, so the parameter j1979\_01\_152 is set to 255

(or FFh) per the J1979 specification.

j1979\_01\_18 This single byte RAM variable contains the current oxygen

sensor voltage for BANK TWO, SENSOR ONE. The range is from

zero to 1.275 volts. One count corresponds to .005 volts.

(This scaling presumes a one volt full scale sensor.)

j1979\_01\_191 This single byte RAM variable contains the current oxygen

sensor voltage for BANK TWO, SENSOR TWO. The range is from

zero to 1.275 volts. One count corresponds to .005 volts.

(This scaling presumes a one volt full scale sensor.)

j1979\_01\_192 This single byte RAM variable represents the SHORT TERM fuel

trim associated with the oxygen sensor: BANK ONE, SENSOR TWO.

Current strategies do not support this feature in the fuel

calculations, so the parameter j1979\_01\_192 is set to 255

(or FFh) per the J1979 specification.

j1979\_01\_1C This single byte parameter will tell the requester the OBD

requirements to which vehicle is designed. Its value is

controlled by the calibration constant J1979\_01\_1C, where:

01 - OBD II (California ARB)

02 - OBD (Federal EPA)

03 - OBD and OBD II

04 - OBD I

05 - Not intended to meet any OBD requirements

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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J1979 Regulated Freeze Frame PIDs

A freeze frame PID refers to the value of a specific parameter at the

time an OBDII failure is detected requiring freeze frame data storage,

per the SAE specification J1979. For further definition on the freeze

frame or any other OBDII related data format, please refer to J1979.

j1979\_02\_00 This four byte parameter consists of a bitmap of the freeze

frame PIDS supported by this system. This shall be a

calibrated constant parameter such that bit 7 (MSB) of the

first byte (1st byte sent in response to the request)

corresponds to freeze frame PID 1 and bit 0 (LSB) of the

first byte corresponds to freeze frame PID 8. The next byte

identifies freeze frame PIDS 9 through 16. The last will

identify freeze frame PIDS 25 through 32. If the bit is a one

then the freeze frame PID is supported. If it is a zero, the

freeze frame PID is not supported. An example of the bitmap

written in hex is 'FF FE C0 00'. In this example freeze frame

PIDs 1 through 15, 17, and 18 are supported.

j1979\_02\_02 This two byte parameter is the OBDII diagnostic code which

triggered the freeze frame. This KAM parameter shall be a

special format as follows. The upper nibble (bits 7,6,5,4) of

the first byte represents the trouble code type (zero, one,

two and three are reserved for Powertrain trouble codes). The

lower nibble of the upper byte (bits 3,2,1,0) will contain the

first decimal digit of the OBDII trouble code. The second

byte shall contain the middle and last decimal digits

corresponding to bits 7 through 4 and bits 3 through 0,

respectively. An example for code 0298 would be hex '02 98'.

j1979\_02\_031 This single byte parameter consists of a bitmap of the freeze

frame fuel control status for BANK 1 (contains cylinder 1).

This KAM variable is defined as the value of j1979\_01\_031 at

the last required freeze frame storage. The parameter

shall be initialized to one upon EEEC KAM initialization.

j1979\_02\_04 This single byte variable contains the freeze frame load

on the engine. It is expressed as a percent where 00h

corresponds to zero percent and FFh corresponds to 100

percent of maximum load of the engine. In other words, one

count represents 1/255 percent of maximum load. This KAM

parameter shall be initialized to zero and set to the percent

load, j1979\_01\_04, at the last required freeze frame storage.

j1979\_02\_05 This single byte variable contains the freeze frame coolant

temperature of the engine expressed in Degrees C (plus 40).

A value of 00h corresponds to -40 Degrees C and a value of FFh

corresponds to 215 Degrees C. This KAM parameter shall be

initialized to zero and set to j1979\_01\_05 upon the last

required freeze frame storage.

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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J1979 Regulated Freeze Frame PIDs (continued)

j1979\_02\_06 This single byte variable contains the SHORT TERM freeze frame

fuel trim adjustment from stochiometry (BANK 1 only). It is

expressed as a percent of range. A value of 00h corresponds

to -100% of max. lean. The maximum value of FFh corresponds

to +99.22% of max. rich. This KAM parameter shall be

initialized to zero. This parameter reflects the value of

j1979\_01\_06 upon the last required freeze frame storage.

j1979\_02\_07 This single byte variable contains the LONG TERM freeze frame

fuel trim adjustment from stochiometry (BANK 1 only). It is

expressed as a percent of range. A value of 00h corresponds

to -100% of max. lean. The maximum value of FFh corresponds

to +99.22% of max. rich. This KAM parameter shall be

initialized to zero. This parameter reflects the value of

j1979\_01\_07 upon the last required freeze frame storage.

j1979\_02\_08 This single byte variable contains the SHORT TERM freeze frame

fuel trim adjustment from stochiometry (BANK 2 only). It is

expressed as a percent of range. A value of 00h corresponds

to -100% of max. lean. The maximum value of FFh corresponds

to +99.22% of max. rich. This KAM parameter shall be

initialized to zero. This parameter reflects the value of

j1979\_01\_08 upon the last required freeze frame storage.

j1979\_02\_09 This single byte variable contains the LONG TERM freeze frame

fuel trim adjustment from stochiometry (BANK 2 only). It is

expressed as a percent of range. A value of 00h corresponds

to -100% of max. lean. The maximum value of FFh corresponds

to +99.22% of max. rich. This KAM parameter shall be

initialized to zero. This parameter reflects the value of

j1979\_01\_09 upon the last required freeze frame storage.

j1979\_02\_0C This double byte variable contains the freeze frame engine

speed in units of one quarter RPM. The range is from zero to

16,383.75. It shall have an accuracy of +/- 50RPM. This KAM

parameter shall be set to zero upon EEEC KAM initialization.

It shall reflect the value of j1979\_01\_0C upon the last

required freeze frame storage.

j1979\_02\_0D This single byte variable contains the freeze frame vehicle

speed in kilometers per hour. The range is from zero to 255

kilometers per hour. It shall have an accuracy of +/- 8KPH.

This KAM parameter shall be set to zero upon EEEC KAM

initialization. It shall reflect the value of j1979\_01\_0D

upon the last required freeze frame storage.

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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Other SCP Specific Parameter Definitions

----------------------------------------

BITMAP\_FMEMx A bitmapped register indicating status of various EEEC FMEM

strategies (see pid\_def definitions for bitmap).

IDBLOCKH\_ADR A single-byte cal constant which represents the ROM Bank in

which the 256-byte Flash EEPROM ID Block is located.

IDBLOCK\_ADR A two-byte cal constant which contains the starting address

(High Byte, Low Byte) of the 256-byte Flash EEPROM ID Block.

{The value of this parameter would be 9F00h for an 88K chip,

and FF00h for a 112K chip.}.

IDBLOCK\_FMT A single-byte register which is assigned the CONTENTS of the

memory location offset 13h from IDBLOCK\_ADR each BG Loop.

(ie. 9F13 for the 88K chip, and FF13 for the 112K chip).

The value of this memory location is FFh as a default, but

can be modified via the SBDS Flash procedure. It is meant to

signify how the 256-byte ID block data is formatted such that

an ODU can request specific information from the EEC with a

Direct Memory Request.

idblock\_adrs The four-byte data string which is created when the following

data is concatenated: IDBLOCKH\_ADR, IDBLOCK\_ADR & IDBLOCK\_FMT,

representing ROM Bank, Starting Address of the 256-byte Flash

ID Block, and the Block format type, respectively.

SCPBITMAP\_x A bitmapped register indicating status of various EEEC control

flags (see pid\_def definitions for bitmap).

scp\_odu\_ram This parameter is a PID of single word length which provides

the beginning address of the ODU user RAM area. This PID will

allow SBDS to download diagnostic routines to the user RAM

area without having to consult the DOC files of the

corresponding strategy.

BITMAP\_MON\_x A bitmapped register indicating status of various EEEC

hardware monitor inputs (see pid\_def definitions for bitmap).

BITMAP\_OFD\_x A bitmapped register indicating status of various EEEC output

fault detection flags. 1 = fault detected (see pid\_def

definitions for bitmap).

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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AFT1\_ADRS A double-word cal constant which contains the following data:

Starting address (High Byte, Low Byte) of Bank 1 KAM Adaptive

Fuel Table, followed by the total number of bytes in this

table, followed by a byte which indicates the number of rows

in the upper nibble and the special adaptive idle cell format

type in the lower nibble.

FOR INSTANCE: An AFT1\_ADRS of 37F15681 would indicate that KAM

Table 1 starts at RAM address 37F1, has 86 adaptive cells, is

formatted with 8 rows (and 10 columns), and the 6 special

adaptive idle cells are of format type 1. Idle cell count is

always the difference between total number of cells and product

of rows & columns. See example below:

AFT2\_ADRS Same as AFT1\_ADRS, except it applies to Adaptive Table 2.

AFTn\_ADRS Format Example

37h F1h 56h 81h

// // // //

Starting address Upper Byte \_\_\_\_// // // //

Starting address Lower Byte \_\_\_\_// // //

Total table cell count \_\_\_\_\_\_\_\_\_// //

Row count Nibble \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_//

Special Cell Type Nibble \_\_\_\_\_\_/

AFTn\_ADRS Special Adaptive Cell Type Definitions

Type

(Nibble value) Description

-------------- ------------------------------

0 Hex No special adaptive cells present.

1 Hex Special adaptive cells per ISFLAG:

0 -> Auto in Drive

1 -> Auto in Drive + A/C

2 -> Manual or Auto in Neutral

3 -> Manual or Auto in Neutral + A/C

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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STRATEGY MODULE: SCP\_PID\_MAP\_CD

BITMAPPED REGISTER DEFINITIONS FOR CDAN2

BEGIN: pid\_definitions

This section defines PIDs which are set up for SBDS/EOL

but are NOT part of the regulated J1979 PIDs.

They WILL BE allowed in repetitive data SCP messages.

THE BITMAPS ARE STANDARDIZED FOR SCP

(The bitwise definition of these parameters WILL NOT change, with

the exception of a standardized definition of any 'unused' bits.)

pid\_def(BITMAP\_FMEM1, ;SCP diagnostic PID #1106

b0: 0, ;TSS FMEM status (TSFMFLG)

b1: VSFMFLG, ;VS FMEM status

b2: EFMFLG, ;EGR FMEM status

b3: OFMFLG, ;ETV FMEM status

b4: MFMFLG, ;MAF FMEM status

b5: TFMFLG, ;TP FMEM status

b6: CFMFLG, ;ECT FMEM status

b7: AFMFLG) ;ACT FMEM status

pid\_def(BITMAP\_FMEM2, ;SCP diagnostic PID #1107

b0: FFG\_CID, ;CID FMEM status

b1: OSFMFLG, ;Output Shaft Speed sensor FMEM

b2: TOT\_FM\_FLG, ;Trans Oil Temp sensor FMEM

b3: FLG\_MLUS\_FM, ;1=unlock due to excessive converter

clutch slip

b4: EGO2FMFLG, ;EGO21 (bank2 upstream) FMEM status

b5: EGO1FMFLG, ;EGO11 (bank1 upstream) FMEM status

b6: ADT2FMFLG, ;Adaptive Table 2 FMEM status

b7: ADT1FMFLG) ;Adaptive Table 1 FMEM status

pid\_def(BITMAP\_FMEM3, ;SCP diagnostic PID #1689

b0: 0, ;1=CHT is currently unreliable

(FFG\_CHT)

b1: PGM\_PFS\_FM, ;1=in PFS sensor FMEM

b2: PGM\_CVS\_FM, ;1=in canister not venting FMEM

b3: PGM\_TPR\_FM, ;1=in TPR sensor FMEM

b4: 0, ;1=Fuel Rail Pressure Transducer is

currently unreliable(FFG\_FRP)

b5: 0, ;1=Fuel Rail Temperature Sensor

Bank 1 is currently unreliable

(FFG\_FRT1)

b6: 0, ;1=Fuel Rail Temperature Sensor

Bank 2 is currently unreliable

(FFG\_FRT2)

b7: 0) ;1=Power Steering Pressure

Transducer is currently unreliable

(FFG\_PSPT)

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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BITMAPPED REGISTER DEFINITIONS FOR CDAN2 (continued)

(continue with pid\_definitions)

pid\_def(SCPBITMAP\_1, ;SCP diagnostic PID #1101

b0: ACSW, ;A/C clutch Demand Switch

b1: BIFLG, ;BRAKE INPUT LEVEL

b2: 0, ;1=4X4 LOW requested(FLG\_4X4L)

b3: NDSFLG, ;NEUTRAL/DRIVE FLAG 1=DRIVE

b4: ITCS, ;1=OVERDRIVE CANCEL SWITCH DEPRESSED

b5: PDL\_ERROR, ;PRNDL POSITION ERROR

b6: 0, ;PERFORMANCE/NORMAL SWITCH(IPES)

b7: 0) ;1=POWER STEERING LOAD PRESENT(POWSFG)

pid\_def(SCPBITMAP\_2, ;SCP diagnostic PID #1102

b0: ACPSW, ;AC Medium Pressure Switch Input

b1: 0, ;Upstream sensor heater(s). 1 output

controls both banks. 0=on(HEGOHTR1)

b2: 0, ;Downstream sensor heater(s). 1 output

controls both banks. 0=on(HEGOHTR2)

b3: OCTADJ, ;Field Octane Adjust input

b4: PIP\_LVL, ;1=PIP input level is high

b5: FFG\_MISFIRE ;Misfire Monitor flag, 1 = Misfiring

b6: 0, ;unused

b7: 0) ;unused

pid\_def(SCPBITMAP\_3, ;SCP diagnostic PID #1103

b0: 0, ;Heated Windshield Status Flag(HWFLAG)

b1: 0, ;1=Purging canister(PRGFLG)

b2: LSF\_FLG, ;1=Low Speed Fan commanded on

b3: HSF\_FLG, ;1=High speed fan commanded on

b4: IMRC\_CMND, ;1=Intake Manifold Runner Control

commanded open

b5: MIL\_ON, ;STATE OF MIL OUTPUT

b6: OLFLG, ;OPEN LOOP FLAG

b7: TRIP) ;Flag indicating OBDII trip completed

pid\_def(SCPBITMAP\_4, ;SCP diagnostic PID #1104

b0: ACCFLG, ;A/C CLUTCH STATUS, 0=disengaged

b1: 0, ;Ride Control output state (ACL/ACL1)

b2: TCIL\_STATE, ;Current State Of TCIL output

b3: 0, ;1=unlock torque convertor for

traction control(TRAC\_ULFLG)

b4: EAM, ;Electric Air Management Control Flag

1=pump on

b5: 0, ;Winter weather switch state(NWSW)

b6: CID\_HIGH, ;Input level of CID sensor

b7: 0) ;Torque modulation requested flag

(SPK\_TQM\_REQ)

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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BITMAPPED REGISTER DEFINITIONS FOR CDAN2 (continued)

(continue with pid\_definitions)

pid\_def(SCPBITMAP\_5, ;SCP diagnostic PID #1105

b0: 0, ;Positive Temp. Coeff. Heater Input

(PTC\_FLG)

b1: FLG\_OT\_LK, ;1=In Trans Overtemp Lockup Mode

b2: OTEMP\_FM\_FLG,;1=Transmission overtemp FMEM

b3: 0, ;1=traction assist is present on this

vehicle(TRAC\_OPTION)

b4: FLG\_SS\_1, ;1=Shift Solenoid #1 commanded on

b5: FLG\_SS\_2, ;1=Shift Solenoid #2 commanded on

b6: 0, ;1=Shift Solenoid #3 commanded on

(FLG\_SS\_3)

b7: 0) ;1=Shift Solenoid #4 (Coast Clutch)

commanded on(FLG\_SS\_4)

pid\_def(SCPBITMAP\_6, ;SCP diagnostic PID #1631

b0: HEGOHTR11, ;1=bank1 upstream output on

b1: HEGOHTR12, ;1=bank1 downstream output on

b2: HEGOHTR21, ;1=bank2 upstream output on

b3: HEGOHTR22, ;1=bank2 downstream output on

b4: HTR\_FAULT11, ;1=bank1 upstream output fault detected

b5: HTR\_FAULT12, ;1=bank1 downstream output fault

detected

b6: HTR\_FAULT21, ;1=bank2 upstream output fault detected

b7: HTR\_FAULT22) ;1=bank2 downstream output fault

detected

pid\_def(SCPBITMAP\_7, ;SCP diagnostic PID #163C

b0: OL\_HOLD, ;1=open loop - conditions not satisfied

to go closed loop

b1: hego\_fdback, ;1=closed loop

b2: OL\_DRIVE, ;1=open loop due to driving conditions

b3: OL\_FMEM, ;1=open loop due to FMEM

b4: hego\_fault, ;1=closed loop with HEGO fault

b5: 0, ;unused

b6: 0, ;unused

b7: 0) ;unused

Note: b0 through b4 of SCPBITMAP\_7 correspond to b0 thru b4 of J1979\_01\_031.

They are defined as part of SCPBITMAP\_7 so that they can be referenced when

requesting ANY repetitive data diagnostics.

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BITMAPPED REGISTER DEFINITIONS FOR CDAN2 (continued)

(continue with pid\_definitions)

pid\_def(SCPBITMAP\_10, ;SCP diagnostic PID #1688

b0: 0, ;1=cyl head temp (CHT) indicator

light is on(CHTIL\_CMD)

b1: 0, ;1=CHT indicator light output fault

detected(CHTIL\_FAULT)

b2: SWC, ;1=speed warning chime is on

b3: SWC\_FAULT, ;1=speed warning chime output fault

detected

b4: FPUMP\_SPEED, ;1=hi speed desired for 2 speed fuel

pump

b5: 0, ;1=Thermactor Air Bypass is supplying

secondary air (versus dumping it

overboard) for either upstream or

downstream of the forward HO2S(AM1)

b6: 0, ;1=Thermactor Air Diverter is

diverting secondary air to upstream

(versus downstream) of the forward

HO2S(AM2)

b7: 0) ;1=secondary spark plugs of Dual Plug

Ignition System are enabled

(DPI\_STATE)

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BITMAPPED REGISTER DEFINITIONS FOR CDAN2 (continued)

(continue with pid\_definitions)

pid\_def(BITMAP\_MON\_1, ;SCP diagnostic PID #110C

b0: F\_PUMP\_S\_MON, ;Fuel Pump Secondary Monitor

b1: EAMM, ;Thermactor Air Pump Monitor

b2: 0, ;Electro Drive Fan Monitor(EDFM)

b3: 0, ;High Speed Fan Monitor (HEDFM)

b4: 0, ;HEGO11 Voltage Monitor(HTRM11)

b5: 0, ;HEGO12 Voltage Monitor(HTRM12)

b6: 0, ;HEGO21 Voltage Monitor(HTRM21)

b7: 0) ;HEGO22 Voltage Monitor(HTRM22)

pid\_def(BITMAP\_KAM\_1, ;SCP diagnostic PID #160D

b0: MIS\_MON\_KAM, ;Misfire OBD2 Trip flag (complete=1)

b1: 0, ;1=Intake Manifold Communication

Control valve 1 commanded closed

(IMCC1)

b2: 0, ;1=Intake Manifold Communication

Control valve 2 commanded closed

(IMCC2)

b3: DOL, ;state of Data Output Link(DOL)

b4: 0, ;1=operation of engine is being

disabled by anti-theft system

(ATH\_DISABLED)

b5: 0, ;1=PTO (Power Take Off) is active

(disable affected monitors)

(PTO\_ACTIVE)

b6: 0, ;1=Shift Indicator Light commanded

on(SIL)

b7: 0) ;1=Shift Indicator Light output

fault detected(SIL\_FAULT)

pid\_def(BITMAP\_OFD\_1, ;SCP diagnostic PID #162D

b0: INJ1\_FAULT, ;1=injector #1 output fault detected

b1: INJ2\_FAULT, ;1=injector #2 output fault detected

b2: INJ3\_FAULT, ;1=injector #3 output fault detected

b3: INJ4\_FAULT, ;1=injector #4 output fault detected

b4: INJ5\_FAULT, ;1=injector #5 output fault detected

b5: INJ6\_FAULT, ;1=injector #6 output fault detected

b6: INJ7\_FAULT, ;1=injector #7 output fault detected

b7: INJ8\_FAULT) ;1=injector #8 output fault detected

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BITMAPPED REGISTER DEFINITIONS FOR CDAN2 (continued)

(continue with pid\_definitions)

Assign value to scp\_162E\_b7 for use in BITMAP\_OFD\_2

In this strategy/hardware we have a problem with using FP\_2SPD\_ERR. FPL and

TCIL are on the same output UPOD3-4. FP\_2SPD\_ERR and TCIL\_FAULT are both

defined as the same bit (as the fault bit for UPOD3-4). If the output is not

being used for FPL, and if a fault occurs, then we do not want the SCP PID

#162E bit7 to show a low speed fuel pump output fault. The software flag

FP\_2SPD\_ERR could be set because there is a fault with the TCIL or because

the unused output is not properly terminated. In these two cases, we do not

want the FP\_2SPD\_ERR bit of BITMAP\_OFD\_2 to be set. This could confuse the

technician.

The following logic is intended to force the FP\_2SPD\_ERR bit of BITMAP\_OFD\_2

to be zero when UPOD3-4 is not being used to control the speed of the fuel

pump (FPL).

FP\_TYPE = 1 ----------------------------| scp\_162E\_b7 = FP\_2SPD\_ERR

;2 speed fuel pump hardware is present | ; 1=low speed fuel pump fault

| ; detected(FP\_2SPD\_ERR)

|

| --- ELSE ---

|

| scp\_162E\_b7 = 0

| ; set bit to zero if FPL hardware

| ; is not used.

pid\_def(BITMAP\_OFD\_2, ;SCP diagnostic PID #162E

b0: IAC\_NO\_CUR, ;1=IAC (ISC-BPA) output fault (open

circuit or short to ground)

detected

b1: IAC\_OVER\_CUR, ;1=IAC (ISC-BPA) over current output

fault (shorted load or short to

VPWR) detected

b2: EVR\_OPEN, ;1=EVR output open detected

b3: EVR\_SHORT, ;1=EVR output shorted to ground

detected

b4: MIL\_FAULT, ;1=MIL output fault detected

b5: ACC\_STATUS, ;1=ACR output fault detected

b6: F\_PUMP\_ERROR, ;1=fuel pump output fault detected

b7: scp\_162E\_b7) ;1=low speed fuel pump fault

detected(FP\_2SPD\_ERR)

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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BITMAPPED REGISTER DEFINITIONS FOR CDAN2 (continued)

(continue with pid\_definitions)

Assign value to scp\_162F\_b2 for use in BITMAP\_OFD\_3

In this strategy/hardware we have a problem with using CANP\_FAULT. CANP and

CANVNT are on the same output SSPOD1-4. CANP\_FAULT and CANVT\_FAULT are both

defined as the same bit (as the fault bit for SSPOD1-4). If the output is not

being used for CANP, and if the flag CANP\_FAULT is set, then we do not want

the SCP PID #162F bit2 to show a canister PURGE output fault. The software

flag CANP\_FAULT could be set because there is a fault with the CANVT or

because the unused output is not properly terminated. In these two cases, we

do not want the CANP\_FAULT bit of BITMAP\_OFD\_3 to be set. This could confuse

the technician.

The following logic is intended to force the CANP\_FAULT bit of BITMAP\_OFD\_3

to be zero when SSPOD1-4 is not being used to control the canister PURGE

(CANP).

PGM\_SELECT = 1 -------------------------| scp\_162F\_b2 = CANP\_FAULT

;Canister PURGE hardware is present | ; 1=canister PURGE output fault

| ; detected(CANP\_FAULT)

|

| --- ELSE ---

|

| scp\_162F\_b2 = 0

| ; set bit to zero if Canister

| ; PURGE hardware is not used.

pid\_def(BITMAP\_OFD\_3, ;SCP diagnostic PID #162F

b0: EDF\_STATUS, ;1=low spd fan output fault detected

b1: HEDF\_STATUS, ;1=high speed fan output fault

detected(HEDF\_STATUS)

b2: scp\_162F\_b2, ;1=canister PURGE output fault

detected(CANP\_FAULT)

b3: EAM\_FAULT, ;1=2ndary Air output fault detected

b4: DOL\_FAULT, ;1=DOL/FFDOL output fault detected

(DOL\_FAULT)

b5: 0, ;1=intake manifold communication

control output fault detected

(IMCC\_FAULT)

b6: IMRC\_FAULT, ;1=IMRC output fault detected

b7: 0) ;1=traction control secondary

throttle output fault detected

(TAPW\_FAULT)

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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BITMAPPED REGISTER DEFINITIONS FOR CDAN2 (continued)

(continue with pid\_definitions)

Assign value to scp\_1630\_b3 for use in BITMAP\_OFD\_4

In this strategy/hardware we have a problem with using CANVT\_FAULT. CANVNT

and CANP are on the same output SSPOD1-4. CANVT\_FAULT and CANP\_FAULT are both

defined as the same bit (as the fault bit for SSPOD1-4). If the output is not

being used for CANVNT, and if the flag CANVT\_FAULT is set, then we do not

want the SCP PID #1630 bit3 to show a canister VENT output fault. The

software flag CANVT\_FAULT could be set because there is a fault with the CANP

or because the unused output is not properly terminated. In these two cases,

we do not want the CANVT\_FAULT bit of BITMAP\_OFD\_4 to be set. This could

confuse the technician.

The following logic is intended to force the CANVT\_FAULT bit of BITMAP\_OFD\_4

to be zero when SSPOD1-4 is not being used to control the canister VENT

(CANVNT).

PGM\_SELECT = 0 -------------------------| scp\_1630\_b3 = CANVT\_FAULT

;Canister VENT hardware is present | ; 1=canister VENT output fault

| ; detected(CANVT\_FAULT)

|

| --- ELSE ---

|

| scp\_1630\_b3 = 0

| ; set bit to zero if Canister

| ; VENT hardware is not used.

pid\_def(BITMAP\_OFD\_4, ;SCP diagnostic PID #1630

b0: 0, ;1=variable cam timing 1 output

fault detected(VCT1OSM)

b1: 0, ;1=variable cam timing 2 output

fault detected(VCT2OSM)

b2: 0, ;1=ride control output fault

detected(ACLOSM)

b3: scp\_1630\_b3, ;1=canister VENT output fault

detected(CANVT\_FAULT)

b4: 0, ;unused

b5: 0, ;unused

b6: 0, ;unused

b7: 0) ;unused

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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BITMAPPED REGISTER DEFINITIONS FOR CDAN2 (continued)

(continue with pid\_definitions)

Assign value to scp\_1632\_b7 for use in BITMAP\_OFD\_5

In this strategy/hardware we have a problem with using TCIL\_FAULT. TCIL and

FPL are on the same output UPOD3-4. TCIL\_FAULT and FP\_2SPD\_ERR are both

defined as the same bit (as the fault bit for UPOD3-4). If the output is not

being used for TCIL, and if the flag TCIL\_FAULT is set, then we do not want

the SCP PID #1632 bit7 to show a transmission control indicator light output

fault. The software flag TCIL\_FAULT could be set because there is a fault

with the FPL or because the unused output is not properly terminated. In

these two cases, we do not want the TCIL\_FAULT bit of BITMAP\_OFD\_5 to be

set. This could confuse the technician.

The following logic is intended to force the TCIL\_FAULT bit of BITMAP\_OFD\_5

to be zero when UPOD3-4 is not being used to control the transmission control

indicator light (TCIL).

TSTRAT = 7 -----------------------------| scp\_1632\_b7 = TCIL\_FAULT

;AOD-E (AOD-I) automatic transmission | ; 1=TCIL output fault detected

| ; (TCIL\_FAULT)

|

| --- ELSE ---

|

| scp\_1632\_b7 = 0

| ; set bit to zero if TCIL hardware

| ; is not used.

pid\_def(BITMAP\_OFD\_5, ;SCP diagnostic PID #1632

b0: SS1\_FAULT, ;1=SS1 output fault detected

b1: SS2\_FAULT, ;1=SS2 output fault detected

b2: 0, ;1=SS3 output fault detected

(SS3\_FAULT)

b3: 0, ;1=SS4 output fault detected

(SS4\_FAULT)

b4: 0, ;unused

b5: 0, ;unused

b6: MCC\_H\_FAULT, ;1=modulated converter clutch output

fault detected

b7: scp\_1632\_b7) ;1=TCIL output fault detected

(TCIL\_FAULT)

Assign values to idblock\_adrs.

unconditionally ------------| IDBLOCK\_FMT := (Contents of memory location

| at address (IDBLOCK\_ADR+13h))

| ; See definitions for data description

pid\_def(idblock\_adrs: IDBLOCKH\_ADR, IDBLOCK\_ADR, IDBLOCK\_FMT)

;ROM Bank ADRmid,ADRlo Block Format

END: pid\_definitions

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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J1979 SCP PID MAP - CDAN2

(NOT TO BE USED IN RAPID DATA TRANSFER)

| | pid\_def() or | OUTPUT | OUTPUT | DATA |

| PID# |PARAMETER NAME| RESOLUTION | SCALING | TYPE |

|------|--------------|-------------------------|-----------|-----------|

| 0000 | j1979\_01\_00 | bitmap | N/A |double word|

|------|--------------|-------------------------|-----------|-----------|

| 0001 | j1979\_01\_011 | bitmap | N/A | byte |

| | j1979\_01\_012 | bitmap | | byte |

| | j1979\_01\_013 | bitmap | | byte |

| | j1979\_01\_014 | bitmap | | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0003 | j1979\_01\_031 | bitmap | N/A | byte |

| | 00 hex | | | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0004 | j1979\_01\_04 | 100/255 % load | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0005 | j1979\_01\_05 | 1 deg C | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0006 | j1979\_01\_06 | 100/128 % rich | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0007 | j1979\_01\_07 | 100/128 % rich | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0008 | j1979\_01\_08 | 100/128 % rich | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0009 | j1979\_01\_09 | 100/128 % rich | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 000C | j1979\_01\_0C | 0.25 rpm | N/A | word |

|------|--------------|-------------------------|-----------|-----------|

| 000D | j1979\_01\_0D | 1 kph | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 000E | j1979\_01\_0E | 0.5 deg spark advance | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 000F | j1979\_01\_0F | 1 deg C | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0010 | j1979\_01\_10 | 0.01 gm/sec | N/A | word |

|------|--------------|-------------------------|-----------|-----------|

| 0011 | j1979\_01\_11 | 100/255 % throttle | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0012 | j1979\_01\_12 | bitmap | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0013 | j1979\_01\_13 | bitmap | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0014 | j1979\_01\_14 | 0.005 volts | N/A | byte |

| | j1979\_01\_06 | 100/128 % rich | | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0015 | j1979\_01\_151 | 0.005 volts | N/A | byte |

| | j1979\_01\_152 | 100/128 % rich | | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0018 | j1979\_01\_18 | 0.005 volts | N/A | byte |

| | j1979\_01\_08 | 100/128 % rich | | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0019 | j1979\_01\_191 | 0.005 volts | N/A | byte |

| | j1979\_01\_192 | 100/128 % rich | | byte |

|------|--------------|-------------------------|-----------|-----------|

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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J1979 SCP PID MAP - CDAN2 (continued)

(NOT TO BE USED IN RAPID DATA TRANSFER)

| | pid\_def() or | OUTPUT | OUTPUT | DATA |

| PID# |PARAMETER NAME| RESOLUTION | SCALING | TYPE |

|------|--------------|-------------------------|-----------|-----------|

| 001C | j1979\_01\_1C | 1.0 | Bin 0 | byte |

|------|--------------|-------------------------|-----------|-----------|

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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J1979 FREEZE FRAME PID MAP - CDAN2

(NOT TO BE USED IN RAPID DATA TRANSFER)

| | pid\_def() or | OUTPUT | OUTPUT | DATA |

| PID# |PARAMETER NAME| RESOLUTION | SCALING | TYPE |

|------|--------------|-------------------------|-----------|-----------|

| 0000 | j1979\_02\_00 | bitmap | N/A |double word|

|------|--------------|-------------------------|-----------|-----------|

| 0002 | j1979\_02\_02 | trouble code map | N/A | word |

|------|--------------|-------------------------|-----------|-----------|

| 0003 | j1979\_02\_031 | bitmap | N/A | byte |

| | 00 hex | | | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0004 | j1979\_02\_04 | 100/255 % load | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0005 | j1979\_02\_05 | 1 deg C | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0006 | j1979\_02\_06 | 100/128 % rich | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0007 | j1979\_02\_07 | 100/128 % rich | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0008 | j1979\_02\_08 | 100/128 % rich | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 0009 | j1979\_02\_09 | 100/128 % rich | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

| 000C | j1979\_02\_0C | 0.25 rpm | N/A | word |

|------|--------------|-------------------------|-----------|-----------|

| 000D | j1979\_02\_0D | 1 kph | N/A | byte |

|------|--------------|-------------------------|-----------|-----------|

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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SCP DIAGNOSTIC PID MAP - CDAN2

| | pid\_def() or | OUTPUT | OUTPUT | DATA |

| PID# |PARAMETER NAME| RESOLUTION | SCALING | TYPE |

|------|--------------|-------------------------|-----------|-----------|

| 0100 | TRIP\_COUNT | 1 OBDII Trip/count | Bin 0 | B U |

| 0101 | DRIVE\_COUNT | 1 OBDII Drive Cycle/cnt | Bin 0 | W U |

| 0200 | CODES\_COUNT | 1 Code per count | Bin 0 | B U |

| 0202 | OD\_CODE\_CNT | 1 Code per count | Bin 0 | B U |

| 1100 | idblock\_adrs | ASCII / Hex values | Bin 0 | DW U |

| 1101 | SCPBITMAP\_1 | Bitmap | Bin 0 | B U |

| 1102 | SCPBITMAP\_2 | Bitmap | Bin 0 | B U |

| 1103 | SCPBITMAP\_3 | Bitmap | Bin 0 | B U |

| 1104 | SCPBITMAP\_4 | Bitmap | Bin 0 | B U |

| 1105 | SCPBITMAP\_5 | Bitmap | Bin 0 | B U |

| 1106 | BITMAP\_FMEM1 | Bitmap | Bin 0 | B U |

| 1107 | BITMAP\_FMEM2 | Bitmap | Bin 0 | B U |

| 110C | BITMAP\_MON\_1 | Bitmap | Bin 0 | B U |

| 1123 | ACT | 2 degrees F | Bin -1 | B S |

| 1125 | APT | -1,0,1 unitless | Bin 0 | B S |

| 1126 | ATMR1 | 1 second | Bin 0 | B U |

| 1127 | BP | 0.125 inches Hg | Bin 3 | B U |

| 1135 | DSDRPM | 16 rpm | Bin -4 | B U |

| 1139 | ECT | 2 degrees F | Bin -1 | B S |

| 113C | EGRDC |100/32768 % on duty cycle| Bin 15 | W U |

| 1141 | FUELPW1 | 32 clock tics | Bin -1 | W U |

| 1142 | FUELPW2 | 32 clock tics | Bin -1 | W U |

| 114A | ACT\_CNTS | 0.0156 A/D count | Bin 6 | W U |

| 114D | ECT\_CNTS | 0.0156 A/D count | Bin 6 | W U |

| 114E | IEGR | 0.0156 A/D count | Bin 6 | W U |

| 1151 | INDS | 0.0156 A/D count | Bin 6 | W U |

| 1153 | ISCDTY |100/32768 % on duty cycle| Bin 15 | W U |

| 1154 | TP\_ENG | 0.0156 A/D count | Bin 6 | W U |

| 1156 | KAMRF1 | 0.00391 A/F ratio | Bin 8 | W U |

| 1157 | KAMRF2 | 0.00391 A/F ratio | Bin 8 | W U |

| 1158 | LAMBSE1 | 1/32768 unitless | Bin 15 | W U |

| 1159 | LAMBSE2 | 1/32768 unitless | Bin 15 | W U |

| 115A | LOAD | 1/32768 of std air chrg | Bin 15 | W U |

| 1165 | N | 0.25 rpm | Bin 2 | W U |

| 1166 | PG\_DC |100/32768 % on duty cycle| Bin 15 | W U |

| 1167 | PGM\_CVS\_DC | 1 EEEC-IV count | Bin 15 | W U |

| 1169 | RATCH | 0.0156 count | Bin 6 | W U |

| 116B | SAFTOT | 0.25 degrees S.A. | Bin 2 | W S |

| 1172 | VBAT | 0.0625 volts | Bin 4 | B U |

| 1173 | VEGO11 | 0.000977 volts | Bin 10 | W U |

| 1174 | VEGO12 | 0.000977 volts | Bin 10 | W U |

| 1175 | VEGO21 | 0.000977 volts | Bin 10 | W U |

| 1176 | VEGO22 | 0.000977 volts | Bin 10 | W U |

| 11B0 | BCSDC\_OUT |100/32768 % on duty cycle| Bin 15 | W U |

| 11B2 | EPCOCM1 | 0.0156 volts | Bin 6 | W U |

| 11B3 | GR\_CM | N/A | Bin 1 | B U |

|------|--------------|-------------------------|-----------|-----------|

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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SCP DIAGNOSTIC PID MAP (continued) - CDAN2

| | pid\_def() or | OUTPUT | OUTPUT | DATA |

| PID# |PARAMETER NAME| RESOLUTION | SCALING | TYPE |

|------|--------------|-------------------------|-----------|-----------|

| 11B5 | NO | 0.25 rpm | Bin 2 | W U |

| 11B6 | PDL | N/A | Bin 1 | B U |

| 11B7 | RT\_GR\_CUR | N/A | Bin 14 | W U |

| 11B8 | SLIP\_ABS | 0.25 rpm | Bin 2 | W U |

| 11BA | SPD\_RATIO | N/A | Bin 14 | W U |

| 11BD | TOT\_CNTS | 0.0156 A/D count | Bin 6 | W U |

| 11C0 | TV\_PRES\_BAR | 0.5 psi | Bin 1 | B U |

| 11C1 | VS | 0.001953 mph | Bin 9 | W U |

| 1600 | MAF\_FIL\_MAX | 1 fault count | Bin 0 | B U |

| 1601 | ACT\_FIL\_MAX | 1 fault count | Bin 0 | B U |

| 1602 | ECT\_FIL\_MAX | 1 fault count | Bin 0 | B U |

| 1603 | TP\_FIL\_MAX | 1 fault count | Bin 0 | B U |

| 1604 | VS\_FIL\_MAX | 1 fault count | Bin 0 | B U |

| 1605 | HTR\_RET\_MX11 | 1 retry count | Bin 0 | B U |

| 1606 | HTR\_RET\_MX12 | 1 retry count | Bin 0 | B U |

| 1607 | HTR\_RET\_MX21 | 1 retry count | Bin 0 | B U |

| 1608 | HTR\_RET\_MX22 | 1 retry count | Bin 0 | B U |

| 160B | AFT1\_ADRS | HEX values | Bin 0 | DW U |

| 160C | AFT2\_ADRS | HEX values | Bin 0 | DW U |

| 160D | BITMAP\_KAM\_1 | Bitmapped | Bin 0 | B U |

| 160E | nummis1 | 1 misfire count | Bin 0 | W U |\*

| 160F | nummis2 | 1 misfire count | Bin 0 | W U |\*

| 1610 | nummis3 | 1 misfire count | Bin 0 | W U |\*

| 1611 | nummis4 | 1 misfire count | Bin 0 | W U |\*

| 1612 | nummis5 | 1 misfire count | Bin 0 | W U |\*

| 1613 | nummis6 | 1 misfire count | Bin 0 | W U |\*

| 1614 | nummis7 | 1 misfire count | Bin 0 | W U |\*

| 1615 | nummis8 | 1 misfire count | Bin 0 | W U |\*

| 1616 | nummis | 1 misfire count | Bin 0 | W U |\*

| 1617 | totevents | 1 cylinder event | Bin 0 | W U |\*

| 1618 | mis\_nocall | 1 cylinder event | Bin 0 | W U |\*

| 1619 | nummis1\_h | 1 misfire count | Bin 0 | B U |\*

| 161A | nummis2\_h | 1 misfire count | Bin 0 | B U |\*

| 161B | nummis3\_h | 1 misfire count | Bin 0 | B U |\*

| 161C | nummis4\_h | 1 misfire count | Bin 0 | B U |\*

| 161D | nummis5\_h | 1 misfire count | Bin 0 | B U |\*

| 161E | nummis6\_h | 1 misfire count | Bin 0 | B U |\*

| 161F | nummis7\_h | 1 misfire count | Bin 0 | B U |\*

| 1620 | nummis8\_h | 1 misfire count | Bin 0 | B U |\*

| 1621 | nummis\_h | 1 misfire count | Bin 0 | B U |\*

| 1622 | totevents\_h | 1 cylinder event | Bin 0 | B U |\*

| 1623 | mis\_nocall\_h | 1 cylinder event | Bin 0 | B U |\*

| 1627 | PFS\_CNTS | 0.0156 A/D count | Bin 6 | W U |

| 162B | NTBART | 0.25 rpm | Bin 2 | W U |

|------|--------------|-------------------------|-----------|-----------|

NOTE: The \*'d PIDs exist in the strategy as three byte parameters. They

are represented here as separate PIDs since the EEEC does not support

three-byte PIDs. The parameters are identified in VECTOR by their

word PID names.

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SCP INTERFACES, SCP PARAMETER IDENTIFIER (PID) LIST - CDAN2

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SCP DIAGNOSTIC PID MAP (continued) - CDAN2

| | pid\_def() or | OUTPUT | OUTPUT | DATA |

| PID# |PARAMETER NAME| RESOLUTION | SCALING | TYPE |

|------|--------------|-------------------------|-----------|-----------|

| 162D | BITMAP\_OFD\_1 | Bitmapped | Bin 0 | B U |

| 162E | BITMAP\_OFD\_2 | Bitmapped | Bin 0 | B U |

| 162F | BITMAP\_OFD\_3 | Bitmapped | Bin 0 | B U |

| 1630 | BITMAP\_OFD\_4 | Bitmapped | Bin 0 | B U |

| 1631 | SCPBITMAP\_6 | Bitmapped | Bin 0 | B U |

| 1632 | BITMAP\_OFD\_5 | Bitmapped | Bin 0 | B U |

| 1633 | IMAF | 0.0156 A/D count | Bin 6 | W U |

| 1634 | IMRCP1\_CNTS | 0.0156 A/D count | Bin 6 | W U |

| 1636 | VMV\_OSM\_CNTS | 0.0156 A/D count | Bin 6 | W U |

| 1638 | IACPRES\_SEN | 0.0156 A/D count | Bin 6 | W U |

| 1639 | TPR\_CNTS | 0.0156 A/D count | Bin 6 | W U |

| 163A | TQ\_NET | 2 ft-lbs | Bin -1 | B U |

| 163C | SCPBITMAP\_7 | Bitmapped | Bin 0 | B U |

| 163E | R\_BIAS1 | 1/8192 unitless | Bin 13 | W S |

| 163F | R\_BIAS2 | 1/8192 unitless | Bin 13 | W S |

| 1671 | j1979\_01\_10 |0.01 gram of air mass/sec| Bin 0 | W U |

| 1672 | FPUMP\_DC |100/32768 % on duty cycle| Bin 15 | W U |

| 1674 | TOT\_ENG | 0.125 degrees F | Bin 3 | W S |

| 1675 | far\_mul\_1 | HEX values | Bin 0 | W U |

| 1676 | far\_mul\_2 | HEX values | Bin 0 | W U |

| 1677 | SLIP\_DES | 0.0625 rpm | Bin 4 | W U |

| 1679 | HTRCM11 | 1/256 Amps | Bin 8 | W U |

| 167A | HTRCM12 | 1/256 Amps | Bin 8 | W U |

| 167B | HTRCM21 | 1/256 Amps | Bin 8 | W U |

| 167C | HTRCM22 | 1/256 Amps | Bin 8 | W U |

| 1687 | PGM\_TANK\_PRS | 1/512 inches of H2O | Bin 9 | W S |

| 1688 | SCPBITMAP\_10 | Bitmapped | Bin 0 | B U |

| 1689 | BITMAP\_FMEM3 | Bitmap | Bin 0 | B U |

| 1695 | S\_VEGO11 | 0.000977 volts | Bin 10 | W S |

| 1696 | S\_VEGO21 | 0.000977 volts | Bin 10 | W S |

| 1699 | S\_VEGO12 | 0.000977 volts | Bin 10 | W S |

| 169A | S\_VEGO22 | 0.000977 volts | Bin 10 | W S |

| E100 | scp\_odu\_ram | Hex Address Values | Bin 0 | W U |

|------|--------------|-------------------------|-----------|-----------|

NOTE: The \*'d PIDs exist in the strategy as three byte parameters. They

are represented here as separate PIDs since the EEEC does not support

three-byte PIDs. The parameters are identified in VECTOR by their

word PID names.

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CHAPTER 6

CRANK/UNDERSPEED/RUN MODE SELECTION STRATEGY

6-1

CRANK/UNDERSPEED/RUN MODE SELECTION - CDAN2

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6.1 CRANK/UNDERSPEED/RUN MODE SELECTION (CDAI0)

OVERVIEW

The EEC IV strategy operation is divided into three distinct strategy

segments. These are:

1) CRANK

2) UNDERSPEED

3) RUN

The CRANK mode is entered after a power-up initialization or after an engine

stall. CRANK employs a special strategy to aid engine starting. When the

CRANK logic first becomes false, the UNDERSPEED mode is entered. The

UNDERSPEED mode employs a special spark and fuel strategy in place of the

normal engine control strategy (RUN). After start, the RUN mode is entered

and the normal engine control strategy is executed. If the engine stumbles

during RUN mode, the UNDERSPEED mode can again be entered to help recover

from the stumble and prevent a stall.

The specific strategies are:

CRANK STRATEGY

Fuel Fire all injector ports simultaneously

every CRKPIP PIPS. See the Fuel strategy.

Spark Advance 10 degrees BTDC (on PIP signal)

Thermactor Air bypass

EGR disabled

Purge disabled

ISC FN884(TCSTRT)

Data Output Link execute strategy

A/C Clutch disabled

S.I.L. disabled

Thermactor Pump Clutch disabled

6-2

CRANK/UNDERSPEED/RUN MODE SELECTION - CDAN2

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UNDERSPEED STRATEGY

Fuel Fire all injector ports in the

same manner as in the RUN mode.

An additional multiplier (FN387

or FN387A) is included in the

pulsewidth equation. See the

Fuel Background Pulsewidth module.

Spark Advance 10 degrees BTDC (on PIP signal)

Other outputs are the same as the RUN mode.

RUN STRATEGY

The normal engine control strategy is described in the remainder of this

book.

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CRANK/UNDERSPEED/RUN MODE SELECTION - CDAN2

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DEFINITIONS

INPUTS

Registers:

- ACSTRT = Temperature of ACT at startup, deg F.

- ECT = Engine coolant temperature, deg F.

- ECTCNT = Number of times ECT sensor input was read.

- N = Engine RPM.

- PIPCNT = Number of PIPs which have occurred.

- RUNUPTMR = Time since runup rpm exceeded (0.125 secs).

- TCSTRT = Temperature of Engine Coolant at Cold Startup, deg F.

- TOT = Transmission oil temperature.

- TSLPIP = Time since last PIP.

Bit Flags:

- CRKFLG = Engine Mode Flag; 1 -> Crank Mode, 0 <> Crank Mode.

- PTSCR = Part throttle since crank mode flag; 0 -> driver has not tipped

in since start, 1 -> driver tipped in, kick down desired RPM.

- UNDSP = Run/Underspeed Flag; 1 -> Underspeed (or CRANK), 0 -> Run.

Calibration Constants:

- CRKPIP = Number of PIPs between injector outputs during Crank.

- FN384(ECT) = Maximum engine speed to exit Crank versus ECT.

- FN385(ECT) = Underspeed-to-run transition as a function of ECT.

- FN387A = Fuelpw multiplier versus ECT; purpose: underspeed mode fuel

control; Input = ECT.

- FN884(TCSTRT) = ISC Duty Cycle in Crank, deg.

- NCNT = Minimum number of PIP necessary to exit CRANK Mode.

- NSTALL = Engine Stall speed to re-enter CRANK Mode.

- UNRPMH = Hysteresis term for UNDERSPEED Mode.

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CRANK/UNDERSPEED/RUN MODE SELECTION - CDAN2

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OUTPUTS

Registers:

- ACSTRT\_ACCUM = ACSTRT accumulator, deg F.

- ECTCNT = See above.

- INIT\_TOT = TOT at start-up; arithmetic average of the first 8 TOT

reading.

- N = See above.

- N\_RUN = Engine RPM to exit Crank mode [=FN384(ECT)].

- PIPCNT = See above.

- TCSTRT\_ACCUM = TCSTRT accumulator, deg F.

Bit Flags:

- AIR\_CRK\_INT = Flag that indicates if the air registers have been

initialize; 0 -> registers not initialiezed yet, 1 -> registers have been

initialiezed.

- AIR\_PIP\_CNT = Counter that counts the first four pip edges.

- CRKFLG = See above.

- FIRST\_PIP = Indicates that first PIP has been received.

- FLG\_STALL = Flag indicating a stall has occurred; transition from

underspeed/run to crank.

- RUNUP\_FLG = Flag indicating that initial runup is complete; 1 -> Runup

complete.

- UNDSP = Run/Underspeed Flag; 1 -> Underspeed (or CRANK), 0 -> Run.

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CRANK/UNDERSPEED/RUN MODE SELECTION - CDAN2

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PROCESS

STRATEGY MODULE: CRK\_UNDSP\_RUN\_COM2

Always -------------------------------------| FLG\_STALL = 0

| N\_RUN = FN384(ECT)

CRKFLG = 1 ---------------------------| | (Crank Mode)

|AND -| PIPCNT = 0

N <= N\_RUN ---------------------------| | PTSCR = 0

| UNDSP = 1

|

| --- ELSE ---

CRKFLG = 1 ---------------------------| |

| |

N > N\_RUN ----------------------------| | (Exit Crank)

|AND -| CRKFLG = 0

ECTCNT >= 8 --------------------------| | UNDSP = 1

| |

PIPCNT >= NCNT -----------------------| |

| --- ELSE ---

|

CRKFLG = 1 ---------------------------| | (Crank Mode)

|AND -| UNDSP = 1

N > N\_RUN ----------------------------| |

| --- ELSE ---

|

| (Engine stall)

N < NSTALL ---------------------------------| PIPCNT = 0

| CRKFLG = 1

| FLG\_STALL = 1

| ECTCNT = 0

| PTSCR = 0

| TCSTRT\_ACCUM = 0

| UNDSP = 1

| ACSTRT\_ACCUM = 0

| INIT\_TOT = 0

| RUNUP\_FLG = 0

| RUNUPTMR = 0

|

| --- ELSE ---

|

| (Enter Underspeed)

N < FN385(ECT) -----------------------------| PIPCNT = 0

| UNDSP = 1

|

| --- ELSE ---

(continued on next page)

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CRANK/UNDERSPEED/RUN MODE SELECTION - CDAN2

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(continued from previous page)

N > (FN385(ECT) + UNRPMH) ------------| |

|AND -| (Enter Run)

UNDSP = 1 ----------------------------| | PIPCNT = 0

| UNDSP = 0

|

| --- ELSE ---

|

| (No Change)

| PIPCNT = 0

TSLPIP >= 800 msec -------------------------| N = 0

| FIRST\_PIP = 0

| AIR\_CRK\_INT = 0

| AIR\_PIP\_CNT = 0

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CRANK/UNDERSPEED/RUN MODE SELECTION - CDAN2

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CHAPTER 7

THROTTLE MODE SELECTION STRATEGY

7-1

THROTTLE MODE SELECTION - CDAN2

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7.1 THROTTLE MODE SELECTION STRATEGY (CDAI0)

OVERVIEW

The throttle mode scheduler is used to determine what engine operating region

is currently extant. The variable APT (At Part Throttle flag) is used to

indicate throttle mode and is assigned the following values:

Throttle Mode APT

------------------ ---

CLOSED THROTTLE -1

PART THROTTLE 0

WIDE OPEN THROTTLE 1

The value of APT is determined by the logic shown on the following page.

Briefly, throttle angle breakpoints, in terms of counts, are used to define

the CLOSED/PART\_THROTTLE and PART/WIDE\_OPEN\_THROTTLE transitions. Hysteresis

is incorporated in both breakpoints to prevent jitter between modes.

TP\_REL is a parameter which indicates the amount of throttle movement beyond

the closed throttle/idle setting. TP\_REL is computed by subtracting RATCH

from TP. Larger values of TP\_REL indicates wide open throttle, smaller

values of TP\_REL indicates part throttle, and near zero TP\_REL indicates

closed throttle.

The variable RATCH is the output of a ratchet algorithm which continuously

seeks the minimum throttle angle corresponding to a CLOSED THROTTLE position.

This alleviates the necessity to set the throttle position sensor at an

absolute position and compensates for system changes and differences between

vehicles. The ratchet algorithm uses filtered throttle position for the

determination of RATCH.

A more detailed explanation of the throttle position ratchets and throttle

position filter is contained in the INPUT CONVERSIONS AND FILTERS chapter.

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THROTTLE MODE SELECTION - CDAN2

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DEFINITIONS

INPUTS

Registers:

- APT = Status of Part Throttle; -1 -> Closed Throttle, 1 -> Wide Open

Throttle, 0 -> Part Throttle.

- TP\_REL = Relative Throttle position, counts.

Bit Flag:

- CRKFLG = Flag indicating engine mode; 1 -> Crank.

Calibration Constants:

- DELTA = CT/PT Breakpoint value above RATCH.

- HYST2 = Hysteresis term to enter WOT mode.

- HYSTS = A/D counts, Closed Throttle to Part Throttle hysteresis value.

- THBP2 = PT/WOT Breakpoint value above RATCH.

OUTPUTS

Registers:

- APT = See inputs above.

Bit Flags:

- CL\_THRTL = Indicates that the throttle is closed; 1 -> closed throttle, 0

-> part throttle or wide open throttle.

- CTPTFG = Closed throttle to PT/WOT transition flag.

- PTSCR = Part throttle mode since exiting CRANK Flag.

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THROTTLE MODE SELECTION - CDAN2

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THROTTLE MODE SELECTION LOGIC

The logic described below considers the current position of the throttle and

compares its value to the RATCH, Closed Throttle, plus the change in throttle

position from the last setting. If both flip-flops in the logic clear, then

Part Throttle is set.

PROCESS

STRATEGY MODULE: THROT\_COM1

TP\_REL <= DELTA ----------------------|S Q-| Closed Throttle mode

| | APT = -1

TP\_REL > DELTA + HYSTS ---------------|C | CL\_THRTL = 1

|

| --- ELSE ---

|

TP\_REL > THBP2 + HYST2 ---------------|S Q-| Wide Open Throttle

| | mode

TP\_REL <= THBP2 ----------------------|C | APT = 1

| CL\_THRTL = 0

|

| --- ELSE ---

|

| Part Throttle Mode

| APT = 0

| CL\_THRTL = 0

NOTE: PTSCR is initialized to 0.

previous APT = -1 --------------------|

|

current APT <> -1 --------------------|AND -| CTPTFG = 1

| | Closed Throttle to

CRKFLG = 1 ---------------------------| | Part Throttle transition

|

| --- ELSE ---

previous APT = -1 --------------------| |

| |

current APT <> -1 --------------------|AND -| CTPTFG = 1

| | Closed Throttle to

CRKFLG = 0 ---------------------------| | Part Throttle transition

| PTSCR = 1

|

| --- ELSE ---

|

| CTPTFG = 0

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CHAPTER 8

FUEL STRATEGY

8-1

FUEL STRATEGY, OVERVIEW - CDAN2

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8.1 FUEL STRATEGY OVERVIEW (CDAI0)

The A/F ratio control actuators consist of injectors whose fuel metering

function is affected by energizing and de-energizing the injector solenoids.

Each injector has a metering needle or pintle which opens or closes the

injector nozzle to release fuel.

A high pressure fuel pump delivers fuel to the injectors at approximately 42

PSI.

Based upon the calculated air mass value, the software calculates the

injector pulsewidths required to give the desired A/F ratio.

The desired A/F ratio for all operating conditions is determined by the A/F

strategy and calibration.

The strategy is designed to handle any reasonable injector configuration and

firing patterns. Example configurations are:

1. 1 or 2 output CFI

2. 1 or 2 output bank EFI

3. 4, 6 or 8 output Sequential EFI

The strategy can run on 4, 6 or 8-cylinder engines. The calibration

parameters ENGCYL and NUMCYL control the engine type. The user must set both

parameters for the strategy to work correctly.

On SEFI applications, each cylinder has an injector located in the intake

port near the intake valve. The injectors are individually fired in an order

that matches the firing order of the engine. The injector output numbers

correspond to engine cylinder numbers. This allows for consistent

nomenclature for the module pinouts and the wiring harness. Under normal

engine running, each injection is timed to occur at an optimum point in the

intake event. Injector timing is determined by strategy and calibration.

Timed sequential fuel injection requires identification of cylinder #1.

8-2

FUEL STRATEGY, OVERVIEW - CDAN2

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STEREO EGO FUEL SYSTEM CONFIGURATION

The following Side 1 and Side 2 designations are used.

| |

| |

| |

| EGO SENSOR ----- E E ----- EGO SENSOR |

| EGO-1 EGO-2 |

| HEGO-1 HEGO-2 |

| |

| |

| |

| ------- |

| | I I | |

| SIDE 1 INJECTORS --> | I I | <-- SIDE 2 INJECTORS|

| | I I | |

| #1 | I I | |

| ------- |

| |

| |

| |

| |

| |

|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|

FRONT OF VEHICLE

(TOP VIEW)

NUMEGO

A calibration switch exists which is used to tell the computer how many EGO

sensors are present. If NUMEGO = 1, the system is treated as a mono EGO

sensor system and all fuel pulsewidths are calculated from the single EGO

sensor (treated as EGO-1). If NUMEGO = 2: Fuel pulsewidths for the EGO-2

injectors are calculated from EGO-2 sensor information; Fuel pulsewidths for

the EGO-1 injectors are calculated from EGO-1 sensor information. FN1327

links the injector outputs to the appropriate EGO sensor.

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FUEL STRATEGY, OVERVIEW - CDAN2

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FUEL MODES

Fuel control strategy is divided into 2 mutually exclusive modes:

- OPEN LOOP

- CLOSED LOOP

OPEN LOOP MODE

During open loop operation, the computer calculates the injector fuel

pulsewidths required to provide a pre-determined A/F ratio or lambda value.

The desired lambda values (LAMBSE1, LAMBSE2) can vary with engine operating

conditions and are calibration-dependent. During open loop, LAMBSE1 equals

LAMBSE2.

CLOSED LOOP MODE

During closed loop operation, the computer ramps the desired lambda values

(LAMBSE1, LAMBSE2) in a limit cycle manner about stoichiometry. Using the

EGO (Exhaust Gas Oxygen) sensor, the computer increases or decreases lambda

at a calculated rate of change. The rate at which lambda changes is

calibration dependent. For Stereo EGO operation, LAMBSE1 and LAMBSE2 vary

independently using EGO-1 and EGO-2 sensors. For Mono EGO operation, LAMBSE1

equals LAMBSE2.

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FUEL STRATEGY, OUTPUT SHAFT SPEED LIMITER LOGIC - CDAN2

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8.2 OUTPUT SHAFT SPEED LIMITER LOGIC (CDAA0)

OVERVIEW

The output shaft speed limiter logic protects vehicle function in three

stages.

These stages are shown below:

1) Stage One: Reduces the engine's power output in a gradual manner by

enriching the fuel and retarding the spark (See Open Loop Fuel and Spark

Strategies).

2) Stage Two: Further reduces the engine output by disabling the outputs to

one-half of the injector ports. This action will occur only if the fuel and

spark strategy in Stage One is ineffective.

3) Stage Three: Turns off all injector outputs.

DEFINITIONS

INPUTS

Registers:

- NOBAR = Filtered output shaft speed, rpm.

Calibration Constants:

- HNO\_CL = Disable stage 1 no speed limiter, rpm.

- HNO\_SH = Enable stage 1 no speed limiter, rpm.

- NOMAX = Stage 3 Output Shaft speed limit.

- VHNO\_CL = Disable stage 2 no speed limiter, rpm.

- VHNO\_SH = Enable stage 2 no speed limiter, rpm.

OUTPUTS

Bit Flags:

- FOFFLG2 = Stage 2 alternate fire VS exceeded.

- HSPFLG = High Speed Mode Flag; 1 -> High Speed Alt. Fuel/Spark Speed

Limit.

- NLMT\_FLG2 = Stage 3 no fuel VS exceeded.

- NO\_LIM\_STG1 = Stage 1 output shaft speed flag

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FUEL STRATEGY, OUTPUT SHAFT SPEED LIMITER LOGIC - CDAN2

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- NO\_LIM\_STG2 = Stage 2 output shaft speed flag

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FUEL STRATEGY, OUTPUT SHAFT SPEED LIMITER LOGIC - CDAN2

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PROCESS

STRATEGY MODULE: FUEL\_NO\_LIM\_COM1

NOBAR > VHNO\_SH ---------------|S Q -| NO\_LIM\_STG2

(very high speed) |

|

NOBAR < VHNO\_CL ---------------|C

NOBAR > HNO\_SH ----------------|S Q -| NO\_LIM\_STG1

(high speed) |

|

NOBAR < HNO\_CL ----------------|C

NOBAR > NOMAX -----------------------| STAGE 3

| (Turn off all injectors)

| NLMT\_FLG2 = 1

|

| --- ELSE ---

|

NO\_LIM\_STG2 = 1 ---------------------| STAGE 2

| (Fire alternate injectors

| using normal fuel strategy)

| FOFFLG2 = 1

| HSPFLG = 0

| NLMT\_FLG2 = 0

|

| --- ELSE ---

|

NO\_LIM\_STG1 = 1 ---------------------| STAGE 1

| (Do fuel enrichment and spark

| retard)

| FOFFLG2 = 0

| HSPFLG = 1

| NLMT\_FLG2 = 0

|

| --- ELSE ---

|

| FOFFLG2 = 0

| HSPFLG = 0

| NLMT\_FLG2 = 0

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FUEL STRATEGY, RPM LIMITER HIGH LOAD - CDAN2

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8.3 RPM LIMITER HIGH LOAD (CDAA0)

OVERVIEW

This mode of the RPM limiter is intended for the SuperCoup package ONLY. It

should be calibrated to have no effect in ALL other strategies.

To calibrate this strategy to give the normal rpm limit strategy, set the

following as shown.

NLMTLO\_1 = 7000

NLNTLO\_2 = 7000

FIRPM\_3 = 7000

DEFINITIONS

INPUTS

Registers:

- ECT = Coolant temp, degree F.

- FINCTR\_1 = Mid gear high rpm timer.

- LOAD = Universal load as ratio of air charge over standard.

- N = RPM.

- PIPLMT\_HIG = Stage 3 rev limit in use.

- PIPLMT\_LOW = Stage 2 rev limit in use.

- TP\_REL = RELATIVE TP ( TP - RATCH ).

- VS\_LIM\_BAR = VSBAR - high range.

Bit Flags:

- NDSFLG = Neutral/drive flag; 1 -> drive.

Calibration Constants:

- FIECT\_3\_SH = ECT to force alternate fire, high load.

- FIECT\_3\_CL = ECT to exit alternate fire, high load.

- FILOAD\_3 = LOAD to force alternate fire.

- FINCECT\_2 = ECT to force alternate fire, top gear.

- FINCTM\_1H = Mid gear high rev duration timer clip.

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FUEL STRATEGY, RPM LIMITER HIGH LOAD - CDAN2

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- FINCTM\_1L = Mid gear high rev duration to force rev limit.

- FINVSBP\_1 = Low gear/mid gear breakpoint.

- FINVSBP\_2 = Mid gear/top gear breakpoint.

- FIRPM\_3 = RPM to force alternate fire.

- FITP\_3 = TP to force alternate fire.

- NLMTHI\_0 = Low gear stage 3 rev limit.

- NLMTHI\_1 = Mid gear stage 3 rev limit.

- NLMTHI\_2 = Top gear stage 3 rev limit.

- NLMTLO\_0 = Low gear stage 2 rev limit.

- NLMTLO\_1 = Mid gear stage 2 rev limit.

- NLMTLO\_2 = Top gear stage 2 rev limit.

- NLMTNEUHI\_0 = Neutral stage 3 rev limit.

- NLMTNEULO\_0 = Neutral stage 2 rev limit.

OUTPUTS

Registers:

- FINCTR\_1 = Mid gear high rpm timer.

- FINCTR\_2 = Top gear high rpm timer.

Bit Flags:

- FOFFLG3 = Stage 2 alternate fire TP exceeded.

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FUEL STRATEGY, RPM LIMITER HIGH LOAD - CDAN2

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PROCESS

STRATEGY MODULE: FUEL\_RPM\_LIM\_BG\_COM3

FINVSBP\_2 <= N/VS\_LIM\_BAR < FINVSBP\_1 -|

|AND -| Increment timer FINCTR\_1

N > NLMTLO\_1 --------------------------| |

| --- ELSE ---

|

| Decrement timer FINCTR\_1

FINVSBP\_2 <= N/VS\_LIM\_BAR < FINVSBP\_1 -|

|

N > NLMTLO\_1 --------------------------|

|AND -| FINCTR\_1 = FINCTM\_1H

FINCTR\_1 > FINCTM\_1L ------------------|

Note : FINCTM\_1L should be calibrated to be less than FINCTM\_1H.

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FUEL STRATEGY, RPM LIMITER HIGH LOAD - CDAN2

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ECT > FIECT\_3\_SH -----------------|S Q -|

| |

ECT < FIECT\_3\_CL -----------------|C |

|

LOAD > FILOAD\_3 ------------------------|

|AND -| FOFFLG3 = 1

TP\_REL > FITP\_3 ------------------------| |

| | --- ELSE ---

N > FIRPM\_3 ----------------------------| |

| FOFFLG3 = 0

| PIPLMT\_HIG =

ECT > FINCECT\_2 ------------------------| | Fn\_A( NLMTHI\_2 )

|AND -| PIPLMT\_LOW =

N/VS\_LIM\_BAR < FINVSBP\_2 ---------------| | Fn\_A( NLMTLO\_2 )

|

| --- ELSE ---

|

FINCTR\_1 >= FINCTM\_1L ------------|S Q -| |

| | |

FINCTR\_1 = 0 ---------------------|C | |

|OR --| PIPLMT\_HIG =

ECT > FINCECT\_1 ------------------| | | Fn\_A( NLMTHI\_1 )

| | | PIPLMT\_LOW =

FINVSBP\_2 <= N/VS\_LIM\_BAR |AND -| | Fn\_A( NLMTLO\_1 )

< FINVSBP\_1 -----| |

| --- ELSE ---

|

NDSFLG = 0 -----------------------------------| PIPLMT\_HIG =

| Fn\_A( NLMTNEUHI\_0 )

| PIPLMT\_LOW =

| Fn\_A( NLMTNEULO\_0 )

|

| --- ELSE ---

|

| PIPLMT\_HIG =

| Fn\_A( NLMTHI\_0 )

| PIPLMT\_LOW =

| Fn\_A( NLMTLO\_0 )

Where y = Fn\_A( x ) is defined as x rpm converted to a pip period y in ticks.

8-11

FUEL STRATEGY, WARM EGO LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.4 WARM EGO LOGIC (CDAL0)

OVERVIEW

The Warm HEGO Logic determines if the HEGO sensor is warm enough to enter

Closed Loop control. Time since start-up and coolant temperature at start-up

are used to determine if the sensor is warm. The output from the logic is

the flag, 'WRMEGO'.

The strategy also offers the alternative to use EXT\_FEG, temperature of the

front EGO sensors to decide if the EGO is warm. If this approach is used, a

URD should be issued to remove the time at temperature inference from this

module.

DEFINITIONS

Registers:

- ATMR1 = Time since start (time since exiting crank mode), sec.

- ATMR2 = Time since ECT became greater than TEMPFB, sec.

- ATMR4 = Time since reaching ECTSTABL, sec.

- ATMR1\_HI\_RES = Time since engine start with higher resolution than ATMR1.

- ECT = Engine coolant temperature, deg F.

- EXT\_FEG = Inferred front HEGO tip temperature, degrees.

- TCSTRT = Temperature of ECT at Cold Startup, deg F.

Bit Flags:

- CRKFLG = Engine Mode Flag; 1 -> Crank Mode, 0 -> not in Crank Mode.

- FLG\_ECTSTABLQ = ECT stabilized flag; 1 -> ECT stabilized, use FN1360.

- FLG\_STABLECT = ATMR4 flip flop flag; 1 -> output enabled.

- WRMEGO = HEGO sensor should be warm flag.

Calibration Constants:

- CTHIGH = Hot Start Minimum Engine coolant Temperature, deg F.

- CTLOW = Cold Start Maximum ECT, deg F.

- ECTSTABL = Minimum ECT for stabilized Open Loop fuel table, deg F.

- ECTSTABL\_CL = ECTSTABL - hysteresis.

- ECTSTABLTIM = Minimum time above ECTSTABL to use FN1360.

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FUEL STRATEGY, WARM EGO LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- HEGO\_WARM = Temperature of front EGO when it can be used for closed loop

fuel control, degrees.

- FNWRMENG = Time into run mode before allowing closed loop fuel as a

function of coolant temp at start.

- OPCLT1 = ATMR1 Closed Loop enable time delay for TCSTRT <= CTLOW.

- OPCLT2 = ATMR1 Closed Loop enable time delay for CTLOW < TCSTRT < CTHIGH.

- OPCLT3 = ATMR1 Closed Loop Enable Time delay for TCSTRT >= CTHIGH.

- OPCLT4 = ATMR2 Closed Loop enable time delay for TCSTRT <= CTLOW.

- OPCLT5 = ATMR2 Closed Loop Enable Time Delay for CTLOW < TCSTRT < CTHIGH.

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FUEL STRATEGY, WARM EGO LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_WRMEGO\_COM1

BEGIN: warm\_ego\_logic

; Execute the following process once per background pass.

EXT\_FEG > HEGO\_WARM --------|

;EGO is warm |

|AND -|

ATMR1\_HI\_RES > | |

FNWRMENG(ECT) ---| |

;engine is warm. |

|

TCSTRT >= CTHIGH -----------| |

|AND -|

ATMR1 >= OPCLT3 ------------| |

|

CTLOW < TCSTRT < CTHIGH ----| |

|AND -|OR --| WRMEGO = 1

ATMR1 >= OPCLT2 ------| | | |

|AND -| | |

ATMR2 >= OPCLT5 ------| | |

| |

TCSTRT <= CTLOW ------------| | |

|AND -| |

ATMR1 >= OPCLT1 ------| | |

|AND -| |

ATMR2 >= OPCLT4 ------| |

| --- ELSE ---

|

| WRMEGO = 0

CRKFLG = 0 -----------------|

|AND -|S Q -| FLG\_STABLECT

ECT >= ECTSTABL ------------| |

|

ECT < ECTSTABL\_CL ----------| |

|OR --|C

CRKFLG = 1 -----------------|

FLG\_STABLECT = 1 -----------------------| Increment ATMR4

|

| --- ELSE ---

|

| ATMR4 = 0

ATMR4 > ECTSTABLTIM --------------------| FLG\_ECTSTABLQ = 1

| (ECT stabilized)

|

| --- ELSE ---

|

| FLG\_ECTSTABLQ = 0

| (cold engine)

END: warm\_ego\_logic

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FUEL STRATEGY, LUGGING MODE DETERMINATION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.5 LUGGING MODE DETERMINATION (CDAA0)

OVERVIEW

The strategy provides the capacity of Open Loop Fuel Control during "lugging"

conditions; lugging usually occurs at part throttle, high load, and low rpm.

The "lugging" open loop multiplier is adjusted for altitude through the use

of FN212A and FN129A.

CALIBRATION NOTES:

1. LDMH and LDMHH should correspond to high loads (near WOT).

2. LDLTM must be less than or equal to LUGTIM (since LUGTMR is

clipped to LUGTIM).

DEFINITIONS

INPUTS

Registers:

- APT = At Part Throttle; -1 -> Closed throttle, 0 -> Part throttle, 1 ->

Wide Open throttle.

- ECT = Engine Coolant Temperature, deg. F.

- PERLOAD = Percent of Peak LOAD at any altitude, unitless.

Bit Flags:

- WRMEGO = Ego sensor should be warm flag.

Calibration Constants:

- LDEL = Minimum ECT to enable Lugging Open Loop, deg. F.

- LDEH = Maximum ECT to enable Lugging Open Loop, deg.F.

- LDMH = Minimum PERLOAD to enable Lugging Open Loop (near W.O.T.).

- LDMHH = Hysteresis for LDMH.

- LDLTM = Minimum time in lugging mode before forcing open loop, sec.

OUTPUTS

Bit Flags:

- LDFLG = Lugging Mode Flag; 1 -> Lugging Mode, 0 -> Not in Lugging Mode.

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FUEL STRATEGY, LUGGING MODE DETERMINATION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_LUG\_MODE\_COM1

APT = 0 ------------------------------|

(part throttle) |

|

LDEL < ECT < LDEH --------------------|

|

LUGTMR >= LDLTM ----------------------|AND ---| LDFLG = 1

| |

PERLOAD >= LDMH + LDMHH ---|S Q-------| | --- ELSE ---

| | |

PERLOAD < LDMH ------------|C | | LDFLG = 0

|

WRMEGO = 1 ---------------------------|

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FUEL STRATEGY, LAMMUL RESET LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.6 LAMMUL RESET LOGIC (CDAC0)

OVERVIEW

This module calculates the parameter, LAMMUL. LAMMUL is used to prevent cold

engine stalls following transmission engagement.

DEFINITIONS

INPUTS

Registers:

- ALT\_CAL\_FLG = Alternate calibration flag; 1 -> Alternate calibration is

used for spark plug fouling prevention.

- MULTMR = Time since incrementing LAMMUL, sec.

- REVFLG = Reverse engagement flag; 1 -> reverse, 0 -> drive.

Bit Flags:

- DNDSUP = Delayed Neutral/Drive flag; 0 -> neutral, 1 -> drive.

- NEUFLG = N/D transition occurred.

Calibration Constants:

- FN371 = Initial LAMMUL as a function of ECT. This is a Fuel Multiplier

to provide fuel compensation during Drive Engagement.

- FN371\_ALT = FN371 which is used during alternate calibration for spark

plug fouling prevention.

- FN393F = Time between LAMMUL decrements - forward gear.

- FN393R = Time between LAMMUL changes - reverse gear.

- TRLOAD = Transmission Load switch;

0 -> Manual Transmission, no clutch or gear switches,

forced neutral state (NDSFLG = 0).

1 -> Manual Transmission, no clutch or gear switch.

2 -> Manual Transmission, one clutch or gear switch.

3 -> Manual Transmission, both clutch and gear switches.

4 -> Auto Transmission, non-electronic, neutral drive switch.

5 -> Auto Transmission, non-electronic, neutral pressure switch,

(AXOD).

6 -> Auto Transmission, electronic, PRNDL sensor - park,

reverse, neutral, overdrive, manual 1, manual 2.

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FUEL STRATEGY, LAMMUL RESET LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- LAMMUL = Multiplier which is used to prevent cold-engine stalls following

transmission engagement.

- MULTMR = See above.

Bit Flags:

- NEUFLG = See above.

PROCESS

STRATEGY MODULE: FUEL\_LAMMUL\_COM4

ALT\_CAL\_FLG = 1 ---------------------------| fn371 = FN371\_ALT(ECT)

|

| --- ELSE ---

|

| fn371 = FN371(ECT)

TRLOAD <= 3 -------------------------------| No LAMMUL RESET

(Manual Transmission) | No change to LAMMUL

| No change to NEUFLG

|

| --- ELSE ---

DNDSUP = 1 --------------------------| |

(Transmission in gear) |AND -| LAMMUL RESET

| | LAMMUL = fn371

NEUFLG = 1 --------------------------| | NEUFLG = 0

(Transition from neutral) |

| --- ELSE ---

|

DNDSUP = 0 --------------------------------| NEUFLG = 1

(Transmission in neutral)

NOTE: LAMMUL, FN371\_ALT, and FN371 have a range of 0 through 1.99. The

LAMMUL Reset logic is done both in open loop and closed loop fuel. LAMMUL,

however, is only applied in open loop fuel.

LAMMUL can either jump lean (ramp rich) or jump rich (ramp lean), depending

upon whether neutral to drive transitions cause rich or lean errors. This

logic is done both in open loop and closed loop fuel.

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FUEL STRATEGY, LAMMUL RESET LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

RAMP BACK LOGIC

REVFLG = 1 --------------|

|AND -|

MULTMR >= FN393R --------| |

(in reverse) |OR --|

| |

REVFLG = 0 --------------| | |

|AND -| | (LAMMUL was RESET RICH)

MULTMR >= FN393F --------| |AND -| LAMMUL = LAMMUL + 0.0039

(in forward) | | MULTMR = 0

| | Clip LAMMUL to

LAMMUL < 1.0 ------------------------| | 1.0 as a maximum

|

| --- ELSE ---

REVFLG = 1 --------------| |

|AND -| |

MULTMR >= FN393R --------| | |

(in reverse) |OR --| |

| | |

REVFLG = 0 --------------| | | |

|AND -| | | (LAMMUL was RESET LEAN)

MULTMR >= FN393F --------| |AND -| LAMMUL = LAMMUL - 0.0039

(in forward) | | MULTMR = 0

| | Clip LAMMUL to

LAMMUL > 1.0 ------------------------| | 1.0 as a minimum

8-19

FUEL STRATEGY, OPEN LOOP FLAG DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.7 OPEN LOOP FLAG DETERMINATION (CDAM0)

OVERVIEW

This module determines the state of the open loop desired flag, OL\_DESIRED.

DEFINITIONS

Registers:

- APT = At Part Throttle; -1 -> Closed throttle, 0 -> Part throttle, 1 ->

Wide Open throttle.

- BG\_TMR = Background timer, sec.

- CAT\_MAX\_CLR = Lower Cat Midbed temp to clear EXT\_FLG, with or without a

reliable EXT\_CMD inference, Deg F.

- CAT\_MAX\_SAFE = Desired Maximum Cat Midbed temperature that the Cat Temp

A/F Controller will maintain; with & without failure mode safety factor,

Deg F.

- COOL\_FLG = Cylinder head overtemperature flag, lack of coolant strategy;

1 -> overtemperature.

- CTNTMR = Closed throttle neutral timer.

- CTTMR = Time since entering Closed throttle mode, secs. CTTMR is used to

delay Decel Fuel Shutoff (DFSO).

- EXT\_CMD = Signed inferred catalyst midbed gas temperature.

- IDLTMR = In-gear idle time.

- LOAD = Universal load as ratio of air charge over standard.

- N = Engine speed rpm.

- NUMEGO = Switch indicating number of HEGO sensors present, select mono or

stereo.

- OLTMR = Open loop delay timer, sec.

- OLTMR\_CROWD = Open loop delay timer specifically for FLG\_OL\_337, sec.

- PERLOAD = Percent of Peak LOAD at any altitude, unitless.

- PPCTR = PIP counter for decel fuel ramp.

- VSBAR = Vehicle speed, mph.

Bit Flags:

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FUEL STRATEGY, OPEN LOOP FLAG DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- CHKAIR = Thermactor Status flag; 0 -> Forced open loop, 1 -> not forced

open loop.

- CTNFLG = 1 -> closed throttle neutral idle.

- DIS\_FMEM = HDR DIS strategy controlled FMEM flag.

- DS\_EGO\_OL = Flag used to force open loop fuel control during a forced A/F

excursion to test the downstream EGOs.

- ER\_FUL\_REQ = Utility flag used during on-demand sequenced tests to

require LAMBSE override.

- EXT\_FLG = Catalyst exhaust overtemperature flag.

- EXT\_FMM\_FLG = Failure Mode Flag to indicate that the inferred Exhaust

Temperature prediction output is suspect; 1 -> EXT model is suspect.

- EXT\_SET\_FLG = Flip flop set flag for EXT\_FLG.

- FL\_OLTMR\_337 = Flip flop flag for FN337.

- FL\_OLTMR\_338 = Flip flop flag for FN338.

- FLG\_ECTSTABLQ = ECT stabilized flag; 1 -> ECT stabilized, use FN1360.

- FLG\_OL\_320A = Open loop due to FN320A, cold crowd enrichment.

- FLG\_OL\_337 = Open loop due to FN337, hot stabilized crowd enrichment.

- FLG\_OL\_338 = Open loop due to FN338, decel.

- FLG\_OL\_VS = Open loop due to high vehicle speed.

- FLG\_OLTMR\_VSBAR = Flip flop flag for VSBAR.

- HALF\_FUEL = Flag which indicates that alternate injections are to be

cut-out; 1 -> Skip alternate injections.

- HSPFLG = High Speed Mode Flag; 1 -> High speed alternate Fuel/Spark.

- LDFLG = Lugging Mode flag; 1 -> Lugging mode.

- LEGOFG11 = Lack of HEGO11 switching flag.

- LEGOFG21 = Lack of HEGO21 switching flag.

- NO\_FUEL = Flag which indicates that all injectors are to be cut-out; 1 ->

Skip all injections.

- OL\_DES = EXT-independant open loop desired flag; 1 -> open loop desired

regardless of the exhaust gas temperature prediction.

- OL\_DESIRED = Open loop desired flag; 1 -> open loop desired, 0 -> closed

loop desired.

- OSC\_OL = 1 -> Output State Control override of LAMBSE is in effect.

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FUEL STRATEGY, OPEN LOOP FLAG DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PxxxMALF = Malfunction flag for code Pxxx; 1 => a malfunction currently

exists for fault Pxxx.

- WRMEGO = EGO sensor should be warm flag.

Calibration Constants:

- CAT\_MAX = Maximum catalyst temperature, at which temp. control will

begin.

- CAT\_MAX\_CL = Catalyst temperature which temp. control is exited.

- CAT\_TEMP\_SW = Cataylst temperature control switch to enable cat. temp.

control via open loop and/or torque control

- CROWD\_DEC = A scalar to mulitply BG\_TMR by and then subtract the product

from OLTMR\_CROWD to create and up/down counter.

- DCEVS = Minimum vehicle speed to do Decel Combustion Enrichment.

- DCEVSH = DCEVS hysteresis (mph).

- DCECTTM = Minimum time at closed throttle to do Decel Combustion

Enrichment.

- EXT\_CMD\_SF = Safety factor used to adjust the maximum catalyst

temperature during periods of unreliable EXT\_CMD calculation, Deg F.

- FN320A(ECT) = Minimum PERLOAD required for Open Loop fuel control,

unitless.

- FN337(N) = Minimum PERLOAD required for Open Loop Fuel, unitless.

- FN338(N) = Maximum LOAD required for Open Loop decels.

- HLDTM1 = Open loop time delay for FN320A(ECT), sec.

- HLDTM4 = Open loop time delay hysteresis for FN337(N), sec.

- HLDTM\_CR = Open loop time delay for FN337(N), seconds (msec resolution).

- HLODH = Hysteresis term for FN320A(ECT) and FN337(N).

- LLDTM = Open loop time delay for FN338(N), sec.

- LOLODH = Hysteresis term for FN338(N).

- NIOLD = Maximum time to allow closed loop fuel if in neutral at idle,

secs.

- OLITD1 = Time allowed at idle before entering open loop.

- PIPNUM = Number of PIPs for DFSO exit fuel ramp.

- VS\_OL\_CL = Maximum vehicle speed to allow entry into closed loop logic.

- VS\_OL\_SH = Minimum vehicle speed to force open loop lambda calculation.

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FUEL STRATEGY, OPEN LOOP FLAG DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OTHER

- P0132 = Heated oxygen sensor cicuit voltage out of range, sensor 11.

- P0135 = Fault code for EGO11 sensor heater circuit malfunction.

- P0152 = Heated oxygen sensor circuit voltage out of range, sensor 12.

- P0155 = Fault code for EGO21 sensor heater circuit malfunction.

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FUEL STRATEGY, OPEN LOOP FLAG DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_OLFLG\_COM28

Intermediate Open loop desired logic.

ER\_FUL\_REQ = 1 ------------------------|

(Engine Running On-Demand testing |

requires specific O.L. LAMBSE values)|

|

FLG\_OL\_320A = 1 -----------------| |

|AND -|

OLTMR >= HLDTM1 -----------------| |

|

FLG\_OL\_337 = 1 ------------------| |

|AND -|

OLTMR\_CROWD > HLDTM\_CR ----------| |

|

FLG\_OL\_338 = 1 ------------------| |

|AND -|

OLTMR >= LLDTM ------------------| |

|

APT = 1 -------------------------------|

|

PPCTR < PIPNUM ------------------------|

(decel fuel shutoff) |

|

CTNTMR > NIOLD ------------------| |

(neutral idle) |AND -|

| |

CTNFLG = 1 ----------------------| |OR --| ;Open loop desired

| | ;for drive mode.

IDLTMR > OLITD1 -----------------------| |

(drive idle) | | OL\_DES = 1

| |

WRMEGO = 0 ----------------------------| |

| |

CHKAIR = 0 ----------------------------| |

| |

HSPFLG = 1 ----------------------------| |

| |

HALF\_FUEL = 1 -------------------------| |

| |

NO\_FUEL = 1 ---------------------------| |

| |

LDFLG = 1 -----------------------------| |

| |

FLG\_OL\_VS = 1 -------------------------| |

| |

DIS\_FMEM = 1 --------------------------| |

| |

DS\_EGO\_OL = 1 -------------------------| |

| |

OSC\_OL = 1 ----------------------------| |

| |

COOL\_FLG = 1 --------------------------| |

(continued on next page)

8-24

FUEL STRATEGY, OPEN LOOP FLAG DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

| |

P0132MALF = 1 ------------| | |

|OR --| | |

P0135MALF = 1 -------------| | | |

| | |

LEGOFG11 = 1 --------------------|AND -| |

| | |

NUMEGO = 1 ----------------------| | |

(sensor overvoltage or | |

heater malfunction exists and | |

sensor is in lack of swithcing | |

and is only a single bank | |

application) | |

| |

P0152MALF = 1 -------------| | |

|OR --| | |

P0155MALF = 1 -------------| | | |

| | |

LEGOFG21 = 1 --------------------| | |

| | |

P0132MALF = 1 -------------| | | |

|OR --|AND -| |

P0135MALF = 1 -------------| | |

| |

LEGOFG11 = 1 --------------------| |

| |

NUMEGO = 2 ----------------------| |

(sensor overvoltage or |

2 heater malfunctions exist and |

sensors are in lack of swithcing |

and is a dual bank |

application) |

| --- ELSE ---

|

| ;Open loop not commanded by

| ;driver demand, idle, or

| ;other exception conditions.

|

| OL\_DES = 0

;Decide whether or not to force Open Loop Fuel.

OL\_DES = 1 -----------------------|

|OR --| ;Force Open Loop.

EXT\_FLG = 1 ----------------------| |

;exhaust temp. forcing Open Loop | OL\_DESIRED = 1

|

| --- ELSE ---

|

| ;Open Loop not desired.

|

| OL\_DESIRED = 0

8-25

FUEL STRATEGY, OPEN LOOP FLAG DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The following timers delay Open Loop fuel control during short transients;

which is helpful during manual shifts or other fast throttle movements.

OLTMR - OPEN LOOP TIMER

(0.125 sec resolution)

OLTMR\_CROWD - Actuated-up counting Open Loop Timer for Crowd Enrichment.

(0.001 sec resolution)

PERLOAD >= FN320A ---------------------|S Q -| FLG\_OL\_320A

(cold crowd enrichment) |

|

PERLOAD < FN320A - HLODH --------------|C

PERLOAD >= FN337(N) -------------------|S Q -| FL\_OLTMR\_337

(stabilized crowd enrichment) |

|

PERLOAD < FN337(N) - HLODH ------------|C

FL\_OLTMR\_337 = 1 ----------------------|

|AND -| FLG\_OL\_337 = 1

FLG\_ECTSTABLQ = 1 ---------------------| |

| --- ELSE ---

|

| FLG\_OL\_337 = 0

LOAD <= FN338 -------------------------|S Q -| FL\_OLTMR\_338

(decel load) |

|

LOAD > FN338 + LOLODH -----------------|C

VSBAR >= DCEVS ------------------------|S Q -| FLG\_OLTMR\_VSBAR

|

VSBAR < DCEVS - DCEVSH ----------------|C

FL\_OLTMR\_338 = 1 ----------------------|

|

FLG\_OLTMR\_VSBAR = 1 -------------------|AND -| FLG\_OL\_338 = 1

| |

CTTMR >= DCECTTM ----------------------| |

| --- ELSE ---

|

| FLG\_OL\_338 = 0

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FUEL STRATEGY, OPEN LOOP FLAG DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_OL\_320A = 1 -----------------------|

|OR --| Increment OLTMR

FLG\_OL\_338 = 1 ------------------------| |

|

| --- ELSE ---

|

| OLTMR := 0

FLG\_OL\_337 = 1 ----------------| Increment OLTMR\_CROWD

| OLTMR\_CROWD = MIN(OLTMR\_CROWD, HLDTM4)

|

| --- ELSE ---

|

| ;Decrement timer according to this logic.

| ;NOTE: If CROWD\_DEC is calibrated to 1.0,

| ;the timer must function as a typical

| ;UP/DOWN actuated timer.

| OLTMR\_CROWD = OLTMR\_CROWD

| - (BG\_TMR \* CROWD\_DEC)

Determine the state of forced open loop based on vehicle speed flag:

VSBAR > VS\_OL\_SH ----------------------|S Q -| FLG\_OL\_VS

|

VSBAR < VS\_OL\_CL ----------------------|C

8-27

FUEL STRATEGY, OPEN LOOP FLAG DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;Determine Open Loop request for exhaust gas temperature concerns.

;Calculate Maximum allowable Catalyst Temperatures.

EXT\_FMM\_FLG = 1 ------------------| CAT\_MAX\_SAFE = CAT\_MAX - EXT\_CMD\_SF

;Exhaust Temp Model is suspect | CAT\_MAX\_CLR = CAT\_MAX\_CL - EXT\_CMD\_SF

|

| --- ELSE ---

|

| CAT\_MAX\_SAFE = CAT\_MAX

| CAT\_MAX\_CLR = CAT\_MAX\_CL

;Service the EXT\_FLG flip flop.

EXT\_CMD > CAT\_MAX\_SAFE -----------|S Q -| EXT\_SET\_FLG

(exhaust temp. control) |

|

EXT\_CMD <= CAT\_MAX\_CLR -----------|C

;EXT\_FLG servicing logic.

EXT\_SET\_FLG = 1 -----------------------|

|

FLG\_ECTSTABLQ = 1 ---------------------|AND -| EXT\_FLG = 1

| |

CAT\_TEMP\_SW = 1 -----------------------| |

| --- ELSE ---

|

| EXT\_FLG = 0

8-28

FUEL STRATEGY, CALCULATION OF LAMAVE - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.8 CALCULATION OF LAMAVE (CDAA0)

OVERVIEW

This module calculates the LAMBSE average to be used in Self Test to

determine if the adaptive tables have reached their clip.

The LAMBSE average, LAMAVE1/LAMAVE2, is only calculated in Closed Loop.

Also, it requires at least two HEGO switches after entering Closed Loop to

calculate an average.

DEFINITIONS

Registers:

- LAMBSE1 = Desired equivalence ratio for HEGO11 injectors.

- LAMBSE2 = Desired equivalence ratio for HEGO21 injectors.

- LAM\_OLD1 = Value of LAMBSE1 the last time HEGO11 switched.

- LAM\_OLD2 = Value of LAMBSE2 the last time HEGO21 switched.

Bit Flags:

- OLFLG = Open Loop Fuel flag; 1 -> open loop, 0 -> closed loop possible.

- SWTFL11 = Bank1 upstream HEGO11 switch flag; 0-> no HEGO11 switch, 1->

sensor HEGO11 switch.

- SWTF211 = Bank1 upstream HEGO21 switch flag; 0-> no HEGO21 switch, 1->

sensor HEGO21 switch.

OUTPUTS

Registers:

- LAMAVE1 = Average of LAMBSE1; averages the value of LAMBSE1 at the

current HEGO11 switch and last HEGO11 switch.

- LAMAVE2 = Average of LAMBSE2; averages the value of LAMBSE2 at the

current HEGO21 switch and last HEGO21 switch.

- LAM\_OLD1 = See above.

- LAM\_OLD2 = See above.

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FUEL STRATEGY, CALCULATION OF LAMAVE - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_LAMAVE\_COM1

OLFLG = 1 -----------------------------| LAM\_OLD1 = 0

| LAM\_OLD2 = 0

| LAMAVE1 = 1.0

| LAMAVE2 = 1.0

|

| Exit FUEL\_LAMAVE\_COM1 module

SWTFL11 = 1 ---------------------|

(HEGO11 switch) |

|AND -| LAM\_OLD1 = LAMBSE1

OLFLG = 0 -----------------------| | (not enough HEGO switches

| | since going Closed Loop

LAM\_OLD1 = 0 --------------------| | to calculate LAMAVE1)

|

| --- ELSE ---

SWTFL11 = 1 ---------------------| |

(HEGO11 switch) |AND -| LAMAVE1 = (LAM\_OLD1 + LAMBSE1) / 2

| | LAM\_OLD1 = LAMBSE1

OLFLG = 0 -----------------------| | (update LAM\_OLD1 for next time)

SWTFL21 = 1 ---------------------|

(HEGO21 switch) |

|AND -| LAM\_OLD2 = LAMBSE2

OLFLG = 0 -----------------------| | (not enough EGO switches

| | since going Closed Loop

LAM\_OLD2 = 0 --------------------| | to calculate LAMAVE2)

|

| --- ELSE ---

SWTFL21 = 1 ---------------------| |

(HEGO21 switch) |AND -| LAMAVE2 = (LAM\_OLD2 + LAMBSE2) / 2

| | LAM\_OLD2 = LAMBSE2

OLFLG = 0 -----------------------| | (update LAM\_OLD2 for next time)

NOTE: LAMAVE1 and LAMAVE2 are initialized to 1.0, and LAM\_OLD1 and LAM\_OLD2

are initialized to 0.0.

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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8.9 OPEN LOOP LAMBSE CALCULATION (CDAN0)

OVERVIEW

The purpose of the Open Loop LAMBSE Calculation is to schedule a desired

equivalence ratio (lambda value) when engine operating conditions either

prevent the use of the HEGO sensor or stoic operation is not appropriate.

Due to the current design of the HEGO sensor, only operation about

stoichiometry can be utilized. In the future, Universal HEGOs will be able

to provide feedback at points either rich or lean of stoic. Closed loop

operation is also required for adaptive fuel to "learn" the variabilities

associated with production tolerances of airflow measuring and fuel metering

devices. Given, however, that closed loop fuel is not always the appropriate

mode of operation, the open loop logic performs two functions:

1. To determine whether open loop fuel is appropriate.

2. To schedule the optimum equivalence ratio (LAMBSE).

Optimum Air/Fuel (A/F) ratio at any given engine speed-load is that which

will develop the required torque with the lowest fuel consumption consistent

with smooth reliable operation. This optimum A/F ratio is not constant but

depends on many factors. The proper A/F ratio for each particular set of

operating conditions is most conveniently viewed under a number of headings:

stabilized, cold engine/startup, catalyst temperature protection, cylinders

deactivated, and wide open throttle condition. Stabilized is taken to mean

continuous operation with normal engine temperatures. Cold engine/startup

includes starting and warming up or when the HEGO sensor is not ready to

switch. Catalyst temperature protection enriches the A/F ratio to control to

a set desired catalyst operating temperature. When cylinders are

deactivated, the torque control module issues an A/F ratio to use. Finally,

for performance requirements, LBT may needed to provided peak torque A/F

ratio fueling.

Notes on Cylinder Disabling (Torque Control request):

The torque control strategy controls any situation in which cylinders are

disabled. When cylinder(s) are disabled, the air fuel must be scheduled lean

of stoichiometry. If not, the unburned fuel from any rich cylinder and the

oxygen from the disabled cylinder(s) will ignite in the catalyst, causing an

over temperature condition.

One excepting to scheduling a lean A/F when disabling cylinders is when the

catalyst is cold (during a cold start up). LAMBSE will be allowed to run

rich until the catalyst mid-bed temperature reaches EXT\_COLD\_CAT. This is to

prevent cold stalls that would occur if a cold engine is forced to run lean

because it was disabling cylinders (ie. transmission torque reduction).

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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Notes on Cold/Start-up Open Loop Fuel:

A. Entry conditions:

- WRMEGO = 0, HEGO sensor may not be ready to switch or,

- ECT < ECTSTABL, engine coolant temperature too cold and OL\_DESIRED = 1;

standard open loop conditions met.

B. Fuel scheduling:

- Fuel may be scheduled as a function of load, temperature and time since

start.

Notes on Stabilized Engine Open Loop Fuel:

A. Mixture conditions:

Mixture requirements for lowest fuel consumption can generally be adequately

described as a function of engine load which for purposes of this discussion

will be defined as the ratio of aircharge to standard aircharge.

Idle, extremely light loads or deceleration -

No useful work is being done at idle other than driving accessory loads, i.e.

brake torque is zero. The lowest fuel consumption is that A/F which provides

steady, reliable cylinder firing. Extremely light loads or decels at high

RPMs may require A/F scheduling. This is because the mass of residual gas

tends to be constant, therefore, at closed throttle/slight part throttle

decels, the percentage of residual diluting the fresh charge increases, hence

the need to enrich the incoming charge.

Medium loads, typical part throttle operation at road load -

Best economy is around 18:1 A/F ratio, however, this may lead to excessive

highway NOx levels. Also, current catalyst technology makes use of the

closed loop fuel limit cycle to maximize conversion efficiency. This, closed

loop fuel operation is desirable from both an adaptive fuel and catalyst

efficiency standpoint.

Full load, typical W.O.T. operation -

A rich A/F ratio is required to maximize the torque output of the engine

during periods of high driver demand. Maximum torque output is about 13:1

A/F ratio (LBT). Best fuel economy is sacrificed in return for higher torque

output.

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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Best economy at a given load is independent of RPM at least down to idle type

loads, under conditions at which fuel distribution is good. Departures from

best fuel economy may be required due to the following:

. Poor distribution (usually a function of TP and RPM).

. To reduce temperature of hot spots such as exhaust

valves, spark plug points or piston crowns - that is,

to assist cooling.

B. Entry Conditions:

- WRMEGO = 1 - engine coolant hot and engine is stabilized, HEGO sensor is

ready to switch.

- High Load enrichment required - scheduled as a function of speed/load.

An open loop delay time is provided to prevent unnecessary enrichment

during high load spikes such as during shifts. A second enrichment timer

provides the ability to schedule fuel as a function of time in the

enrichment mode to enhance durability in heavy truck applications.

- Decel loads - either enrichment or enleanment can be scheduled as a

function of speed/load.

- Extended idle - the ability to go open loop for idle stability is

provided as a function of time at idle.

- CHKAIR = 0 - thermactor air control can put upstream air into the exhaust

manifold ahead of the HEGO sensor causing the HEGO to always read lean.

Open loop is therefore required.

- Lack of HEGO switching requires the scheduling of open loop operation.

C. Fuel Scheduling:

- Fuel may be scheduled as a function of load, RPM, temperature and time at

high load.

Notes on execution of LAMBSE\_RESET logic:

The LAMBSE\_RESET logic is only executed in Closed Loop Fuel Control mode, but

parameters used in LAMBSE\_RESET must be updated each background pass. As

such, logic was added to execute the call to FUEL\_LAMBSE\_RESET\_COMx from this

module and assign the values of ISCFLG\_LST and OLFLG\_LST. This specification

provides a more descriptive execution sequence which is required for the

proper function of the FUEL\_LAMBSE\_RESET\_COMx module.

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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Notes on Catalyst Temperature Protection:

The catalyst temperature model provides an inferred catalyst temperature 1"

into the first brick from the inlet. This is considered the hottest

operating point in the catalyst, which we refer to as the midbed temperature,

or simply EXT\_CMD.

The air/fuel controller requires little calibration (CAT\_MAX, CAT\_MAX\_CL,

CAT\_MAX\_SAFE and LAM\_EXT\_STEP) once the real time exhaust algorithm is

calibrated to good agreement with the actual thermocouple measurements. As a

result, the controller should exhibit good temperature control (always within

one air/fuel step below the maximum) with no overshoot and no hunting of

LAMBSE.

If the catalyst midbed temperature (EXT\_CMD) is above CAT\_MAX\_SAFE but not

below CAT\_MAX\_CLR (EXT\_FLG = 1), LAMBSE\_EXT is calculated to maintain and

operate the midbed temperature as close to, but not over CAT\_MAX\_SAFE.

Control starts by calculating what the steady state condition would be for

the midbed temperature operating at current conditions (EXT\_SS\_FL +

EXT\_SS\_EXO - EXT\_LS\_CIN). This calculation is possible by using the exhaust

model parameters that do not have any of the systems delays associated with

them. If this steady state speculation is above CAT\_MAX\_SAFE, fuel is

enrichened by decrementing LAMBSE\_EXT by LAM\_EXT\_STEP each background loop,

or until the lower limit of LAMBSE\_EXT is reached, LAM\_EXT\_MIN. Otherwise,

if the steady state temperature is below CAT\_MAX\_SAFE, further calculations

are performed to see if LAMBSE\_EXT can be enleaned so as to operate the

catalyst midbed temperature closer to, but not above CAT\_MAX\_SAFE.

LAMBSE\_EXT will not be allowed to return to stoichiometry (go leaner than

LAM\_EXT\_MAX) until the EXT\_FLG is reset. This is to allow a cool down period

in the catalyst before exposing the recently hot, rich catalyst to the oxygen

levels associated with stoichiometry.

If "lambse\_try" is not leaner than LAM\_EXT\_MAX, then the steady state midbed

temperature is calculated to find the midbed temperature that would result if

lambse\_try was used. If this resultant midbed temperature is above

CAT\_MAX\_SAFE, LAMBSE\_EXT is not changed. Otherwise, LAMBSE\_EXT can assume

the leaner value of lambse\_try (which results in a midbed temperature closer

to CAT\_MAX\_SAFE and a leaner LAMBSE\_EXT).

The effects of LAMBSE1,2 on catalyst midbed temperatures (given a constant

load, spark retard, and percent EGR) are shown below:

| +

| + +

EXT\_CMD | + \ +

| + \ +

| \LAM\_EXT\_MAX

| + +

| \

| + \LAM\_EXT\_MIN +

|

|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

rich 0.8 1.0 1.1 lean

LAMBSE1,2 scheduling

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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DEFINITIONS

Registers:

- ACT = Air charge temperature, degrees farenheit.

- AM = Air mass flow bin 10.

- APT = At Part Throttle; -1 -> Closed throttle, 0 -> Part throttle,

1 -> Wide Open throttle.

- ATMR1 = Time since start (time since exiting crank mode), sec.

- ATMR1\_HI\_RES = Time since start with a greater resolution than ATMR1

(time since exiting crank mode), sec.

- BG\_TMR = Background loop timer.

- BP = Barometric pressure (Note: Upper byte of BP\_WORD).

- CAT\_MAX\_CLR = Lower Cat Midbed temp to clear EXT\_FLG, with or without a

reliable EXT\_CMD inference, Deg F.

- CAT\_MAX\_SAFE = Desired Maximum Cat Midbed temperature that the Cat Temp

A/F Controller will maintain; with & without failure mode safety factor,

Deg F.

- ECT = Coolant temperature degrees farenheit.

- ER\_LAM\_DSD1 = LAMBSE1 value requested by engine running on demand self

test.

- ER\_LAM\_DSD2 = LAMBSE2 value requested by engine running on demand self

test.

- EXT\_CMD = Mid bed catalyst temperature.

- EXT\_LS\_CIN = Steady state temperature loss in exhaust pipe between

exhaust flange and catalyst inlet, degrees.

- EXT\_SS\_EXO = Steady state value of inferred rise in temperature in the

catalyst, the "exotherm", in degrees.

- EXT\_SS\_FLS = Steady state exhaust flange temperature at a stoic air/fuel

mixture, degrees.

- EXT\_SS\_FL = Steady state exhaust flange temperature, degrees.

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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- FUEL\_SOURCE1 = Value to indicate the source of the final open loop LAMBSE

calculation for bank 1.

0 -> No open loop fuel control (closed loop).

1 -> Cylinder disablement logic is enabled.

2 -> Exhaust temperature fuel controller logic.

3 -> Wide open throttle performance logic.

4 -> Cold engine/startup open loop logic.

5 -> Stabilized normal drivability logic.

6 -> Flex fuel lean error logic (if applicable).

7 -> Engine running EGO monitoring testing.

8 -> Engine running On-Demand testing.

9 -> Cylinder disablement logic enabled on a cold start.

12 -> Secondary air monitor flow testing.

- FUEL\_SOURCE2 = Same as FUEL\_SOURCE1, but for bank 2.

- INJ\_ON = Number of injectors actively producing engine torque.

- ISCFLG = Mode indicator flag.

- ISCFLG\_LST = Last pass value of ISCFLG.

- LAMBSE1 = Desired equivalence ratio for Bank 1 injectors. LAMBSE1

appears in the fuel pulsewidth equation for HEGO11.

- LAMBSE2 = Desired equivalence ratio for Bank 2 injectors. LAMBSE2

appears in the fuel pulsewidth equation for HEGO21.

- LAMBSE\_DRV = Desired LAMBSE for drivability concerns.

- LAMBSE\_EXT = Desired LAMBSE for catalyst temperature control concerns.

- LAMMUL = Multiplier which is used to prevent cold-engine stalls following

transmission engagement.

- LOAD = Universal load as ratio of aircharge over standard.

- N = Engine speed, rpm.

- NOBAR = Filtered output shaft speed, rpm.

- OL\_LEAN\_TMR = Open loop timer used for enleanment, sec.

- OV\_TMR\_11 = EGO11 overvoltage timer.

- OV\_TMR\_21 = EGO21 overvoltage timer.

- PERLOAD = Percent of peak LOAD at any altitude.

- PPCTR = PIP counter for torque management to control open loop fueling.

- SAIR\_LAM\_DSD = Required lambse value for continuous secondary air test.

- SPK\_LAMBSE = Value of LAMBSE to be used in spark calculations.

- TCSTRT = Temperature of ECT at Cold Start, deg F.

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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- TSLAMUn = Time at which last LAMBDA update occurred, clock ticks.

- VS\_RATE = Filtered vehicle acceleration rate.

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

- DIS\_FMEM = Flag indicating that a primary side failure has occurred on a

DIS system and that an alternate strategy has been requested.

- DNDSUP = Delayed Neutral/Drive flag; 0 -> neutral, 1 -> drive.

- DS\_EGO\_LEAN1 = Flag used by the downstream EGO monitor to trigger a lean

A/F excursion for bank1; 1 -> excursion in progress.

- DS\_EGO\_LEAN2 = Flag used by the downstream EGO monitor to trigger a lean

A/F excursion for bank2; 1 -> excursion in progress.

- DS\_EGO\_OL = Flag used to force open loop fuel control during a forced A/F

excursion to test the downstream EGOs.

- DS\_EGO\_RICH1 = Flag used by the downstream EGO monitor to trigger a rich

A/F excursion for bank1; 1 -> excursion in progress.

- DS\_EGO\_RICH2 = Flag used by the downstream EGO monitor to trigger a rich

A/F excursion for bank2; 1 -> excursion in progress.

- EGO1FMFLG = EGO1 FMEM flag; 1 -> EGO1 sensor failure.

- EGO2FMFLG = EGO2 FMEM flag; 1 -> EGO2 sensor failure.

- ER\_FUL\_REQ = Flag to signal fuel system to set LAMBSE to KOER\_LQM\_DSD.

- EXT\_FLG = The exhaust catalyst temperature is over CAT\_MAX\_SAFE.

- FFG\_CSD11 = Fault flag for CSD on sensor 11.

- FFG\_CSD21 = Fault flag for CSD on sensor 21.

- FLG\_ECTSTABLQ = ECT stabilized flag; 1 -> ECT stabilized, 0 -> ECT cold.

- HALF\_FUEL = Flag which indicates one half of the injectors are cut out; 1

-> half\_fuel mode.

- HEGO\_FAULT = Flag indicating at least one EGO sensor is faulted.

- HEGO\_FDBACK = Flag indicating normal closed loop operation.

- HSPFLG = High speed mode flag; 1 -> High Speed alternate fuel/spark.

- LDFLG = "Lugging" mode open loop flag; 1 -> lugging mode.

- LEGOFG11 = Lack of HEGO11 switching.

- LEGOFG21 = Lack of HEGO21 switching.

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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- LESFLG1 = Lack of Bank1 HEGO switching flag; 1 -> HEGO is not switching,

0 -> HEGO is switching.

- OL\_DRIVE = Open loop due to driving conditions (not FMEM or HOLD

related).

- OLFLG = Open loop flag; 1 -> open loop mode, 0 -> closed loop mode.

- OLFLG\_LST = Last pass value of OLFLG.

- OL\_FMEM = Open loop due to detected system fault flag; 1 ->open loop due

to FMEM.

- OL\_HOLD = Present conditions not satisfied to go closed loop flag; 1 ->

hold in open.

- OL\_DES = EXT-independant open loop desired flag; 1 -> open loop desired

regardless of the exhaust gas temperature prediction.

- OL\_DESIRED = Open loop desired flag; 1 -> open loop desired, 0 -> closed

loop desired.

- SAIR\_TST\_ENA = OBD-II secondary air test enable flag; 1 -> test enabled.

- WRMEGO = If set; HEGO sensor should be warm and flag set to 1 if HEGO

sensor is switching, and reset to 0 if it has cooled down. Its state is

controlled by the WRMEGO logic.

Calibration Constants:

- CAT\_MAX = Desired operating temperature of catalyst that the catalyst

temperature controller will control to, degrees.

- CAT\_MAX\_CL = Catalyst temperature which temp. control is exited.

- CTHIN = Maximum TCSTRT value to use NUMPR.

- CTLOW = Cold Start Maximum ECT, deg F.

- DFSLAM = Relative LAMBSE value to exit decel fuel shutoff.

- EXT\_COLD\_CAT = Catalyst temperature below which AFR is allowed to be rich

during torque control cylinder cutout, degrees F.

- FN022B = Temperature normalizing function; used for table lookup.

Input = temp\_b = FRCBFT \* ACT + (1 - FRCBFT) \* ECT

--OR--

Input = temp\_s = FRCSFT \* ACT + (1 - FRCSFT) \* ECT

- FN034A = LOAD normalizing function for FNCYL\_OFF table lookup.

Input = LOAD.

Output = Normalized load.

- FN070C = RPM normalizing function for FNCYL\_OFF input.

Input = N.

Output = Normalized RPM.

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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- FN072A = PERLOAD normalizing function; used for table lookup.

Input = PERLOAD.

Output = Normalized perload.

- FN129A(BP) = Multiplier to FN309 to compensate for altitude.

- FN212A(BP) = Multiplier to FN308 to compensate for altitude.

- FN300 = Multiplier as a function of ACT, modifies FN1360.

- FN301 = Multiplier for closed throttle as a function of engine speed, N.

- FN303 = WOT Fuel Multiplier as a function of engine speed N.

- FN308 = Sea level fuel multiplier, RPM.

- FN309 = Altitude lugging fuel multiplier, RPM.

- FN321 = Multiplier used to lean-out fuel upon initial closed loop.

- FN325 = Multiplier as a function of ECT for FN1360.

- FN396C = High Speed Fuel enrichment, mph.

- FN441A('lambse') = Effect of LAMBSE on inferred exhaust flange

temperature. (NOTE: various lambda inputs are used with this function).

- FN448(AM) = Steady-state increase in exhaust temp in the catalyst as a

function of Air Mass, at an equivalence ratio of 1.0; degrees F.

- FN448A('lambse') = Steady-state exotherm in the catalyst for a given

LAMBSE; deg F. (NOTE: Various lambda inputs are used with this

function).

- FN911(LOAD) = LAMBSE multiplier during DIS FMEM.

- FN1360 = Stabilized Open Loop Fuel Table = an 8 X 10 table of lambda

values as a function of engine speed N, and PERLOAD.

X = FN070B(N)

Y = FN072B(PERLOAD)

- FN1361\_H\_RES = Startup Open Loop Fuel Table = a 8 x 10 table of lambda

values as a function of temp\_s (ie. FRCSFT \* ACT + (1 - FRCSFT) \* ECT)

and ATMR1\_HI\_RES. TABSFT is the Synonym for this Table.

X = FN022B(temp\_s)

Y = FN018C(ATMR1\_HI\_RES)

- FN1362 = Base Open Loop Fuel table = a 10 x 8 table of lambda values as a

function of temp\_b (FRCBFT \* ACT + (1 - FRCBFT) \* ECT) and PERLOAD.

TABBFT is the Synonym for this Table.

X = FN022B(temp\_b)

Y = FN072A(PERLOAD)

- FN1362\_ALT = Alternative FN1362 used in Anti-plug fouling strategy.

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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- FNCYL\_OFF = Lambse value to use when cylinders are disabled. Use of a

lean A/F ensures protection of the catalyst, while use of richer values

closer to stoic (still lean) may be needed in low speed/low conditions.

Use of the round robin cylinder logic protects the valves when running

lean.

X = FN070C(N)

Y = FN034A(LOAD)

- FRCBFT = Act fraction for FN1362 lookup.

- FRCSFT = ACT fraction for FN1361 lookup.

- LAM\_COLD\_ENG = LAMBSE value to be used by spark if the engine is cold.

- LAM\_EXT\_MAX = Base LAMBSE value when controlling catalyst temperature via

open loop fuel.

- LAM\_EXT\_MIN = Lowest LAMBSE is allowed to go when controlled by catalyst

temperature protection logic.

- LAM\_EXT\_STEP = LAMBSE increment/decrement size done per background loop

to control catalyst temperatures DIVIDED by the average background loop

time (40ms).

- LEAN\_EXCRSN = LAMBSE to command while forcing an A/F excursion to force

the downstream EGO sensors lean.

- MINACCL = Minimum Vehicle Speed rate of change to enable FN303(N)

fueling.

- NUMCYL = Number of engine cylinders.

- NUMEGO = Number of EGO sensors.

- NUMPR = Open Loop Fuel multiplier.

- OLIDRV = Drive Open Loop Idle fuel multiplier.

- OLINEUT = Neutral Open Loop Idle fuel multiplier.

- OLMCL = Open loop fuel multiplier,

- OLMTD1 = NUMPR open loop fuel multiplier time delay, seconds.

- PIPNUM = Number of PIPs before DFSO exit fuel ramp.

- RICH\_EXCRSN = LAMBSE to command while forcing an A/F excursion to force

the downstream EGO sensors rich.

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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- TRLOAD = Transmission Load switch;

0 -> Manual Transmission, no clutch or gear switches,

forced neutral state

1 -> Manual Transmission, no clutch or gear switch.

2 -> Manual Transmission, one clutch or gear switch.

3 -> Manual Transmission, both clutch and gear switches.

4 -> Auto Transmission, non-electronic, neutral drive switch.

5 -> Auto Transmission, non-electronic, neutral pressure switch,

(AXOD).

6 -> Auto Transmission, electronic, PRNDL sensor - park,

reverse, neutral, overdrive, manual 1, manual 2.

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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PROCESS

STRATEGY MODULE: FUEL\_OL\_LAMBSE\_COM25

BEGIN: open\_loop\_ram\_init

Execute this logic ONLY during RAM initialization.

unconditionally ------------------------| OL\_LEAN\_TMR := 255

| ; to provide consistent starts.

|

| OLFLG\_LST := OLFLG

| ISCFLG\_LST := ISCFLG

| ; Initialize to same value.

| ; For LAMBSE Reset Logic.

END: open\_loop\_ram\_init

BEGIN: pid\_definitions

;The J1979 PID definitions may be executed upon demand by SCP

;or each background loop, as determined by the S/W implementor.

pid\_def(j1979\_01\_031, b0:OL\_HOLD,

b1:HEGO\_FDBACK,

b2:OL\_DRIVE,

b3:OL\_FMEM,

b4:HEGO\_FAULT,

b5:0,

b6:0,

b7:0)

END: pid\_definitions

FUEL SYSTEM STATUS FOR BANK1

OLFLG = 0 ------------------------|

|

LEGOFG21 = 0 ---------------------|

|

LEGOFG11 = 0 ---------------------|

|

FFG\_CSD11 = 0 --------------------|AND -| HEGO\_FDBACK = 1

| |

FFG\_CSD21 = 0 --------------------| |

| |

OV\_TMR\_11 = 0 --------------------| |

| |

OV\_TMR\_21 = 0 --------------------| |

| --- ELSE ---

|

| HEGO\_FDBACK = 0

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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OLFLG = 0 ------------------------|

|AND -| HEGO\_FAULT = 1

HEGO\_FDBACK = 0 ------------------| |

| --- ELSE ---

|

| HEGO\_FAULT = 0

Open loop due to detected system fault.

DIS\_FMEM = 1 ---------------------|

|

NUMEGO = 2 -----------------| |

| |

LEGOFG11 = 1 ---------| | |

| | |

FFG\_CSD11 = 1 --------|OR --| |

| | |

OV\_TMR\_11 > 0 --------| | |OR --| OL\_FMEM := 1

|AND -| | ;CSD or Lack of

LEGOFG21 = 1 ---------| | | | ;switching or

| | | | ;overvoltage on

FFG\_CSD21 = 1 --------|OR --| | | ;an upstream

| | | ;sensor

OV\_TMR\_21 > 0 --------| | |

| |

NUMEGO = 1 -----------------| | |

| | |

LEGOFG11 = 1 ---------| |AND -| |

| | |

FFG\_CSD11 = 1 --------|OR --| |

| |

OV\_TMR\_11 > 0 --------| |

| --- ELSE ---

|

| OL\_FMEM := 0

Present conditions not satisfied to go closed loop.

OL\_FMEM = 0 ----------------------|

|AND -| OL\_HOLD = 1

WRMEGO = 0 -----------------------| |

| --- ELSE ---

|

| OL\_HOLD = 0

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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;Assign last OLFLG value for LAMBSE\_RESET

unconditionally ------------------------| OLFLG\_LST = OLFLG

Open/Closed Loop decision logic.

OL\_FMEM = 0 ----------------------|

|

OL\_DESIRED = 0 -------------------|AND -| ;closed loop fuel.

| | OLFLG = 0

OL\_HOLD = 0 ----------------------| | OL\_DRIVE = 0

| FUEL\_SOURCE1 = FUEL\_SOURCE2 = 0

|

| ;Execute the LAMBSE\_RESET logic.

| Do: FUEL\_LAMBSE\_RESET\_COMx

| ISCFLG\_LST = ISCFLG

|

| ;Allow OSC to force Open Loop

| ;This will NOT override LAMBSE.

| Do: substitute(4,LAMBSE1)

| Do: substitute(5,LAMBSE2)

|

| Do: determine\_spk\_lambse

|

| Exit FUEL\_OL\_LAMBSE module.

|

| --- ELSE ---

WRMEGO = 0 -----------------------| |

(cold HEGO) |OR --| ;Cold Engine/Startup Fuel Tables

| | Do: c\_multiplier\_logic

FLG\_ECTSTABLQ = 0 ----------------| |

(ECT cold) | ;temporary FN1361 & FN1362 inputs

| temp\_s = FRCSFT \* ACT +

| (1 - FRCSFT) \* ECT

| temp\_b = FRCBFT \* ACT +

| (1 - FRCBFT) \* ECT

| Do: get\_fn1362\_output

|

| LAMBSE\_DRV = C \* LAMMUL \* OLMCL \*

| [FN300(ACT) \* fn1362 -

| FN1361\_H\_RES(temp\_s,

| ATMR1\_HI\_RES)] \*

| FN321(OL\_LEAN\_TMR)

| fuel\_source = 4

|

| --- ELSE ---

|

| ;stabilized engine fuel table

| Do: c\_multiplier\_logic

| LAMBSE\_DRV =

| FN1360(N,PERLOAD) \*

| FN325(ECT) \* FN300(ACT) \*

| C \* LAMMUL \* OLMCL \*

| FN321(OL\_LEAN\_TMR)

| fuel\_source = 5

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

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BEGIN: get\_fn1362\_output

;Execute only when called.

ALT\_CAL\_FLG = 1 ------------------------| fn1362 = FN1362\_ALT(temp\_b,PERLOAD)

|

| --- ELSE ---

|

| fn1362 = FN1362(temp\_b,PERLOAD)

END: get\_fn1362\_output

;Store last pass value of LAMBSE\_EXT

unconditionally ------------------------| lam\_ext\_last = LAMBSE\_EXT

;Find lambse (LAMBSE\_EXT) for catalyst temperature protection.

EXT\_FLG = 0 ----------------------------| LAMBSE\_EXT = LAM\_EXT\_MAX

|

| --- ELSE ---

EXT\_SS\_FL + EXT\_SS\_EXO - |

EXT\_LS\_CIN > CAT\_MAX\_SAFE --| LAMBSE\_EXT = lam\_ext\_last -

| (LAM\_EXT\_STEP \* BG\_TMR)

| (Clip to LAM\_EXT\_MIN as a minimum)

|

| --- ELSE ---

|

lambse\_try > LAM\_EXT\_MAX ---------------| LAMBSE\_EXT = LAM\_EXT\_MAX

|

| --- ELSE ---

(EXT\_SS\_FLS \* FN441A(lambse\_try)) + |

(FN448(AM) \* FN448A(lambse\_try)) - |

EXT\_LS\_CIN < CAT\_MAX\_SAFE ----------| LAMBSE\_EXT = lambse\_try

|

| --- ELSE ---

|

| No Change to LAMBSE\_EXT.

Where lambse\_try is calculated as follows:

lambse\_try = lam\_ext\_last + (LAM\_EXT\_STEP \* BG\_TMR)

8-45

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;Determine Final LAMBSE (note Output State Control substitution):

unconditionally ------------------------| Do: determine\_final\_lambse(1)

| Do: substitute(4,lambse1)

| (output state control override)

| Do: determine\_final\_lambse(2)

| Do: substitute(5,lambse2)

| (output state control override)

| LAMBSE1 = lambse1

| LAMBSE2 = lambse2

|

| ; Required for next LAMBSE\_RESET

| ISCFLG\_LST = ISCFLG

|

| Do: determine\_spk\_lambse

8-46

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;Determine reason for going Open Loop (J1979 requirement):

OL\_FMEM = 0 ----------------------|

|

OL\_HOLD = 0 ----------------------|AND -| OL\_DRIVE = 1

| |

OLFLG = 1 ------------------------| |

| --- ELSE ---

|

| OL\_DRIVE = 0

BEGIN: determine\_final\_lambse(bank)

HALF\_FUEL = 1 --------------|

(speed limiting or OFM FM) |OR --|

| |

INJ\_ON < NUMCYL ------------| |AND -| ; Cylinder disablement - Cold CAT

(failsafe cooling active) | | lambse(bank) = LAMBSE\_DRV

| | OLFLG = 1

EXT\_CMD < EXT\_COLD\_CAT -----------| | TSLAMU(bank) = clock

(CAT temp margin available) | FUEL\_SOURCE(bank) = 9

|

| --- ELSE ---

HALF\_FUEL = 1 --------------------| |

(speed limiting or OFM\_FMEM = 1) |OR --| ;disabling cylinders.

| | lambse(bank) = FNCYL\_OFF(N,LOAD)

INJ\_ON < NUMCYL ------------------| | OLFLG = 1

(cylinders disabled; failsafe cooling) | TSLAMU(bank) = clock

| FUEL\_SOURCE(bank) = 1

|

| --- ELSE ---

PPCTR < PIPNUM -------------------| |

(decel fuel shut off) |AND -| Decel Fuel Shutoff Exit

| | (ramp fuel)

DIS\_FMEM = 0 ---------------------| | lambse(bank) = 1 + DFSLAM -

| [(PPCTR/PIPNUM) \* DFSLAM]

| OLFLG = 1

| TSLAMU(bank) = clock

| FUEL\_SOURCE(bank) = 1

|

| --- ELSE ---

|

ER\_FUL\_REQ = 1 -------------------------| lambse(bank) = ER\_LAM\_DSD(bank)

(Engine Running On-Demand testing | OLFLG = 1

requires specific LAMBSE values) | TSLAMU(bank) = clock

| FUEL\_SOURCE(bank) = 8

|

| --- ELSE ---

|

SAIR\_TST\_ENA = 1 -----------------------| lambse(bank) = SAIR\_LAM\_DSD

(secondary air monitor flow test | OLFLG = 1

requires specific LAMBSE values) | TSLAMU(bank) = clock

| FUEL\_SOURCE(bank) = 12

|

| --- ELSE ---

|

(Continued on following page)

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(Continued from previous page)

DS\_EGO\_OL = 1 --------------------| |

|AND -| Do: ego\_monitor\_control(bank)

DS\_EGO\_RICH(bank) = 1 ------| | | OLFLG = 1

|OR --| | TSLAMU(bank) = clock

DS\_EGO\_LEAN(bank) = 1 ------| | FUEL\_SOURCE(bank) = 7

|

| --- ELSE ---

EXT\_FLG = 1 ----------------------| |

;Cat Temp Model says over temp | |

|AND -| lambse(bank) = LAMBSE\_EXT

LAMBSE\_DRV > LAMBSE\_EXT ----| | | OLFLG = 1

;Lean LAMBSE demanded |OR --| | TSLAMU(bank) = clock

| | FUEL\_SOURCE(bank) = 2

OL\_DES = 0 -----------------| |

;Open Loop for EXT\_FLG only |

| --- ELSE ---

|

| lambse(bank) = LAMBSE\_DRV

| OLFLG = 1

| TSLAMU(bank) = clock

| FUEL\_SOURCE(bank) = fuel\_source

END: determine\_final\_lambse

8-48

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: c\_multiplier\_logic

DIS\_FMEM = 1 ---------------------------| DIS Failure Mode

| 'C' = FN911(LOAD)

|

| --- ELSE ---

|

HSPFLG = 1------------------------------| High Vehicle Speed

| Limiting Mode

| 'C' = FN396C(NOBAR)

|

| --- ELSE ---

|

LDFLG = 1 ------------------------------| Lugging Mode

| 'C' = FN308(N) \* FN212A(BP)

| + FN309(N) \* FN129A(BP)

|

| --- ELSE ---

DNDSUP = 1 -----------------| |

(in drive) |OR --| |

| | |

TRLOAD <= 3 ----------------| | |

(manual trans) |AND -| 'C' = FN301(N)

| |

APT = -1 -------------------------| |

| |

WRMEGO = 0 -----------------| | |

(cold HEGO) |OR --| |

| |

FLG\_ECTSTABLQ = 0 ----------| |

(ECT cold) |

| --- ELSE ---

DNDSUP = 0 -----------------------| |

(in neutral) | |

| |

APT = -1 -------------------------| |

(closed throttle) |AND -| Mid ambient neutral idle

| | 'C' = OLINEUT \* NUMPR

CTLOW < TCSTRT < CTHIN -----------| |

| |

ATMR1 < OLMTD1 -------------------| |

| --- ELSE ---

DNDSUP = 0 -----------------------| |

(In neutral) |AND -| Neutral Idle

| | 'C' = OLINEUT

APT = -1 -------------------------| |

(closed throttle) |

| --- ELSE ---

(continued on next page)

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FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

DNDSUP = 1 -----------------------| |

(in drive) |AND -| Drive Idle

| | 'C' = OLIDRV

APT = -1 -------------------------| |

(closed throttle) | --- ELSE ---

|

APT = 1 --------------------------| | Wide Open Throttle

|AND -| 'C' = FN303(N)

VS\_RATE >= MINACCL ---------------| |

| --- ELSE ---

|

| 'C' = 1

END: c\_multiplier\_logic

8-50

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: determine\_spk\_lambse

Service SPK\_LAMBSE and OL\_LEAN\_TMR in this section.

SPK\_LAMBSE is 1.0 when the fuel calculation is closed loop because the

air/fuel mixture will be at stoichiometry regardless of the value of the Open

Loop LAMBSE calculation. By assuming SPK\_LAMBSE to be 1.0, the spark is not

erroneously corrected for mixture errors when closed loop fuel control is

corrected to stoic.

When the engine is cold, the Open Loop LAMBSE is set overly rich (to account

for 'lost fuel' down the cylinder walls), thus the SPK\_LAMBSE should

represent a value which is closer to what air/fuel mixture is actually in the

cylinder.

Since each bank can obtain a unique LAMBSE during HEGO monitoring, the value

used for SPK\_LAMBSE is the average of both banks.

OLFLG = 0 ------------------------------| SPK\_LAMBSE = 1.0

(closed loop) | OL\_LEAN\_TMR = 0

|

| --- ELSE ---

|

FLG\_ECTSTABLQ = 0 ----------------------| SPK\_LAMBSE = LAM\_COLD\_ENG

(cold engine) | Increment OL\_LEAN\_TMR

|

| --- ELSE ---

|

LAMBSE1 <> LAMBSE2 ---------------------| SPK\_LAMBSE =(LAMBSE1 + LAMBSE2) / 2

(HEGO monitoring test) | Increment OL\_LEAN\_TMR

|

| --- ELSE ---

|

| SPK\_LAMBSE = LAMBSE1

| Increment OL\_LEAN\_TMR

END: determine\_spk\_lambse

BEGIN: ego\_monitor\_control(bank)

The following logic will overwrite LAMBSE1 or LAMBSE2 if necessary

during the intrusive portion of the downstream EGO monitor.

DS\_EGO\_RICH(bank) = 1 ------------------| lambse(bank) = RICH\_EXCRSN

|

| --- ELSE ---

|

DS\_EGO\_LEAN(bank) = 1 ------------------| lambse(bank) = LEAN\_EXCRSN

END: ego\_monitor\_control

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FUEL STRATEGY, LAMBSE RESET LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.10 LAMBSE RESET LOGIC (CDAN2)

OVERVIEW

The following logic is executed under the conditions defined in strategy

module FUEL\_OL\_LAMBSE\_COMx. LAMBSE is reset to (1 + BIAS\_Gx) under the

conditions listed below, provided it is in Closed Loop fuel control. LAMBSE

is not reset in Open Loop Fuel Control because the value of LAMBSE is

calculated using the Open Loop Fuel logic.

A LAMBSE reset is commanded for the conditions described below:

1. When entering or exiting Closed Loop RPM Control mode.

2. When Changing load states.

3. Any time a transition is made from Open loop to Closed Loop Fuel control.

When this transition is detected, special logic will increase the ramp

rate to quickly bring LAMBSEx towards the stoichiometric point.

4. When a tip out occurs while purging.

When LAMBSE is clipped to (1 + BIAS\_Gx) as a maximum, the intent is to allow

rich errors and to prevent lean errors, given that running rich should not

cause any drivability concerns. Since Open Loop lambda's may be excessively

rich or lean of stoic (based upon driving conditions as well as to control

Catalyst temperatures), the closed loop ramp rate multiplier logic is used to

command the quickest return to 1.0 without noticeably affecting vehicle

performance or inducing excess feedgas emissions.

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FUEL STRATEGY, LAMBSE RESET LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- ANPIPn = Actual number of PIP signals since the last HEGO switch; clipped

to a maximum of 255; reset to zero when not in closed loop.

- APT = At Part Throttle; -1 -> Closed throttle, 0 -> Part throttle, 1 ->

Wide open Throttle.

- BIAS\_G1 = Closed loop fuel biasing term for bank one.

- BIAS\_G2 = Closed loop fuel biasing term for bank two.

- ENPIPn = Expected number of PIP signals between HEGO switches; reset to 1

when not in closed loop.

- ISCFLG = ISC mode indicator flag; -1 -> Dashpot Mode, 0 -> Dashpot

Preposition Mode, 1 -> closed Loop RPM Control Mode, 2 -> Closed Loop RPM

Control (Lock\_out entry to RPM control).

- ISCFLG\_LST = Last pass value of ISCFLG.

- ISFLAG = Flag that indicates the degree of loading on the engine at idle;

0 -> Drive, 1 -> Drive and A/C (WAC Relay De-Energized), 2 -> Neutral, 3

-> Neutral and A/C (WAC Relay De-Energized).

- ISLAST = Register which indicates the engine load state from the previous

background pass.

- LAMBSE1 = Desired open loop equivalence ratio for bank 1 injectors.

LAMBSE1 appears in the fuel pulsewidth equation for HEGO11.

- LAMBSE2 = Desired open loop equivalence ratio for bank 2 injectors.

LAMBSE2 appears in the fuel pulsewidth equation for HEGO21.

- LESTMR11 = Lack of HEGO11 switching timer, sec.

- LESTMR21 = Lack of HEGO21 switching timer, sec.

- TSLAMUn = Time at which last LAMBDA update occurred, clock ticks.

Bit Flags:

| - DFIB\_LEANn1 = Flag which is set when the lo catcher calculation is stuck.

| Initiates a lambse reset from the lean clip as part of the switchpoint

| recovery process.

| - DFIB\_RICHn1 = Flag which is set when the hi catcher calculation is stuck.

| Initiates a lambse reset from the rich clip as part of the switchpoint

| recovery process.

- EGOFL11 = Bank1 upstream HEGO flag.

- EGOFL21 = Bank2 upstream HEGO flag.

- OLFLG\_LST = Last pass value of OLFLG;

1 -> Previously in Open Loop Fuel,

0 -> Previously Closed Loop.

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FUEL STRATEGY, LAMBSE RESET LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- RESET\_LEAN1 = Flag passed from lambse reset to closed loop logic to

indicate whether LAMBSE1 was lean or rich upon last transition; 1 =>

lean, 0 => rich.

- RESET\_LEAN2 = Flag passed from lambse reset to closed loop logic to

indicate whether LAMBSE2 was lean or rich upon last transition; 1 =>

lean, 0 => rich.

- RESET\_REQ1 = Flag passed from lambse reset to closed loop logic to enable

use of ramp rate multiplier for Bank 1.

- RESET\_REQ2 = Flag passed from lambse reset to closed loop logic to enable

use of ramp rate multiplier for Bank 2.

- V\_LAMJMP1 = Self test flag indicating a LAMBSE1 jump has occured.

- V\_LAMJMP2 = Self test flag indicating a LAMBSE2 jump has occured.

- PC\_RESET = Purge Lambse reset flag; 1 -> purge requesting lambse reset.

Calibration Constants:

- LAM\_ISC\_SW = LAMBDA Reset Switch for entering/exiting Idle Speed control

modes; 1 => Allow LAMBSE reset due to Idle Speed Control logic.

- LAM\_LOAD\_SW = LAMBDA Reset Switch for Load State Changes at Idle; 1 =>

Allow LAMBSE reset due to Load State Change at closed throttle.

- PRG\_LAM\_SW = Calibration switch to enable PCOMP/Purge induced lambse

resets.

- LMBJMP = Desired rich correction.

- LAMMIN = Min LAMBSE clip when closed loop.

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FUEL STRATEGY, LAMBSE RESET LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_LAMBSE\_RESET\_COM13

BEGIN: FUEL\_LAMBSE\_RESET\_COM13

;THIS MODULE SHOULD ONLY BE EXECUTED IN CLOSED LOOP MODE.

;IT IS CALLED FROM MODULE FUEL\_OL\_LAMBSE\_COMx.

1) Lambse Reset - Entering/Exiting Closed Loop RPM Control mode.

ISCFLG = 1 -------------------|

|

ISCFLG\_LST <> 1 --------------|

(entering RPM control mode) |

|AND -| Clip LAMBSE1 to (1 + BIAS\_G1) as

LAMBSE1 > (1 + BIAS\_G1) ------| | a maximum

(operating lean) | | LESTMR11 = 0

| | ANPIP1 = 0

LAM\_ISC\_SW = 1 ---------------| | ENPIP1 = 1

| V\_LAMJMP1 = 1

| TSLAMU1 = clock

ISCFLG = 1 -------------------|

|

ISCFLG\_LST <> 1 --------------|

(entering RPM control mode) |

|AND -| Clip LAMBSE2 to (1 + BIAS\_G2) as

LAMBSE2 > (1 + BIAS\_G2) ------| | a maximum

(operating lean) | | ANPIP2 = 0

| | ENPIP2 = 1

LAM\_ISC\_SW = 1 ---------------| | LESTMR21 = 0

| V\_LAMJMP2 = 1

| TSLAMU2 = clock

LAM\_ISC\_SW = 1 ---------------|

|

ISCFLG = 0 -------------------|AND -| LAMBSE1 = LAMBSE1

| | - LMBJMP

ISCFLG\_LST = 1 ---------------| | LAMBSE2 = LAMBSE2

(leaving RPM control mode and | - LMBJMP

entering Dashpot preposition) | Clip LAMBSE1 and LAMBSE2 to

| to LAMMIN as a minimum.

| V\_LAMJMP1 = 1

| V\_LAMJMP2 = 1

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FUEL STRATEGY, LAMBSE RESET LOGIC - CDAN2

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2) Lambse Reset - Load State Change at Idle

APT = -1 ---------------------|

(closed throttle) |

|

ISFLAG <> ISLAST -------------|AND -| Clip LAMBSE1 to (1 + BIAS\_G1) as

(load state change) | | a maximum

| | ANPIP1 = 0

LAMBSE1 > (1 + BIAS\_G1) ------| | ENPIP1 = 1

| | LESTMR11 = 0

LAM\_LOAD\_SW = 1 --------------| | V\_LAMJMP1 = 1

| TSLAMU1 = clock

APT = -1 ---------------------|

(closed throttle) |

|

ISFLAG <> ISLAST -------------|

(load state change) |AND -| Clip LAMBSE2 to (1 + BIAS\_G2) as

| | a maximum

LAMBSE2 > (1 + BIAS\_G2) ------| | ANPIP2 = 0

| | ENPIP2 = 1

LAM\_LOAD\_SW = 1 --------------| | LESTMR21 = 0

| V\_LAMJMP2 = 1

| TSLAMU2 = clock

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FUEL STRATEGY, LAMBSE RESET LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

3) Lambse Reset - Open Loop to Closed Loop Transition

;(Executed only once per Open-Closed transition, or during

| ;an adaptive switchpoint recovery action triggered by the

| ;DFIB\_LEAN/RICH flags setting for one background loop.)

| DFIB\_LEAN11 = 1 --------------------|

| (reset lambse from lean clip) |

|

OLFLG\_LST = 1 ----------------| |OR --| RESET\_REQ1 = 1

(previously in Open Loop) | | | RESET\_LEAN1 = 1

| | | ANPIP1 = 0

LAMBSE1 > (1 + BIAS\_G1) ------|AND -| | ENPIP1 = 1

(Lean A/F commanded) | | LESTMR11 = 0

| | V\_LAMJMP1 = 1

EGOFL11 = 0 ------------------| | TSLAMU1 = clock

(Lean A/F sensed by HEGO) |

| --- ELSE ---

| DFIB\_RICH11 = 1 --------------------| |

| (reset lambse from rich clip) | |

| |

OLFLG\_LST = 1 ----------------| |OR --| RESET\_REQ1 = 1

(previously in Open Loop) | | | RESET\_LEAN1 = 0

| | | ANPIP1 = 0

LAMBSE1 <= (1 + BIAS\_G1) -----|AND -| | ENPIP1 = 1

(Rich A/F commanded) | | LESTMR11 = 0

| | V\_LAMJMP1 = 1

EGOFL11 = 1 ------------------| | TSLAMU1 = clock

(Rich A/F sensed by HEGO)

| DFIB\_LEAN21 = 1 --------------------|

| (reset lambse from lean clip) |

|

OLFLG\_LST = 1 ----------------| |OR --| RESET\_REQ2 = 1

(previously in Open Loop) | | | RESET\_LEAN2 = 1

| | | ANPIP2 = 0

LAMBSE2 > (1 + BIAS\_G2) ------|AND -| | ENPIP2 = 1

(Lean A/F commanded) | | LESTMR21 = 0

| | V\_LAMJMP2 = 1

EGOFL21 = 0 ------------------| | TSLAMU2 = clock

(Lean A/F sensed by HEGO) |

| --- ELSE ---

| DFIB\_RICH21 = 1 --------------------| |

| (reset lambse from rich clip) | |

| |

OLFLG\_LST = 1 ----------------| |OR --| RESET\_REQ2 = 1

(previously in Open Loop) | | | RESET\_LEAN2 = 0

| | | ANPIP2 = 0

LAMBSE2 <= (1 + BIAS\_G2) -----|AND -| | ENPIP2 = 1

(Rich A/F commanded) | | LESTMR21 = 0

| | V\_LAMJMP2 = 1

EGOFL21 = 1 ------------------| | TSLAMU2 = clock

(Rich A/F sensed by HEGO)

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FUEL STRATEGY, LAMBSE RESET LOGIC - CDAN2

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4) Lambse Reset - tip out during purging

(Logic enabled from within PCOMP or Purge logic)

PC\_RESET = 1 -----------------|

|

LAMBSE1 > (1 + BIAS\_G1) ------|AND -| Clip LAMBSE1 to (1 + BIAS\_G1) as

(operating lean) | | a maximum

| | ANPIP1 = 0

PRG\_LAM\_SW = 1 ---------------| | ENPIP1 = 1

(reset calibrated in) | LESTMR11 = 0

| V\_LAMJMP1 = 1

| TSLAMU1 = clock

PC\_RESET = 1 -----------------|

|

LAMBSE2 > (1 + BIAS\_G2) ------|AND -| Clip LAMBSE2 to (1 + BIAS\_G2) as

(operating lean) | | a maximum

| | ANPIP2 = 0

PRG\_LAM\_SW = 1 ---------------| | ENPIP2 = 1

(reset calibrated in) | LESTMR21 = 0

| V\_LAMJMP2 = 1

| TSLAMU2 = clock

END: FUEL\_LAMBSE\_RESET\_COM13

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FUEL STRATEGY, LAMBSE CLIP LOGIC - CDAN2

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8.11 LAMBSE CLIP LOGIC (CDAH0)

OVERVIEW

LAMBSE1 and LAMBSE2 (the desired equivalence ratios) are clipped as shown

below:

DEFINITIONS

INPUTS

Bit Flags:

- OLFLG = Open Loop Flag; 1 -> Open Loop Fuel Control, 0 -> Closed Loop

Fuel Control.

Calibration Constants:

- LAMMAX = Maximum LAMBSE clip when in closed loop.

- LAMMIN = Minimum LAMBSE clip when in closed loop.

OUTPUTS

Registers:

- LAMBSE1 = Desired equivalence ratio for HEGO11 injectors.

- LAMBSE2 = Desired equivalence ratio for HEGO21 injectors.

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FUEL STRATEGY, LAMBSE CLIP LOGIC - CDAN2

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PROCESS

STRATEGY MODULE: FUEL\_LAMBSE\_CLIP\_COM4

OLFLG = 0 ----------------------------| CLIP LAMBSE1 AND

| LAMBSE2 BETWEEN

| LAMMIN AND LAMMAX

|

| --- ELSE ---

|

| CLIP LAMBSE1 AND

| LAMBSE2 BETWEEN

| 0.0000305 AND

| 1.9999695

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FUEL STRATEGY, LAMBSE CLIP LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.12 FEATURE: ADAPTIVE FUEL CONTROL AND OBD-II FUEL SYSTEM MONITOR -

V1.5\_FADPT (CDAN0)

8.12.1 ADAPTIVE FUEL CONTROL LOGIC (CDAN0)

OVERVIEW

Fuel injected systems may exhibit vehicle to vehicle steady state A/F ratio

errors due to normal variability in fuel system components. The adaptive

fuel strategy attacks this problem by memorizing the characteristics of the

individual fuel system being used. This memorized information is used to

predict what the system will do based on past experience.

The ability to predict fuel system behavior improves both open loop and

closed loop fuel control. As an example, the memorized information can be

used on cold starts to achieve better open loop fuel control before the HEGO

sensor reaches operating temperature.

The chief benefit of the adaptive fuel strategy will be to reduce the effects

of product variability in the field.

The memorized or adaptive information is stored in table or vector form in

the Keep Alive Memory (KAM). KAM is continuously powered by the vehicle

battery even when the vehicle is shut off. As a result, this information is

not lost on vehicle shutdown.

APPROACH

The adaptive fuel tables, LTMTB1 and LTMTB2, are 2-dimensional arrays of

learned fuel system corrections. Ideally, if LAMBSE1 = 1.0, LAMBSE2 = 1.0

and data from a mature adaptive fuel table is used, a stoichiometric A/F

ratio would result at whatever speed-load point adaptive learning had taken

place.

Present table size is 8(rows) x 10(columns) or 80 cells for each Adaptive

Fuel Table, plus depending on the strategy family, either 4 or 6 special idle

adaptive cells. There will always be 86 total cells per table.

The total learned fuel system correction for the HEGO11 side of the engine is

called KAMRF1 where KAMRF1 = 0.5 + LTMTB1[r,c]. The corresponding fuel

correction for the HEGO21 side is called KAMRF2, where KAMRF2 = 0.5 +

LTMTB2[r,c].

During adaptive learning, only the LTMTB1 and LTMTB2 cells are modified.

Therefore, the ranges of each of the KAMRF1 and KAMRF2 multipliers (0.5 +

0.0) to (0.5 + 1.0) or 0.5 to 1.5.

The range of the LTMTB1 and LTMTB2 cells can be further restricted by use of

the calibration parameter clips, MINADP and MAXADP.

The KAMRF1 and KAMRF2 are used in the desired fuel/air ratio equation

(strategy module FUEL\_BG\_CALC\_COM).

If KAM fails the KAM validation test (described later), or if there is a lack

of HEGO switching (described in the Failure Mode Strategy chapter), all

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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LTMTB1 and/or LTMTB2 cells are initialized to 0.5 or 80 (HEX) resulting in a

value of KAMRF1 = KAMRF2 = 0.5 + 0.5 = 1.0.

Updates to LTMTB1 and LTMTB2 are randomly distributed in the vicinity of the

speed-load operating point, except in the case of the idle cells. Only the

current idle cell is updated, no distribution is done. Over time, this

random distribution will approximate a statistical, weighted distribution of

the fuel/air error into the KAM table.

Data extracted from the table undergoes a 4-point linear interpolation. This

is explained further under the FN1325A description. Note that the idle cells

do not undergo four point interpolation. Only the current idle cell is used.

LTMTB1, LTMTB2 and FN1325A share the same normalizing functions. FN021A is

the LOAD normalizing function. FN041 is the AM normalizing function. The

calibration constant, ADAPT\_SEL, selects whether the AM or LOAD normalizing

function should be used for the Y-axis. FN070D is the engine speed, N,

normalizing function.

As an example of an adaptive fuel table, LTMTB1, is shown on the next page.

HEGO21 Adaptive Fuel Table, LTMTB2, uses similar nomenclature.

ADAPTIVE FUEL TABLE (LTMTB1)

LTMTB1[r,c] CELLS

(LTMTB2 has similar designation)

Special idle ------>|80 81 82 83 84 85

adaptive cells |

7 |70 71 72 73 74 75 76 77 78 79

FN021A |

NORMALIZED 6 |60 61 62 63 64 65 66 67 68 69

ENGINE |

LOAD 5 |50 51 52 53 54 55 56 57 58 59

(LOAD) |

4 |40 41 42 43 44 45 46 47 48 49

--- OR --- |

3 |30 31 32 33 34 35 36 37 38 39

FN041 |

NORMALIZED 2 |20 21 22 23 24 25 26 27 28 29

AIR MASS |

(AM) 1 |10 11 12 13 14 15 16 17 18 19

|

0 |00 01 02 03 04 05 06 07 08 09

------------------------------

0 1 2 3 4 5 6 7 8 9

FN070D NORMALIZED

ENGINE SPEED

(N)

The special Adaptive Idle cells are not defined by FN021A or FN070D, they are

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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defined by the value of the ISFLAG. (See ISFLAG definition)

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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FN1325A DESCRIPTION

FN1325A is a 9(rows) x 10(columns) table containing 1 cell corresponding to

each cell in the adaptive fuel table LTMTB1 or LTMTB2. (The 9th row is used

to reference the idle cells and is not accessible from FN021A which only goes

from 0 to 7).

The normalizing functions for FN1325A, LTMTB1 and LTMTB2 are shared. FN021A

is the LOAD normalizing function. FN041 is the AM normalizing function. The

calibration constant, ADAPT\_SEL, selects whether the AM or LOAD normalizing

function should be used for the Y-axis. FN070D is the engine speed, N,

normalizing function.

FN1325A is designed to do the following:

- Identify LTMTB1 and LTMTB2 cells where learning is allowed to occur.

Learning is allowed in any LTMTB1 and LTMTB2 cells whose corresponding

FN1325A[r,c] cell contains a value >= 0. Negative FN1325A cell values

disallow learning in the corresponding LTMTB1 and LTMTB2 cell(s).

- Define a high confidence speed-load region that can be referenced from

any other speed-load point.

This occurs whenever a negative value is entered into a FN1325A cell.

The negative number serves as an offset to LTMTB1[0,0] and LTMTB2[0,0].

If 1 of the 4 cells used by the 4-point linear interpolation LTMTB1 or

LTMTB2 table lookup routine contained -42, the cell value used by the

interpolation routine for the cell that contained the -42 would be the

value found in the LTMTB1 or LTMTB2 cell located at the intersection of

row 4 and column 2. In the extreme, if -42 was entered into every cell

of FN1325A[r,c] except for the cell corresponding to LTMTB1[4,2] and

LTMTB2[4,2], learning would be allowed only in cell LTMTB1[4,2] and

LTMTB2[4,2] and the learned correction in LTMTB1[4,2] and LTMTB2[4,2]

would be applied to all speed-load points for fuel calculations

referencing HEGO11 (every cell referenced by the 4-point linear

interpolation routine during the LTMTB1 table lookup would point to cell

LTMTB1[4,2]). This calibration for FN1325A is shown on the next page.

- Specify the values of the Loop Counters (LPCT1L, LPCT1R, LPCT2L and

LPCT2R) required to update an individual LTMTB1 or LTMTB2 cell(s).

This is done by entering a value into FN1325A that is >= 0. The value

entered represents 1/2 the required update value. A value of 20 entered

would require (LPCT1R, LPCT1L, LPCT2L and LPCT2R) to be greater than 40

for an update to occur.

NOTE: FN1325A controls the update rate and update area for both LTMTB1 and

LTMTB2.

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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LTMTB1 AND LTMTB2 LEARNING/USE CONTROL TABLE FN1325A

FN1325A CELLS

Special idle

adaptive cells ---->|-42 -42 -42 -42 -42 -42

|

7 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

FN021A |

NORMALIZED 6 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

ENGINE |

LOAD 5 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

(LOAD) |

4 |-42 -42 20 -42 -42 -42 -42 -42 -42 -42

--- OR --- |

3 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

FN041 |

NORMALIZED 2 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

AIR MASS |

(AM) 1 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

|

0 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

---------------------------------------

0 1 2 3 4 5 6 7 8 9

FN070D NORMALIZED

ENGINE SPEED

(N)

CALIBRATION NOTES

To disable adaptive learning, the FADPT\_ENABLE flag must be held at zero.

Please refer to the FADPT\_ENABLE strategy module for information on how to

disable this feature entirely.

It is not possible to reference a cell which is itself referencing. Such

double referencing must be avoided, as it will inhibit learning in the

present implementation.

It is possible to reference a normal cell to a special idle cell. It is not

possible to reference a special idle cell to normal cell, as the four-point

interpolation scheme will not be invoked.

HCAMSW is a calibration switch allowing the developer to select how the

adaptive fuel idle cells are to be used. If HCAMSW is set to 0, the adaptive

fuel idle cells are used as soon as the filtered air mass region is entered

(REFFLG = 1). If HCAMSW is set to 1, the adaptive fuel idle cells are used

only when in the filtered air mass region and no RPM adder above base idle is

present (HCAMFG = 0). This includes FN825A, FN825B, FN026 and BZZRPM.

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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DEFINITIONS

Registers:

- AM = Air mass flow, lb/min.

- BIAS\_G1/BIAS\_G2 = Closed loop fuel biasing term = FN1353(N,LOAD).

- CHKSUM = KAM memory word which contains the sum of the LTMTB1 and LTMTB2

table contents.

- COLTBU = A register which contains the column number of the adaptive

learning cell to be updated.

- ECT = Coolant temperature, degrees F.

- HEGO = Heated Exhaust Gas Oxygen Sensor. HEGO11 and HEGO21 represent the

HEGO sensors in stereo mode; generic representation = HEGOxy.

- EGOCT11 = HEGO11 switches since last Adaptive Fuel update.

- EGOCT21 = HEGO21 switches since last Adaptive Fuel update.

- KAM = Keep Alive Memory.

- KAM\_MON\_TMR = Adaptive cell residency timer (required for monitoring).

- KAMCOL = Table index value used for interpolation. This value comes

directly from FN070D (real).

- KAMCOL\_CUR = Current adaptive fuel table column indicator (integer).

This is the integer portion of KAMCOL, obtained through truncation.

- KAMCOL\_OLD = Adaptive fuel table column indicator (integer) from last

background pass.

- KAMROW = Table index value used for interpolation. This value comes

directly from either FN021A or FN041 (real).

- KAMROW\_CUR = Current adaptive fuel table row indicator (integer). This

is the integer portion of KAMROW, obtained through truncation.

- KAMROW\_OLD = Adaptive fuel table row indicator (integer) from last

background pass.

- KAMRF1/KAMRF2 = Adaptive Fuel strategy correction factor. It is composed

of the value LTMTB1[r,c] + 0.5.

- KWUCTR = KAM warm-up counter. Stores number of warm-ups in KAM. Reset

to zero if KAM is corrupted battery disconnect, etc.)

- LAMBSE1 = Desired open loop equivalence ratio for bank 1 injectors.

LAMBSE1 appears in the fuel pulsewidth equation for HEGO11.

- LAMBSE2 = Desired open loop equivalence ratio for bank 2 injectors.

LAMBSE2 appears in the fuel pulsewidth equation for HEGO21.

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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- LAMWIN1/LAMWIN2 = LAMBSE window outside which adaptive is enabled.

- LOAD = Universal Load parameter, unitless; aircharge normalized to Sea

Level.

- LPCT1L = Number of background loops that the LAMBSE1 outside a deadband

in the rich direction, with HEGO11 sensor reading lean.

- LPCT2L = Number of background loops that the LAMBSE2 was outside a

deadband in the rich direction, with HEGO21 sensor reading lean.

- LPCT1R = Number of background loops that the LAMBSE1 was outside a

deadband in the lean direction, with HEGO11 sensor reading rich.

- LPCT2R = Number of background loops that the LAMBSE2 was outside a

deadband in the lean direction, with HEGO21 sensor reading rich.

- LSTCOL = Last normalized column value.

- LSTROW = Last normalized row value.

- LTMTB1[r,c] = HEGO11 Adaptive Fuel Table cell.

- LTMTB2[r,c] = HEGO21 Adaptive Fuel Table cell.

- N = Engine revolutions, RPM.

- PG\_DC = Purge duty cycle, unitless.

- PTPAMP1/PTPAMP2 = Limit cycle peak-to-peak amplitude.

- RANNUM = Random number adder.

- ROWTBU = Register which contains the row number of the Adaptive Fuel cell

to be updated.

- TCSTRT = Temperature of ECT at cold start, degrees F.

- UPRATE = KAM update rate.

Bit Flags:

- CRKFLG = Crank flag; 1 -> in crank mode, 0 -> not in crank mode.

- EGOFL11 = Bank 1 upstream HEGO11 flag.

- EGOFL21 = Bank 2 upstream HEGO21 flag.

- EGO1FMFLG = EGO1 FMEM flag; 1 -> EGO1 sensor failure.

- EGO2FMFLG = EGO2 FMEM flag; 1 -> EGO2 sensor failure.

- FADPT\_ENABLE = Flag indicating enable state of adaptive fuel strategy.

- FFG\_CSD11 = Fault flag for CSD on sensor 11.

- FFG\_CSD21 = Fault flag for CSD on sensor 21.

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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- HCAMFG = Flag indicating state of Hi Cam.

- ISCFLG = ISC mode indicator flag; -1 -> Dashpot Mode, 0 -> Dashpot

Preposition Mode, 1 -> closed Loop RPM Control Mode, 2 -> Closed Loop RPM

Control (Lock-out entry to RPM control).

- ISFLAG = Flag that indicates the degree of loading on the engine at Idle.

See the ISC Chapter; 0 -> Drive, 1 -> Drive + A/C (WAC Relay

De-Energized), 2 -> Neutral, 3 -> Neutral + A/C (WAC Relay De-Energized).

- KAM\_ERROR = KAM error flag, set for 1 background loop after error is

detected; 1 -> KAM data invalid.

- LEGOFG11 = Lack of HEGO11 switching.

- LEGOFG21 = Lack of HEGO21 switching.

- LIMIT\_PURGE = Flag which indicates purge duty cycle is being limited due

to lambse being clipped; 1 -> limited purge.

- SWTFL11 = Bank 1 upstream HEGO11 switch flag; 0-> no HEGO11 switch, 1->

sensor HEGO11 switch.

- SWTFL21 = Bank 2 upstream HEGO21 switch flag; 0-> no HEGO21 switch, 1->

sensor HEGO21 switch.

- UNDSP = Underspeed flag; 1 -> underspeed mode or crank.

- WARM\_UP = Indicates engine warm-up occurred.

Calibration Constants:

- ADAPT\_SEL = AM versus LOAD select switch; 0 -> use LOAD in FN1325A and

LTMTB1/2 tables, 1 -> use AM in FN1325A and LTMTB1/2 tables.

- ADEGCT = HEGO switch requirement to increment counters.

- AMPMUL = Multiplier to determine LAMWINx from PTPAMPx.

- DELCOL = Calibration constant (normalized engine speed N) which provides

the ability to lock out table updates under transient conditions;

establishes an operating range (engine speed) within which the

appropriate loop counter may be incremented.

- DELROW = Same function as DELCOL but for either normalized LOAD or AM

(depending upon the value of ADAPT\_SEL).

- DELAMB = Deadband (around LAMBSE1 = 1.0) within which loop counter values

are not altered.

- FADPT\_SW = Switch allowing the complete disablement of adaptive fuel and

the fuel system monitor. FADPT\_SW = 0 -> disable all adaptive fuel

activity.

- FAEGCT = Fast Adaptive HEGO count. Number of HEGO switches required to

permit adaptive learning when KWUCTR < KWUCNT. Should be set to 0 to

permit fast adaptive learning for the first few warm-up cycles.

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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- FN021A = LOAD normalizing function for LTMTB1(LTMTB2) and FN1325A.

Input = Load.

Output = Normalized Load.

- FN041 = AM normalizing function.

- FN070D = N normalizing function.

- FN1325A[r,c] = LTMTB1 and LTMTB2 learning/use control table.

- HCAMSW = Calibratable switch which allows selection of when and which

adaptive fuel cells are to be used.

- IDLE\_CELL\_SW = Calibration switch to enable use of the special idle

cells; 1 -> special cells enabled.

- KAM\_NO\_RESET = Switch which indicates if KAM should be reset upon an EGO

failure; 1 -> do not reset KAM.

- KWUCNT = Maximum number of warm-up cycles to use fast adaptive HEGO

count. It should be set to approx. 3 to 5 warm-ups.

- MAXADP = Maximum adaptive correction.

- MINADP = Minimum adaptive correction.

- NUMEGO = Switch indicating number of HEGO sensors present; select mono or

stereo.

- RANMUL = Multiplier for Random number generation.

- VECT3 = Minimum coolant temperature (engine on), degrees F.

- VECT5 = Starting coolant temperature for warm-up counter, degrees F.

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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PROCESS

STRATEGY MODULE: FADPT\_GENERIC\_COM1

BEGIN: ADAPTIVE\_FUEL\_CONTROL

The Adaptive Fuel Control strategy, generic version.

Execute once per background pass.

Check the integrity of the adaptive fuel area in KAM after initial system

startup, during execution of the RAM\_INIT software module. The checksum

should also be validated when KAM corruption is detected. This can be done

either during KAM qualification, or within the adaptive fuel software module.

First background pass -------------|

|OR --| Do: FADPT\_SELF\_TEST

KAM\_ERROR = 1 ---------------------|

Update the adaptive fuel values in KAM if necessary, check for error

conditions which may require reset of the KAM values, and assign values to

the correction term for each bank.

Unconditionally -------------------------| Do: FADPT\_UPDATE\_STATUS

| Do: FADPT\_EGO\_FAILURE\_RESET

| Do: FADPT\_UPDATE\_TABLE

| Do: FADPT\_UPDATE\_KAMRF

| Do: FADPT\_FUEL\_MONITOR

END: ADAPTIVE\_FUEL\_CONTROL

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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BEGIN: FADPT\_SELF\_TEST

Each time the vehicle is started, the data stored in KAM may or may not be

valid. Power interruptions, noise, etc., may have altered the KAM contents.

Alternatively, the computer may not be reading KAM registers correctly

because of a hardware fault. The KAM qualification test judges the validity

of the KAM data, and KAM can be initialized as required. Based on the

results of the KAM qualification test, validate the adaptive fuel table as

follows.

CHKSUM is a KAM memory word containing the sum of the LTMTB1 or LTMTB2

contents. CHKSUM is incremented or decremented each time any LTMTB1 or

LTMTB2 cell is updated. A one count difference between the present sum and

the stored sum is allowed to account for the case of power down after a KAM

update but prior to CHKSUM update.

This routine should be executed during RAM initialization, and each time a

KAM error is detected.

[(SUM OF ALL ADAPTIVE FUEL

KAM CELLS) - CHKSUM] <= 1 ---| CHKSUM := SUM OF ADAPTIVE FUEL CELLS

| ;Assume the adaptive fuel data in KAM

| ; is valid.

|

| --- ELSE ---

|

| ;Assume the adaptive fuel data in KAM

| ; is wrong.

| ;Do a total initialization of the

| ; adaptive fuel data in KAM.

| For each cell:

| 1) Set LTMTB1[r,c] := 0.5

| Set LTMTB2[r,c] := 0.5

| 2) Set CHKSUM := 22016

| KWUCTR := 0

END: FADPT\_SELF\_TEST

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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BEGIN: FADPT\_UPDATE\_TABLE

Calculate the random number to be used this background pass.

Unconditionally -------------------------| RANNUM := RANNUM\*RANMUL + RANMUL/4

| rancol := rannum\_hi

| ;The high byte of the low

| ; word of RANNUM

| ranrow := rannum\_lo

| ;The low byte of the low

| ; word of RANNUM

| RANNUM := the low word of RANNUM

| ;Save for next pass

Calculate the cell to be updated this background pass.

IDLE\_CELL\_SW = 1 ------------------|

;Idle cells enabled |

|AND -| KAMCOL := ISFLAG

ISCFLG = 1 ------------------------| | COLTBU := ISFLAG

;RPM control | | KAMROW := 8.0

| | ROWTBU := 8.0

HCAMFG = 0 ------------------| | |

|OR --| |

HCAMSW = 0 ------------------| |

| --- ELSE ---

|

ADAPT\_SEL = 0 ---------------------------| KAMCOL := FN070D(N)

| COLTBU := KAMCOL + 0.5 + rancol

| KAMROW := FN021A(LOAD)

| ROWTBU := KAMROW + 0.5 + ranrow

|

| --- ELSE ---

|

| KAMCOL := FN070D(N)

| COLTBU := KAMCOL + 0.5 + rancol

| KAMROW := FN041(AM)

| ROWTBU := KAMROW + 0.5 + ranrow

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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Service adaptive cell residency timer, which is used by the OBD-II Fuel

System Monitor.

Unconditionally -------------------------| KAMCOL\_CUR := int(KAMCOL)

| KAMROW\_CUR := int(KAMROW)

KAMCOL\_CUR <> KAMCOL\_OLD ----------|

|OR --| KAM\_MON\_TMR := 0

KAMROW\_CUR <> KAMROW\_OLD ----------| | ;Reset the adaptive residency

| ; timer to prevent similar

| ; conditions reset

Unconditionally -------------------------| KAMCOL\_OLD := KAMCOL\_CUR

| KAMROW\_OLD := KAMROW\_CUR

Determine if adaptive is enabled/disabled or if adaptive area has changed.

FADPT\_ENABLE = 0 ------------------|

|

abs(KAMROW - LSTROW) > DELROW -----|OR --| LPCT1R := 0

| | LPCT1L := 0

abs(KAMCOL - LSTCOL) > DELCOL -----| | LPCT2R := 0

| LPCT2L := 0

| EGOCT11 := 0

| EGOCT21 := 0

| LSTCOL := KAMCOL

| LSTROW := KAMROW

|

| Do: FADPT\_NEW\_UPRATE\_CALC

| Exit: FADPT\_UPDATE\_TABLE

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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Calculate the LAMBSE windows, LAMWIN1 and LAMWIN2. LAMBSE values must be

outside this

window to initiate adaptive fuel table updates.

Unconditionally -------------------------| LAMWIN1 := DELAMB + (PTPAMP1 \*

| AMPMUL)

| LAMWIN2 := DELAMB + (PTPAMP2 \*

| AMPMUL)

Calculate the EGO based learning rate

This logic gives the system the capability to learn faster during "green

engine" conditions.

WARM\_UP = 0 -----------------------|

|

TCSTRT < VECT5 --------------------|

|AND -| WARM\_UP := 1

ECT >= VECT3 ----------------------| | KWUCTR := KWUCTR + 1

| | KWUCTR := MIN(KWUCTR, 255)

UNDSP = 0 -------------------------|

KWUCTR < KWUCNT -------------------------| egolearn\_rat := FAEGCT

;First few warm-up cycles | ;Use fast learning rate

|

| --- ELSE ---

|

| egolearn\_rat := ADEGCT

| ;Use normal learning rate

Update the EGO switch counters used by the adaptive fuel logic.

SWTFL11 = 1 -----------------------------| EGOCT11 := EGOCT11 + 1

SWTFL21 = 1 -----------------------|

|AND -| EGOCT21 := EGOCT21 + 1

NUMEGO = 2 ------------------------|

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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Calculate Bank 1 loop counters, LPCT1L and LPCT1R.

EGOCT11 >= egolearn\_rat -----------|

|

EGOFL11 = 1 -----------------------|

;HEGO11 is rich |AND -| LPCT1R := LPCT1R + 1

| | LPCT1R := MIN(LPCT1R, 255)

LAMBSE1 >= (1 + BIAS\_G1 + LAMWIN1)-| | ;Increment rich counter, bank 1

| |

LIMIT\_PURGE = 1 -------| | |

|AND -| | |

PG\_DC = 0 -------------| |OR --| |

| |

LIMIT\_PURGE = 0 -------------| |

|

| --- ELSE ---

EGOFL11 = 0 -----------------------| |

;HEGO11 is lean | |

|AND -| LPCT1L := LPCT1L + 1

LAMBSE1 <= (1 + BIAS\_G1 - LAMWIN1)-| | LPCT1L := MIN(LPCT1L, 255)

| | ;Increment lean counter, bank 1

EGOCT11 >= egolearn\_rat -----------|

Calculate Bank 2 loop counters, LPCT2L and LPCT2R.

NUMEGO = 2 ------------------------|

|

EGOCT21 >= egolearn\_rat -----------|

|

EGOFL21 = 1 -----------------------|AND -| LPCT2R := LPCT2R + 1

;HEGO21 is rich | | LPCT2R := MIN(LPCT2R, 255)

| | ;Increment rich counter, bank 2

LAMBSE2 >= (1 + BIAS\_G2 + LAMWIN2)-| |

| |

LIMIT\_PURGE = 1 -------| | |

|AND -| | |

PG\_DC = 0 -------------| |OR --| |

| |

LIMIT\_PURGE = 0 -------------| |

|

| --- ELSE ---

NUMEGO = 2 ------------------------| |

| |

EGOFL21 = 0 -----------------------| |

;HEGO21 is lean |AND -| LPCT2L := LPCT2L + 1

| | LPCT2L := MIN(LPCT2L, 255)

LAMBSE2 <= (1 + BIAS\_G2 - LAMWIN2)-| | ;Increment lean counter, bank 2

|

EGOCT21 >= egolearn\_rat -----------|

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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Determine if adaptive cells should be incremented/decremented, bank 1.

LTMTB1 cells are updated when the following conditions are satisfied. Note

that r = ROWTBU and c = COLTBU in the following charts.

FN1325A[r,c] >= 0 -----------------|

|

LPCT1R > 2 \* UPRATE ---------------|AND -| LTMTB1[r,c] := LTMTB1[r,c]

| | - 0.00390625

LTMTB1[r,c] > MINADP --------------| | CHKSUM := CHKSUM - 1

| ;Decrement table by one bit

| ; (unsigned bin-8) and update

| ; checksum (unsigned word bin-0)

| LPCT1R := 0

| EGOCT11 := 0

| ;Reset rich loop counter and

| ; HEGO switch counter for bank 1

|

| --- ELSE ---

|

LPCT1R > 2 \* UPRATE ---------------------| LPCT1R := 0

| EGOCT11 := 0

| ;Reset rich loop counter and

| ; HEGO switch counter for bank 1

|

| --- ELSE ---

LPCT1L > 2 \* UPRATE ---------------| |

| |

LTMTB1[r,c] < MAXADP --------------|AND -| LTMTB1[r,c] := LTMTB1[r,c]

| | + 0.00390625

FN1325A[r,c] >= 0 -----------------| | CHKSUM := CHKSUM + 1

| ;Increment table by one bit

| ; (unsigned bin-8) and update

| ; checksum (unsigned word bin-0)

| LPCT1L := 0

| EGOCT11 := 0

| ;Reset lean loop counter and

| ; HEGO switch counter for bank 1

|

| --- ELSE ---

|

LPCT1L > 2 \* UPRATE ---------------------| LPCT1L := 0

| EGOCT11 := 0

| ;Reset lean loop counter and

| ; HEGO switch counter for bank 1

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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Determine if adaptive cells should be incremented/decremented, bank 2.

FN1325A[r,c] >= 0 -----------------|

|

LPCT2R > 2 \* UPRATE ---------------|

|AND -| LTMTB2[r,c] := LTMTB2[r,c]

LTMTB2[r,c] > MINADP --------------| | - 0.00390625

| | CHKSUM := CHKSUM - 1

NUMEGO = 2 ------------------------| | ;Decrement table by one bit

| ; (unsigned bin-8) and update

| ; checksum (unsigned word bin-0)

| LPCT2R := 0

| EGOCT21 := 0

| ;Reset rich loop counter and

| ; HEGO switch counter for bank 2

|

| --- ELSE ---

NUMEGO = 2 ------------------------| |

|AND -| LPCT2R := 0

LPCT2R > 2 \* UPRATE ---------------| | EGOCT21 := 0

| ;Reset rich loop counter and

| ; HEGO switch counter for bank 2

|

| --- ELSE ---

LPCT2L > 2 \* UPRATE ---------------| |

| |

LTMTB2[r,c] < MAXADP --------------| |

|AND -| LTMTB2[r,c] := LTMTB2[r,c]

FN1325A[r,c] >= 0 -----------------| | + 0.00390625

| | CHKSUM := CHKSUM + 1

NUMEGO = 2 ------------------------| | ;Decrement table by one bit

| ; (unsigned bin-8) and update

| ; checksum (unsigned word bin-0)

| LPCT2L := 0

| EGOCT21 := 0

| ;Reset lean loop counter and

| ; HEGO switch counter for bank 2

|

| --- ELSE ---

NUMEGO = 2 ------------------------| |

|AND -| LPCT2L := 0

LPCT2L > 2 \* UPRATE ---------------| | EGOCT21 := 0

| ;Reset lean loop counter and

| ; HEGO switch counter for bank 2

END: FADPT\_UPDATE\_TABLE

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

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BEGIN: FADPT\_EGO\_FAILURE\_RESET

Reset the adaptive fuel table in KAM due to EGO failure, as necessary.

Execute when called from ADAPTIVE\_FUEL\_CONTROL.

CHKSUM is the sum of all 86 bytes in both adaptive fuel tables, regardless of

the NUMEGO calibration. All table cells are treated as integer values when

computing this sum. This feature (table reset on HEGO failure) can be

disabled by setting KAM\_NO\_RESET.

EGO1FMFLG = 1 --------------------|

|AND -| LTMTB1[x,y] := 0.5

KAM\_NO\_RESET = 0 -----------------| | ;Reset entire table

| KWUCTR := 0

| CHKSUM := sum of all adaptive

fuel cells

NUMEGO = 2 ------------------------|

|

EGO2FMFLG = 1 ---------------------|AND -| LTMTB2[x,y] := 0.5

| | ;Reset entire table

KAM\_NO\_RESET = 0 ------------------| | KWUCTR := 0

| CHKSUM := sum of all adaptive

fuel cells

END: FADPT\_EGO\_FAILURE\_RESET

8-78

FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FADPT\_NEW\_UPRATE\_CALC

This algorithm calculates the average loop counter value to be used during

the adaptive algorithm. The standard four point interpolation routine is

used. If, however, one or more of the cells in the four points is a

reference cell, then the average of the values in the positive cells is used

in place of the negative values.

If the system is in the special idle cells, the UPRATE value is equal to the

value in FN1325A as specified by KAMCOL.

Note: kamrow\_max = maximum number of table rows (excluding the Special Idle

Cells row).

kamrow\_spec = row number for the Special Idle Adaptive Cells.

kamcol\_max = maximum number of table columns.

KAMROW = kamrow\_spec ------------| Read the value in FN1325A

| specified by KAMCOL.

| If negative, then use value from

| referenced cell of FN1325A

| Load this value in UPRATE.

|

| Exit: FADPT\_NEW\_UPRATE\_CALC

Separate KAMCOL and KAMROW into an integer and remainder.

Unconditionally -----------------| kamcol\_rem := KAMCOL - int(KAMCOL)

| kamcol := int(KAMCOL)

| kamrow\_rem := KAMROW - int(KAMROW)

| kamrow := int(KAMROW)

Check for row and column boundary conditions.

kamcol < kamcol\_max -------|

|AND -| adapt1\_uprat := FN1325A(kamcol,kamrow)

kamrow < kamrow\_max -------| | adapt2\_uprat := FN1325A(kamcol + 1,kamrow)

| adapt3\_uprat := FN1325A(kamcol,kamrow + 1)

| adapt4\_uprat :=

| FN1325A(kamcol + 1,kamrow + 1)

|

| --- ELSE ---

|

kamcol = kamcol\_max -------| |

|AND -| adapt1\_uprat := FN1325A(kamcol,kamrow)

kamrow = kamrow\_max -------| | adapt2\_uprat := adapt1\_uprat

| adapt3\_uprat := adapt1\_uprat

| adapt4\_uprat := adapt1\_uprat

| ;Use FN1325A 4 times so not to wrap

| ; around table or use special idle cells

|

| --- ELSE ---

(continued on next page)

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

kamcol = kamcol\_max -------------| adapt1\_uprat := FN1325A(kamcol,kamrow)

| adapt2\_uprat := adapt1\_uprat

| adapt3\_uprat := FN1325A(kamcol,kamrow + 1)

| adapt4\_uprat := adapt3\_uprat

| ;Use kamcol\_max values twice so not to

| ; wrap around table

|

| --- ELSE ---

|

kamrow = kamrow\_max -------------| adapt1\_uprat := FN1325A(kamcol,kamrow)

| adapt2\_uprat := FN1325A(kamcol + 1,kamrow)

| adapt3\_uprat := adapt1\_uprat

| adapt4\_uprat := adapt2\_uprat

| ;Use kamrow\_max values twice so not to

| ; wrap around table or use special

| ; idle cells

Unconditionally -----------------| uprat\_cnt := 0

Check for reference cells:

adapt1\_uprat >= 0 ---------------| uprat\_cnt := uprat\_cnt + 1

| adapt1\_uprat\_ref := 0

|

| --- ELSE ---

|

| adapt1\_uprat := 0

| adapt1\_uprat\_ref := 1

adapt2\_uprat >= 0 ---------------| uprat\_cnt := uprat\_cnt + 1

| adapt2\_uprat\_ref := 0

|

| --- ELSE ---

|

| adapt2\_uprat := 0

| adapt2\_uprat\_ref := 1

adapt3\_uprat >= 0 ---------------| uprat\_cnt := uprat\_cnt + 1

| adapt3\_uprat\_ref := 0

|

| --- ELSE ---

|

| adapt3\_uprat := 0

| adapt3\_uprat\_ref := 1

8-80

FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

adapt4\_uprat >= 0 ---------------| uprat\_cnt := uprat\_cnt + 1

| adapt4\_uprat\_ref := 0

|

| --- ELSE ---

|

| adapt4\_uprat := 0

| adapt4\_uprat\_ref := 1

If all cells are referenced cells, set UPRATE to a maximum value. Otherwise,

find UPRATE average.

uprat\_cnt = 0 -------------------| UPRATE := 127 (maximum value)

|

| --- ELSE ---

|

| uprate\_avg := (adapt1\_uprat +

| adapt2\_uprat + adapt3\_uprat +

| adapt4\_uprat) / uprat\_cnt

|

| Truncate UPRATE to an integer

adapt1\_uprat\_ref = 1 ------------| adapt1\_uprat := uprate\_avg

adapt2\_uprat\_ref = 1 ------------| adapt2\_uprat := uprate\_avg

adapt3\_uprat\_ref = 1 ------------| adapt3\_uprat := uprate\_avg

adapt4\_uprat\_ref = 1 ------------| adapt4\_uprat := uprate\_avg

Unconditionally -----------------| Do four point interpolation using the real

| numbers KAMROW and KAMCOL, and the four

| adaptn\_uprat values calculated above.

| Store this value in UPRATE.

END: FADPT\_NEW\_UPRATE\_CALC

8-81

FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FADPT\_UPDATE\_KAMRF

The adaptive fuel tables stored in KAM are used as a reference for both open

and closed loop fuel control. The method by which the adaptive fuel table is

referenced as shown below.

When four-point interpolation is used to retrieve the KAMRF1 and KAMRF2

values, the row and column numbers must be clipped to 7 and 9, respectively.

If the interpolation is to be based on a cell of row 7, the values from the

two cells of row 7 should be used again in place of (non-existent) row 8.

The same is true of column 9, where the two cell values of column 9 should be

used in place of column 10 in the interpolation equation. Finally, if the

base cell for interpolation is LTMTB1[7,9], no interpolation is necessary.

For purposes of interpolation, the LTMTBn 80 to LTMTBn 85 cells are not

included. These cells should correspond to the special idle cells.

Execute this routine when called from ADAPTIVE\_FUEL\_CONTROL.

FADPT\_SW = 0 ----------------|

|

CRKFLG = 1 ------------------|

;Crank mode |

|OR --| KAMRF1 := 1.0

LEGOFG11 = 1 ----| | | KAMRF2 := 1.0

|OR --| | | ;Use no interpolation

FFG\_CSD11 = 1 ---| | | |

|AND -| |

LEGOFG21 = 1 ----| | |

|OR --| |

FFG\_CSD21 = 1 ---| |

| --- ELSE ---

IDLE\_CELL\_SW = 1 ------------| |

;Idle cells enabled | |

| |

ISCFLG = 1 ------------------|AND -| KAMRF1 := 0.5 + LTMTB1[8,ISFLAG]

| | KAMRF2 := 0.5 + LTMTB2[8,ISFLAG]

HCAMFG = 0 ------------| | | ;Use no interpolation

;No RPM adder |OR --| |

| |

HCAMSW = 0 ------------| |

;Ignore HCAMFG |

| --- ELSE ---

|

| r := KAMROW; c := KAMCOL

| KAMRF1 := 0.5 + LTMTB1[r,c]

| KAMRF2 := 0.5 + LTMTB2[r,c]

| ;Use 4 point interpolation, and use

| ; reference cells when FN1325A is

| ; negative

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FUEL STRATEGY, ADAPTIVE FUEL CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Lack of HEGO switching affect on KAMRF1/2. If there is only one HEGO bank,

KAMRF2 will follow KAMRF1. If either HEGO stops switching, the KAMRF value

from the other bank will be used.

LEGOFG21 = 1 ----------------|

|

FFG\_CSD21 = 1 ---------------|OR --| KAMRF2 := KAMRF1

| |

NUMEGO = 1 ------------------| |

| --- ELSE ---

|

LEGOFG11 = 1 ----------------| |

|OR --| KAMRF1 := KAMRF2

FFG\_CSD11 = 1 ---------------|

END: FADPT\_UPDATE\_KAMRF

BEGIN: FADPT\_PID\_DEFINITIONS

Update the LONG TRIM 1 and LONG TRIM 2 diagnostic parameters.

Unconditionally ------------------------| long\_trim\_1 := 128 \* KAMRF1

| long\_trim\_2 := 128 \* KAMRF2

pid\_def(j1979\_01\_07, long\_trim\_1 )

pid\_def(j1979\_01\_09, long\_trim\_2 )

END: FADPT\_PID\_DEFINITIONS

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FUEL STRATEGY, ADAPTIVE FUEL ENABLE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.12.2 ADAPTIVE FUEL ENABLE LOGIC (CDAN0)

OVERVIEW

The Adaptive Fuel feature is intended to compensate for variability in fuel

system components. This is achieved by allowing the system to learn fuel

system errors, and then to apply this information directly to the fuel

pulsewidth calculated from the desired fuel/air ratio. This learned error is

retained in keep-alive memory, and is stored in the form of either a

speed-load table, or single air mass column. There is one table for each

engine bank (if NUMEGO = 2).

This module controls the FADPT\_ENABLE flag. When set, the adaptive fuel

control system will be allowed to learn fuel system errors. When cleared,

the learning mechanism is disabled. In either case, the compensation factor

retrieved from the table will be used in the fuel pulsewidth calculation.

A secondary flag, FADPT\_READY, is used for handshaking with the purge system.

This flag indicates that all enable conditions have been met, and adaptive

learning will proceed as soon as PCOMP is fully disabled.

CALIBRATION NOTES

To completely disable the Adaptive Fuel Control and OBD-II Fuel System

Monitor features, set the calibration switch FADPT\_SW to 0. This will force

KAMRF1 and KAMRF2 to 1.0, disable all table updates, and disable the Fuel

System Monitor.

To disable only the table update portion of the adaptive fuel feature, use

values of AFECT1 and AFECT2 such that AFECT1 > AFECT2. This will also

require a non-zero value of ADAPTM. In this case, existing data in the

adaptive fuel tables will be used to calculate KAMRF1 and KAMRF2, but table

updates and the Fuel System Monitor will be disabled.

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FUEL STRATEGY, ADAPTIVE FUEL ENABLE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- ACT = Air charge temperature, degrees F.

- ADPTMR = Adaptive learning enable timer.

- ECT = Engine coolant temperature, degrees F.

- EFTR = Equilibrium fuel transfer rate.

- LOAD = Universal normalized load parameter.

- TP\_REL = Relative throttle position, counts.

- PG\_DC = Purge valve duty cycle, % on.

Bit Flags:

- ADPTMR\_FLG = Adaptive Fuel Time Flag.

- AFMFLG = ACT Failure Mode (FMEM) flag.

- CFMFLG = ECT FMEM flag.

- FADPT\_ENABLE = Flag to indicate enable state of Adaptive Fuel Strategy.

- FADPT\_READY = Flag indicating that the conditions to enable adaptive

learning have been satisfied. Adaptive fuel will be enabled as soon a

PCOMP is disabled.

- LAM\_MOD\_FLG = Flag used to initiate high frequency fuel modulation for

the upstream EGO monitor.

- OLFLG = Open loop fuel flag; 1-> open loop fuel, 0-> closed loop fuel.

- MAF\_INTP\_FLG = Flag indicating that the MAF sensor signal is unreliable;

0 -> MAF signal OK, 1 -> MAF signal unreliable.

- MFMFLG = MAP/MAF FMEM flag.

- PCOMP\_ENA = PCOMP strategy enabled flag; 1 -> PCOMP is enabled (adaptive

fuel disabled).

- TFMFLG = TP FMEM flag.

- UNDSP = Underspeed flag; 1 -> Underspeed mode or Crank.

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FUEL STRATEGY, ADAPTIVE FUEL ENABLE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- ADAPTM = Adaptive learning enable time delay, seconds.

- ADEFTR = Transient fuel threshold to update adaptive fuel.

- ADPLOD = Minimum allowable load to enable adaptive learning.

- ADPTP = Maximum allowable TP\_REL to enable adaptive fuel.

- AFACT1 = Minimum ACT to Update Adaptive Fuel Table degrees F.

- AFACT2 = Maximum ACT to update Adaptive Fuel Table, degrees F.

- AFECT1 = Minimum ECT for starting the Adaptive Fuel timer, degrees F.

- AFECT2 = Over-temperature ECT to zero the adaptive fuel timer.

- FADPT\_SW = Switch allowing the complete disablement of adaptive fuel and

the fuel system monitor. FADPT\_SW = 0 -> disable all adaptive fuel

activity.

- PCOMP\_SW = PCOMP strategy select switch; 1 -> execute PCOMP strategy.

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FUEL STRATEGY, ADAPTIVE FUEL ENABLE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FADPT\_UPDATE\_STATUS\_COM1

BEGIN: FADPT\_UPDATE\_STATUS

Module to control the state of the Adaptive Fuel Control status flags.

Execute once per background pass.

The ADPTMR timer allows Adaptive Fuel to be enabled if the engine is in run

mode and the inferred engine temperature is within a certain band. Since the

engine temperature is inferred here from the Engine Coolant Temperature

sensor, an ECT sensor failure will reset this timer. This way, if the ADPTMR

feature is disabled in the calibration (i.e., ADAPTM = 0), an ECT sensor

failure will not inhibit adaptive learning.

ADPTMR is an actuated timer, which counts up whenever ADPTMR\_FLG is set.

UNDSP = 0 ------------------------|

;In run mode |

|

AFECT1 <= ECT <= AFECT2 ----------|AND -| COUNT UP ADPTMR

;Reasonable engine temperature | | ADPTMR\_FLG := 1

| |

CFMFLG = 0 -----------------------| |

;Failed ECT sensor |

|

| --- ELSE ---

|

| ADPTMR := 0

| ADPTMR\_FLG := 0

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FUEL STRATEGY, ADAPTIVE FUEL ENABLE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Check Adaptive Fuel Control enable conditions. The FADPT\_READY flag

indicates that learning can continue as soon as PCOMP is fully disabled.

This flag is used for handshaking with the Purge Compensation feature.

FADPT\_SW = 0 ---------------------|

;Adaptive Fuel feature disabled |

|

LAM\_MOD\_FLG = 1 ------------------|

;HEGO monitor in progress |

|

OLFLG = 1 ------------------------|OR --| FADPT\_READY := 0

;Open loop fuel control | | ;Adaptive system not ready to

| | ; learn

|EFTR| > ADEFTR ------------------| |

;High transient fuel value | |

| |

ACT <= AFACT1 --------------------| |

| |

ACT >= AFACT2 --------------------| |

;Extreme ambient temperature | |

| |

AFMFLG = 1 -----------------------| |

;Failed ACT sensor | |

| |

ADPTMR < ADAPTM ------------------| |

;Stable engine temperature | |

| |

TP\_REL > ADPTP -------------------| |

;High TP value | |

| |

TFMFLG = 1 -----------------------| |

;Failed throttle position sensor | |

| |

LOAD < ADPLOD --------------------| |

;Low LOAD value | |

| |

MFMFLG = 1 -----------------------| |

;MAF sensor failed | |

| |

MAF\_INTP\_FLG = 1 -----------------| |

;MAF sensor unreliable | --- ELSE ---

|

| FADPT\_READY := 1

| ;Adaptive learning conditions

| ; are satisfied

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FUEL STRATEGY, ADAPTIVE FUEL ENABLE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Enable Adaptive Fuel Control learning, provided all enable conditions are are

met, and the Purge Compensation feature is fully disabled.

FADPT\_READY = 1 ------------------|

|

PCOMP\_ENA = 0 --------| |AND -| FADPT\_ENABLE := 1

|AND -| | |

PG\_DC = 0 ------------| |OR --| |

| |

PCOMP\_SW = 0 ---------------| |

| --- ELSE ---

|

| FADPT\_ENABLE := 0

END: FADPT\_UPDATE\_STATUS

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FUEL STRATEGY, FUEL SYSTEM MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.12.3 FUEL SYSTEM MONITOR (CDAM0)

OVERVIEW

As fuel control system components parameters change from nominal with time

the adaptive fuel table contents will reflect the change. As the parameters

continue to change the adaptive table will reach the adaptive tables clip.

This means that the adaptive table cannot compensate for any additional

changes in fuel control component parameters. Further change in the fuel

control system components parameters will cause LAMBSEn switch point to move

toward its clips. As this trend continues the ability of the fuel control

system to control fuel will cease.

The adaptive fuel monitor test examines KAM\_BARn and LAM\_BARn (i.e., filtered

values of LAMBSEn and KAMRFn, respectively). When KAM\_BARn indicates that

KAMRFn is near its limit and LAM\_BARn indicates that LAMBSEn is about to lose

its ability to control the fuel, the test will indicate a fuel control

failure. The criteria for failure detection is shown below.

XXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXX

XXXXXXXXXXXXXXXXXXXXXX XXXX KAM\_BARn XXXX

XXXX LAM\_BARn XXXX XXXXXXXXXXXXXXXXXXXXXX

- -XXXXXXXXXXXXXXXXXXXXXX - - - - - - - - - - - - - - - - - - V\_KAMBAR\_MAX

XXXXXXXXXXXXXXXXXXXXXX

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - V\_LAMBAR\_MAX

------------------------------------------------------------- 1.0

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - V\_LAMBAR\_MIN

XXXXXXXXXXXXXXXXXXXXXX

- - - - - - - - - - - - - - - - - - XXXXXXXXXXXXXXXXXXXXXX- - V\_KAMBAR\_MIN

XXXXXXXXXXXXXXXXXXXXXX XXXX LAM\_BARn XXXX

XXXX KAM\_BARn XXXX XXXXXXXXXXXXXXXXXXXXXX

XXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXX

RICH ENGINE FAILURE LEAN ENGINE FAILURE

This module will also control the two adaptive fuel failure mode flags, one

for each adaptive table in a two HEGO control system (ADT1FMFLG, ADT2FMFLG).

These indicate a general fuel system failure on the corresponding HEGO bank.

FMEM flags indicating failed LAMBSE1 or LAMBSE2 are also maintained by this

module.

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FUEL STRATEGY, FUEL SYSTEM MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- AM = Mass air flow bin 10.

- FADPT\_LEAN11 = Flag indicating a lean fuel system error on bank 1.

- FADPT\_LEAN21 = Flag indicating a lean fuel system error on bank 2.

- FADPT\_RICH11 = Flag indicating a rich fuel system error on bank 1.

- FADPT\_RICH21 = Flag indicating a rich fuel system error on bank 2.

- KAM\_MON\_TMR = Adaptive cell residency timer (required for monitoring).

- KAMRF1 = Total learned fuel system correction (from HEGO11).

- KAMRF2 = Total learned fuel system correction (from HEGO21).

- KAM\_BAR1 = Average KAMRF1, used both to filter codes and to determine

exit conditions for adaptive fuel (see PCOMP Enable logic).

- KAM\_BAR2 = Average KAMRF2, used both to filter codes and to determine

exit conditions for adaptive fuel (see PCOMP Enable logic).

- LAM\_BAR1 = Average LAMBSE1, used both to filter codes and to determine

exit conditions for adaptive fuel (see PCOMP Enable logic).

- LAM\_BAR2 = Average LAMBSE2, used both to filter codes and to determine

exit conditions for adaptive fuel (see PCOMP Enable logic).

- LAMBSE1 = Lambda equivalence ratio (EGO-1).

- LAMBSE2 = Lambda equivalence ratio (EGO-2).

- LOAD = Universal normalized load parameter.

- N = Engine speed, RPM.

Bit Flags:

- ADT1FMFLG = Adaptive table 1 failure mode.

- ADT2FMFLG = Adaptive table 2 failure mode.

- FADPT\_ENABLE = Flag indicating enable state of adaptive fuel strategy.

- FFG\_LAMBSE1 = OBD-II system FMEM flag for LAMBSE1; 1 = LAMBSE1 is not

currently reliable.

- FFG\_LAMBSE2 = OBD-II system FMEM flag for LAMBSE2; 1 = LAMBSE2 is not

currently reliable.

- FUEL\_ENA\_OLD = previous background value of FUEL\_TST\_ENA.

- FUEL\_MON = Completion flag for fuel monitor; 1 -> all fuel faults have

been monitored at least once since power-up.

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FUEL STRATEGY, FUEL SYSTEM MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FUEL\_TST\_ENA = Fuel monitor enable flag; 1 -> testing enabled.

- FUEL\_TST\_RDY = Fuel monitor ready flag; 1 -> all entry conditions have

been met; ready to run fuel monitor.

- KAM\_ERROR = Flag indicating KAM failure or uninitialized KAM. Set and

cleared by the KAM Qualification strategy module.

- OBDII\_RESET = Flag which represents the receipt of an OBD-II scan tool

reset message.

- PxxxMALF = Malfunction flag for fault XXX; 1 -> malfunction.

- SWTFL11 = Bank 1 upstream HEGO switch flag.

- SWTFL21 = Bank 2 upstream HEGO switch flag.

Calibration Constants:

- ADAPT\_SEL = 0 -> use load, 1 -> use AM.

- CADP\_RES\_TM = Adaptive cell residency timer threshold.

- KAM\_BAR\_FK = Filter constant for calculating filtered values KAM\_BAR1 and

KAM\_BAR2.

- LAM\_BAR\_FK = Filter constant for LAM\_BAR1 and LAM\_BAR2.

- NUMEGO = Number of HEGO sensors.

- V\_ADPAM\_MAX = Maximum AM to perform adaptive fuel monitor test.

- V\_ADPAM\_MIN = Minimum AM to perform adaptive fuel monitor test.

- V\_ADPLD\_MAX = Maximum LOAD to perform adaptive fuel monitor test.

- V\_ADPLD\_MIN = Minimum LOAD to perform adaptive fuel monitor test.

- V\_ADPN\_MAX = Maximum N to perform adaptive fuel monitor test.

- V\_ADPN\_MIN = Minimum N to perform adaptive fuel monitor test.

- V\_KAMBAR\_MIN = Lower limit of filtered KAMRF, below which a rich fuel

system fault will be indicated.

- V\_KAMBAR\_MAX = Upper limit of filtered KAMRF, above which a lean fuel

system fault will be indicated.

- V\_LAMBAR\_MIN = Lower limit of filtered LAMBSE, below which a lean fuel

system fault will be indicated.

- V\_LAMBAR\_MAX = Upper limit of filtered LAMBSE, above which a rich fuel

system fault will be indicated.

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FUEL STRATEGY, FUEL SYSTEM MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OTHER

- fuel\_codes = SET OF {P0171,P0172,P0174,P0175}. The set of OBD-II fault

codes that relate to the fuel monitor.

- malfunction(fuel,PXXX) = Public procedure updating the MIL control status

provided by the MIL control module.

- P0171 = lean clipped value from HEGO11 adaptive fuel table was used.

- P0172 = rich clipped value from HEGO11 adaptive fuel table was used.

- P0174 = lean clipped value from HEGO21 adaptive fuel table was used.

- P0175 = rich clipped value from HEGO21 adaptive fuel table was used.

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FUEL STRATEGY, FUEL SYSTEM MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FADPT\_FUEL\_MONITOR\_COM1

BEGIN: FADPT\_FUEL\_MONITOR

Reset KAM memory locations and all filters used in fault determination, This

must occur upon detection of a KAM error or during an OBD-II system reset (as

requested by the OBD-II Executive).

It is not necessary to clear malfunctions at this time, as the OBD-II

Executive will clear all codes in this case.

KAM\_ERROR = 1 --------------|

|OR --| KAM\_BAR1 := 1.0

OBDII\_RESET = 1 ------------| | KAM\_BAR2 := 1.0

| LAM\_BAR1 := 1.0

| LAM\_BAR2 := 1.0

| Do: FADPT\_FM\_FAULT\_CLEAR

If the Fuel System Monitor entry conditions are satisfied, perform the

necessary filtering and check for a fuel system failure.

Unconditionally ------------------| Do: FADPT\_FM\_READY\_CHK

| Do: FADPT\_FM\_FAULT\_CHK

| Do: FADPT\_FMEM\_CHECK

END: FADPT\_FUEL\_MONITOR

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FUEL STRATEGY, FUEL SYSTEM MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FADPT\_FM\_READY\_CHK

Information for control of fuel ready flag based on transition of the OBD-II

executive Fuel System Monitor enable flag. This logic is used to hold the

FUEL\_TST\_RDY flag at zero for the first background pass after the monitor is

disabled. After one background pass with FUEL\_TST\_RDY held low, this flag

will again reflect the state of the Fuel Monitor entry conditions. The

FUEL\_TST\_RDY flag is used in the handshake with the OBD-II Executive.

FUEL\_TST\_ENA = 0 -----------------|

;Current ena state |AND -| ena\_transition\_to\_off := 1

| | ;Enable transition to off

FUEL\_ENA\_OLD = 1 -----------------| | ;has occurred

;Previous ena state | FUEL\_ENA\_OLD := FUEL\_TST\_ENA

|

| --- ELSE ---

|

| ena\_transition\_to\_off := 0

| ;no on to transition off

| ;transition this time

| FUEL\_ENA\_OLD := FUEL\_TST\_ENA

ADAPT\_SEL = 0 --------|

;Table adaptive |

|

LOAD >= V\_ADPLD\_MIN --|AND -|

;Min load to test | |

| |

LOAD <= V\_ADPLD\_MAX --| |

;Max load to test |OR --|

| |

ADAPT\_SEL = 1 --------| | |

;Column adaptive | | |

| | |

AM >= V\_ADPAM\_MIN ----|AND -| |

;Min AM to test | |

| |

AM <= V\_ADPAM\_MAX ----| |

;Max AM to test |AND -| FUEL\_TST\_RDY := 1

| |

N <= V\_ADPN\_MAX ------------------| |

;Max RPM to test | |

| |

N >= V\_ADPN\_MIN ------------------| |

;Min RPM to test | |

| |

ena\_transition\_to\_off = 0 --------| |

;No ena trans to off | |

| |

FADPT\_ENABLE = 1 -----------------| |

;Adaptive enabled |

| --- ELSE ---

|

| FUEL\_TST\_RDY := 0

| KAM\_MON\_TMR := 0

END: FADPT\_FM\_READY\_CHK

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FUEL STRATEGY, FUEL SYSTEM MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FADPT\_FM\_FAULT\_CHK

Calculate of stable average LAMBSE and KAMRF values for banks 1 and 2. These

are used in the Fuel System Monitor as a failure criteria.

FADPT\_ENABLE = 1 --------|

|AND -| LAM\_BAR1 := ROLAV\_FK(LAMBSE1,LAM\_BAR\_FK)

SWTFL11 = 1 -------------| | ;Filter constant rolling average of

| ; LAMBSE1 at the time of the EGO11 switch

| KAM\_BAR1 := ROLAV\_FK(KAMRF1,KAM\_BAR\_FK)

| ;Filter constant rolling average of KAMRF1

NUMEGO = 2 --------------|

|

FADPT\_ENABLE = 1 --------|AND -| LAM\_BAR2 := ROLAV\_FK(LAMBSE2,LAM\_BAR\_FK)

| | ;Filter constant rolling average of

SWTFL21 = 1 -------------| | ; LAMBSE2 at the time of the EGO21 switch

| KAM\_BAR2 := ROLAV\_FK(KAMRF2,KAM\_BAR\_FK)

| ;Filter constant rolling average of KAMRF2

If the Fuel Monitor is enabled by the OBD-II Executive (FUEL\_TST\_ENA), and

the entry conditions are satisfied (FUEL\_TST\_RDY), then check for fuel system

failure on each applicable HEGO bank. Clear all faults when the test is

disabled by the OBD-II Executive. The flag FUEL\_MON indicates to the OBD-II

Executive that the fuel monitor has executed.

FUEL\_TST\_ENA = 1 -----------------|

;OBD-II enable flag which |

; enables this test |AND -| Do: FADPT\_FM\_TEST\_EGO11\_KAM

| | Do: FADPT\_FM\_TEST\_EGO21\_KAM

FUEL\_TST\_RDY = 1 -----------------| | FUEL\_MON := 1

;Entry conditions satisfied |

| --- ELSE ---

|

FUEL\_TST\_ENA = 0 -----------------------| Do: FADPT\_FM\_FAULT\_CLEAR

;Executive is disabling this monitor

END: FADPT\_FM\_FAULT\_CHK

8-96

FUEL STRATEGY, FUEL SYSTEM MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FADPT\_FM\_TEST\_EGO11\_KAM

Check for a rich or lean fault on HEGO bank 1. Hysteresis is provided by the

KAM\_MON\_TMR timer, which is controled in the base Adaptive Fuel Control

strategy module.

KAM\_BAR1 <= V\_KAMBAR\_MIN ---------|

|AND -| FADPT\_RICH11 := 1

LAM\_BAR1 >= V\_LAMBAR\_MAX ---------| | FADPT\_LEAN11 := 0

| Do: malfunction(fuel,P0172)

| ;Rich failure detected

|

| --- ELSE ---

KAM\_BAR1 >= V\_KAMBAR\_MAX ---------| |

|AND -| FADPT\_LEAN11 := 1

LAM\_BAR1 <= V\_LAMBAR\_MIN ---------| | FADPT\_RICH11 := 0

| Do: malfunction(fuel,P0171)

| ;Lean failure detected

|

| --- ELSE ---

|

KAM\_MON\_TMR > CADP\_RES\_TM --------------| FADPT\_RICH11 := 0

| FADPT\_LEAN11 := 0

| ;No HEGO11 adaptive table

| ;failures this pass

| Do: check\_fuel\_conds(P0171)

| Do: clear\_malf(P0171)

| Do: check\_fuel\_conds(P0172)

| Do: clear\_malf(P0172)

END: FADPT\_FM\_TEST\_EGO11\_KAM

8-97

FUEL STRATEGY, FUEL SYSTEM MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FADPT\_FM\_TEST\_EGO21\_KAM

Check for a rich or lean fault on HEGO bank 2, if necessary. Hysteresis is

provided by the KAM\_MON\_TMR timer, which is controled in the base Adaptive

Fuel Control strategy module.

NUMEGO = 1 -----------------------------| FADPT\_RICH21 := 0

| FADPT\_LEAN21 := 0

|

| --- ELSE ---

KAM\_BAR2 <= V\_KAMBAR\_MIN ---------| |

|AND -| FADPT\_RICH21 := 1

LAM\_BAR2 >= V\_LAMBAR\_MAX ---------| | FADPT\_LEAN21 := 0

| Do: malfunction(fuel,P0175)

| ;Rich failure detected

|

| --- ELSE ---

KAM\_BAR2 >= V\_KAMBAR\_MAX ---------| |

|AND -| FADPT\_LEAN21 := 1

LAM\_BAR2 <= V\_LAMBAR\_MIN ---------| | FADPT\_RICH21 := 0

| Do: malfunction(fuel,P0174)

| ;Lean failure detected

|

| --- ELSE ---

|

KAM\_MON\_TMR > CADP\_RES\_TM --------------| FADPT\_RICH21 := 0

| FADPT\_LEAN21 := 0

| ;No HEGO11 adaptive table

| ;failures this pass

| Do: check\_fuel\_conds(P0174)

| Do: clear\_malf(P0174)

| Do: check\_fuel\_conds(P0175)

| Do: clear\_malf(P0175)

END: FADPT\_FM\_TEST\_EGO21\_KAM

8-98

FUEL STRATEGY, FUEL SYSTEM MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FADPT\_FMEM\_CHECK

This procedure sets and clears two sets of adaptive fuel failure mode flags,

one set for each HEGO bank. The FFG\_LAMBSEn flags indicate that the LAMBSE

parameter for that bank is not in control. The ADTnFMFLG indicate a general

fuel system error on the bank.

FADPT\_LEAN11 = 1 -----------------|

|OR --| ADT1FMFLG := 1

FADPT\_RICH11 = 1 -----------------| | FFG\_LAMBSE1 := 1

|

| --- ELSE ---

|

| ADT1FMFLG := 0

| FFG\_LAMBSE1 := 0

FADPT\_LEAN21 = 1 -----------------|

|OR --| ADT2FMFLG := 1

FADPT\_RICH21 = 1 -----------------| | FFG\_LAMBSE2 := 1

|

| --- ELSE ---

|

| ADT2FMFLG := 0

| FFG\_LAMBSE2 := 0

END: FADPT\_FMEM\_CHECK

BEGIN: FADPT\_FM\_FAULT\_CLEAR

Unconditionally ------------------------| FADPT\_LEAN11 := 0

| FADPT\_RICH11 := 0

| FADPT\_LEAN21 := 0

| FADPT\_RICH21 := 0

END: FADPT\_FM\_FAULT\_CLEAR

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FUEL STRATEGY, FUEL SYSTEM MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.13 FEATURE: TRANSIENT FUEL - V1.1\_FTRAN\_TRANSIENT\_FUEL (CDAM0)

8.13.1 BACKGROUND TRANSIENT FUEL LOGIC (CDAM0)

OVERVIEW

Background:

A liquid fuel film resides on the walls of the intake manifold. The film

mass varies primarily with manifold absolute pressure and manifold wall

temperature. During steady state conditions, the film mass is constant. The

rates of condensation and evaporation on the manifold walls are equal.

During transients, the film mass changes creating air/fuel ratio errors.

. During accelerations, the film mass increases. Fuel will condense faster

on the manifold walls until equilibrium is reached. In an uncompensated

system at stoichiometry, fuel is diverted from the cylinders, resulting

in a momentary lean condition.

. During decelerations, the film mass decreases. Fuel will evaporate

faster from the manifold walls until equilibrium is reached. In an

uncompensated system at stoichiometry, fuel is added to the cylinders,

resulting in a momentary rich condition.

The problem is magnified in closed loop fuel systems because the fuel control

will incorrectly chase the transient air/fuel excursions.

Intent:

The Transient Fuel Compensation Strategy (TFC) augments the closed/open loop

fuel control to keep cylinder events at the desired air/fuel ratio during all

engine transients. The goals are:

. To eliminate lean air/fuel excursions during accelerations.

. To eliminate rich air/fuel excursions during decelerations.

8-100

FUEL STRATEGY, BACKGROUND TRANSIENT FUEL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Approach:

. The film mass rate of change is proportional to the amount of fuel that

must be added to or subtracted from the manifold film.

/ \

FILM MASS 1 | STEADY ACTUAL |

RATE OF = --------------- \* | STATE - |

CHANGE TIME CONSTANT | FILM MASS FILM MASS |

\ /

EFTR = (EISF\_FG - AISF)/EFTC

WHERE:

EISF\_FG = FN1321(ECT,LOAD) \* FN313(N) \* MTEISF + (foreground correction)

EFTC = FN1322DL(ECT,LOAD) \* MTEFTC (during decels)

-- or --

= FN1322AL(ECT,LOAD) \* MTEFTC (during accels)

. Steady state film mass is calculated from LOAD (+ forground correction)

and ECT and must be calibrated for different applications.

. The actual film mass is a time integration of the film mass rate of

change.

/ \

ACTUAL ACTUAL | FILM MASS TIME SINCE |

FILM = FILM + | RATE OF \* LAST |

MASS MASS | CHANGE UPDATE |

\ /

AISF = AISF + (EFTR \* DT12S \* T\_TO\_S)

. The computer adjusts fuel flow to match the transient fuel flow to or

from the manifold fuel film.

COMPENSATED CLOSED/OPEN LOOP FILM MASS RATE OF CHANGE

FUEL FLOW = FUEL FLOW + OR FUEL FLOW

(ACTUAL) (BASE STRATEGY) (TFC STRATEGY)

Please Note: To deliver increased transient fuel resolution this

strategy now uses a double word specification on AISF, EISF, EFTR and

TFC\_HR. This is contained within two parameters identifying the upper

and lower words, ie (EISFU, EISFLO). Unique parameter names are required

for each word to enable monitoring via the RCON.

The RCON can only display 16 bit (word) length registers, it is

considered necessary, for transient fuel control, that both the upper and

lower words are availible for in-vehicle development.

8-101

FUEL STRATEGY, BACKGROUND TRANSIENT FUEL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- AISFLO = Actual Intake Surface Fuel, (Lower word).

- AISFU = Actual Intake Surface Fuel, (Upper word).

- ATMR1 = Time since exiting Crank Mode, secs.

- CYL\_AIR\_CHG = Current cylinder aircharge to be used in the fuel

calculation, lbm.

- DSDRPM = Idle speed control desired RPM.

- DT12S = The period of time between two adjacent rising edges of PIP,

ticks/pip.

- EFTCA = Time constant for transient fuel - ACCEL., sec.

- EFTCD = Time constant for transient fuel - DECEL., sec.

- EFTR = Equilibrium Fuel Transfer Rate during the previous program pass.

lbm/sec.

- EISFU = Background based steady state fuel film mass,(Upper word) - Lb.

- EISFLO = Background based steady state fuel film mass,(Lower word) - Lb.

- EISF\_FGU = Foreground based steady state fuel film mass, (Upper word) -

Lb.

- EISF\_FGL = Foreground based steady state fuel film mass, (Lower word) -

Lb.

- EFTC = Time Constant for transient fuel, sec.

- ISCFLG = ISC Mode Flag; 1 -> rpm control mode.

- LOAD = Universal load as ratio of aircharge over standard.

- N = RPM.

- TFC\_HR = Fuel mass per injection from transient fuel compensation,

lbs/cylinder.

- TFC\_MULTA = Transient fuel multiplier - ACCEL.

- TFC\_MULTD = Transient fuel multiplier - DECEL.

- TFC\_CHG = Aircharge that transient fuel (background) was evaluated at,

Lb.

- TFC\_SLOPE = Change in the transient fuel puddle mass per change in

aircharge.

- TFC\_TMR = Transient fuel timer, secs.

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FUEL STRATEGY, BACKGROUND TRANSIENT FUEL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- CRKFLG = Flag indicating engine mode; 1 -> engine Cranking, 0 -> engine

not Cranking.

- DFSFLG = Indicates Decel Fuel Shutoff.

- EFFLG1 = Equilibrium Fuel Flag. This flag controls the initialization of

AISF.

- TFC\_FG\_EN = Foreground TFC\_HR calculation enable flag; 1 -> calculate

TFC\_HR, 0 -> don't calculate TFC\_HR.

- UNDSP = 1 -> engine in UNDERSPEED or CRANK, 0 -> engine not in UNDERSPEED

or CRANK.

Calibration Constants:

- AISFM = Multiplier on AISF when in DFSO. Determines Fuel Puddle size

upon re-entering normal fuel.

- FN018 = ATMR1 normaling function for valve temp. compensator tables.

- FN022C = ECT normalizing function for transient fuel tables.

- FN071L = LOAD Normalizing function; used for table lookup.

- FN312S(ECT) = Change in the transient fuel puddle mass per change in

aircharge.

- FN313(N) = Equilibrium intake surface fuel engine speed multiplier,

unitless.

- FN1323A = Transient fuel accel time since start multiplier, unitless.

This empirical table compensates for intake valve temperatures during

warm-up. X = FN022C(ECT) Y = FN018(ATMR1)

- FN1323D = Transient fuel decel time since start multiplier, unitless.

This empirical table compensates for intake valve temperatures during

warm-up. X = FN022C(ECT) Y = FN018(ATMR1)

- FN1321 = Equilibrium Intake Surface Fuel Table.

X = FN022C(ECT)

Y = FN071L(LOAD)

- FN1322AL = Transient fuel time constant for accels.

X = FN022C(ECT)

Y = FN071L(LOAD)

- FN1322DL = Transient fuel time constant for decels.

X = FN022C(ECT)

Y = FN071L(LOAD)

- MTEFTC = Equilibrium Fuel transfer constant multiplier.

- MTEISF = Equilibrium intake surface fuel multiplier.

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FUEL STRATEGY, BACKGROUND TRANSIENT FUEL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SARCHG = Standard Air Charge, lbm/Intake = 4.4256 \* 10E-5 \* (Engine size

in cubic inches / number of cylinders).

- TFC\_IDLE\_OFF = Calibration switch which disables use of transient fuel at

idle; 1 -> no TFC at idle, 0 -> TFC at idle.

- TFCISW = Transient fuel compensation initialization switch.

- TFCTM = Time delay after start before enabling Transient Fuel

compensation.

- TFC\_MIN = The minimum compensation clip.

- TFSMN = Maximum rpm deadband above Idle rpm to disable Transient Fuel

during Dashpot Mode, rpm.

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FUEL STRATEGY, BACKGROUND TRANSIENT FUEL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FTRAN\_XTMODEL\_BG

TRANSIENT FUEL COMPENSATION BACKGROUND CALCULATIONS

The Transient Fuel Compensation (TFC) background calculations are performed

during each program pass (background loop), except that none of the TFC

background calculations are performed during Engine Running (ER) On-Demand

Self Test.

BEGIN: tfc\_bg\_stage1\_calculations

; Calculate (EISFU,EISFLO), the Equilibrium Intake Surface Fuel,

; to be used in the foreground TFC calculations if conditions permit.

; LOAD is recalculated here with the updated value for CYL\_AIR\_CHG.

; TFC\_CHG is stored for use in the delta aircharge calculation in the

; foreground.

; This routine is not executed during Engine Running (ER) On-Demand

; VIP Self Test.

UNDSP = 0 ------------------------------| Increment TFC\_TMR

;in run mode. | ;clips at 255.

|

| --- ELSE ---

|

| TFC\_TMR := 0

TFC\_TMR < TFCTM ------------------------| EFFLG1 := 0

;make sure manifold emptying is over. | TFC\_HR := 0

| TFC\_FG\_EN := 0

| EXIT this process.

|

| ;Do not perform transient

| ;fuel compensation.

|

| --- ELSE ---

|

| LOAD := CYL\_AIR\_CHG / SARCHG

| ;update load value.

|

| Do: tfc\_bg\_stage2\_calculations

END: tfc\_bg\_stage1\_calculations

8-105

FUEL STRATEGY, BACKGROUND TRANSIENT FUEL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: tfc\_bg\_stage2\_calculations

;This routine is executed ONLY when it is invoked from within the

;tfc\_bg\_stage1\_calculations routine. Please note: order of

;execution in the action blocks is most critical.

EFFLG1 = 0 -----------------------|

|AND -| EFFLG1 := 1

TFCISW = 1 -----------------------| | (AISFU,AISFLO) := FN1321(ECT,LOAD)

| \* FN313(N) \* MTEISF

| (EISFU,EISFLO) := (AISFU,AISFLO)

| TFC\_HR := 0

| TFC\_FG\_EN := 0

|

| (The FN1321 look-up routine MUST

| return a 16 bit result from the

| table interpolation algorithm,

| NOT the standard 8 bit result!)

|

| --- ELSE ---

EFFLG1 = 0 -----------------------| |

|AND -| EFFLG1 := 1

TFCISW = 0 -----------------------| | (AISFU,AISFLO) := 0

;assume dry manifold at startup | TFC\_HR := 0

| TFC\_FG\_EN := 0

|

| --- ELSE ---

|

DFSFLG = 1 -----------------------------| (AISFU,AISFLO) := (EISFU,EISFLO)

| \* AISFM

;in DFSO | TFC\_HR := 0

| Do: tfc\_bg\_stage3\_calculations

| TFC\_FG\_EN := 0

|

| --- ELSE ---

TFC\_IDLE\_OFF = 1 -----------| |

|AND -| |

ISCFLG > 0 -----------------| | |

;rpm control or lockout |OR --| (AISFU,AISFLO) := (EISFU,EISFLO)

| | TFC\_HR := 0

ISCFLG = -1 ----------------| | | Do: tfc\_bg\_stage3\_calculations

|AND -| | TFC\_FG\_EN := 0

N - DSDRPM < TFSMN ---------| |

;low rpm decel |

| --- ELSE ---

|

| Do: tfc\_bg\_stage3\_calculations

| TFC\_FG\_EN := 1

END: tfc\_bg\_stage2\_calculations

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FUEL STRATEGY, BACKGROUND TRANSIENT FUEL LOGIC - CDAN2

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BEGIN: tfc\_bg\_stage3\_calculations

;This routine is executed ONLY when it is invoked from within the

;tfc\_bg\_stage2\_calculations routine.

;Calculate the Equilibrium Fuel Time Constant (EFTC), the Transient

;Fuel Compensation MULTiplier (TFC\_MULT), and TFC\_SLOPE, (EISFU,EISFLO).

;NOTE: For increase resolution a 32 bit representation (double word)

;be used for AISF and EISF. These parameters are held in two word

;registers referenced as (parm(U), parm(LO)).

unconditionally ------------------------| TFC\_SLOPE := FN312S(ECT)

| \* FN313(N)

| TFC\_CHG := CYL\_AIR\_CHG

| (EISFU,EISFLO) := FN1321(ECT,LOAD)

| \* FN313(N) \* MTEISF

|

| FPW\_FG\_ISF\_A := (FPW\_FG\_ISF\_C \*

| (EISFU,EISFLO)) /

| / AHISL\_TICK

|

| (The FN1321 look-up routine MUST

| return a 16 bit result from the

| table interpolation algorithm,

| NOT the standard 8 bit result!)

| EFTCD := FN1322DL(ECT,LOAD)

| \* MTEFTC

| TFC\_MULTD := FN1323D(ECT,ATMR1)

| \* T\_TO\_S \* DT12S

| ;use decel multiplier

|

| EFTCA := FN1322AL(ECT,LOAD)

| \* MTEFTC

| TFC\_MULTA := FN1323A(ECT,ATMR1)

| \* T\_TO\_S \* DT12S

| ;use accel multiplier

END: tfc\_bg\_stage3\_calculations

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FUEL STRATEGY, FOREGROUND TRANSIENT FUEL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.13.2 FOREGROUND TRANSIENT FUEL LOGIC (CDAL0)

OVERVIEW

Background:

A liquid fuel film resides on the walls of the intake manifold. The film

mass varies primarily with manifold absolute pressure and manifold wall

temperature. During steady state conditions, the film mass is constant. The

rates of condensation and evaporation on the manifold walls are equal.

During transients, the film mass changes creating air/fuel ratio errors.

. During accelerations, the film mass increases. Fuel will condense faster

on the manifold walls until equilibrium is reached. In an uncompensated

system at stoichiometry, fuel is diverted from the cylinders, resulting

in a momentary lean condition.

. During decelerations, the film mass decreases. Fuel will evaporate

faster from the manifold walls until equilibrium is reached. In an

uncompensated system at stoichiometry, fuel is added to the cylinders,

resulting in a momentary rich condition.

The problem is magnified in closed loop fuel systems because the fuel control

will incorrectly chase the transient air/fuel excursions.

Intent:

The Transient Fuel Compensation Strategy (TFC) augments the closed/open loop

fuel control to keep cylinder events at the desired air/fuel ratio during all

engine transients. This module documents those actions that take place in

the foreground execution task. The goals are:

. To eliminate lean air/fuel excursions during accelerations.

. To eliminate rich air/fuel excursions during decelerations.

DEFINITIONS

Registers:

- AISFLO = Actual Intake Surface Fuel - Lower word of a double word - bin

32.

- AISFU = Actual Intake Surface fuel - Upper word of a double word - Bin

32.

- CYL\_AIR\_CHG = Current cylinder air charge.

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FUEL STRATEGY, FOREGROUND TRANSIENT FUEL LOGIC - CDAN2

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- DT12S = The period of time between two adjacent rising edges of PIP.

- DT23S = Last DT12S time.

- EFTC = Time constant for transient fuel.

- EFTCA = Time constant for transient fuel - accel.

- EFTCD = Time constant for transient fuel - decel.

- EFTR = Equil fuel transfer rate; bin 16, lbm/sec.

- EISFLO = Equilibrium intake surface fuel - lower word of double word -

bin 32.

- EISFU = Equilibrium intake surface fuel - upper word of double word - bin

32.

- EISF\_FGL = Equilibrium intake surface fuel lower word of double word -

bin 32.

- EISF\_FGU = Equilibrium surface fuel foreground upper word of double word

- bin 32.

- TFC\_CHG = Aircharge that transient fuel (background) was evaluated at.

- TFC\_FUEL = Computed fuel mass that is lost or gained in the cylinder from

the puddles.

- TFC\_MULT = Transient fuel multiplier.

- TFC\_MULTA = Transient fuel multiplier - accel.

- TFC\_MULTD = Transient fuel multiplier - decel.

- TFC\_SLOPE = Change in the transient fuel puddle mass per change in

aircharge.

- TFC\_HR = Transient fuel compensation - high resolution.

Bit Flags:

- ALT\_PIP\_MODE = Flag indicating that fuel and air foreground calculations

are occurring every-other PIP.

- TFC\_FG\_EN = Foreground update TFC\_FUEL enable flag; 1 -> update TFC\_FUEL.

Calibration Constants:

- TFC\_MIN = TFC\_HR minimum magnitude clip.

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FUEL STRATEGY, FOREGROUND TRANSIENT FUEL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FTRAN\_XTMODEL\_FG

TRANSIENT FUEL COMPENSATION FOREGROUND CALCULATIONS

BEGIN: fuel\_transient\_fg\_calculations

;Called from within the FUEL\_FG\_PIPEDG strategy module.

;In the PIP service routine, just after the calculation of CYL\_AIR\_CHG,

;calculate TFC\_HR.

1. Determine if foreground is enabled.

TFC\_FG\_EN = 0 --------------------------| EXIT THIS ROUTINE

(foreground disabled) |

| --- ELSE ---

|

| CONTINUE THIS ROUTINE

2. Calculate the equilibrium puddle mass based on EISF (background) and the

new CYL\_AIR\_CHG.

(EISF\_FGU,EISF\_FGL) = (EISFU,EISFLO) + [(CYL\_AIR\_CHG - TFC\_CHG) \* TFC\_SLOPE]

3. Decide if currently in an accel or decel condition and use appropriate

EFTC and TFC\_MULT parameter

(EISF\_FGU,EISF\_FGL) < (AISFU,AISFLO) --------| TFC\_MULT = TFC\_MULTD

| EFTC = EFTCD

|

| --- ELSE ---

|

| EFTC = EFTCA

| TFC\_MULT = TFC\_MULTA

4. Calculate EFTR; the puddle mass transfer rate.

EFTR = ((EISF\_FGU,EISF\_FGL) - (AISFU,AISFLO)) / EFTC

5. Calculate AISF; the actual intake surface fuel.

ALT\_PIP\_MODE = 1 ----------------------------| dt\_time := DT12S + DT23S

|

| --- ELSE ---

|

| dt\_time := DT12S

(AISFU,AISFLO) = (AISFU,AISFLO) + (EFTR \* dt\_time \* T\_TO\_S)

(clip AISF to zero as a minimum)

8-110

FUEL STRATEGY, FOREGROUND TRANSIENT FUEL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

6. Calculate TFC\_HR; the transient fuel compensation.

tfc\_hr = EFTR \* TFC\_MULT

|tfc\_hr| > TFC\_MIN ---------------------| TFC\_HR = tfc\_hr

(magnitude of tfc\_hr great enough) |

| --- ELSE ---

|

| TFC\_HR = 0

END: fuel\_transient\_fg\_calculations

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FUEL STRATEGY, HOT INJECTOR COMPENSATION - CDAN2

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8.14 HOT INJECTOR COMPENSATION (CDAN0)

OVERVIEW

Under conditions of high injector tip temperatures, injector fuel delivery

decreases as a function of increasing injector tip temperature. The amount

of vaporized fuel delivered by the injector increases as hot soak time

increases, or as conducted heat (from cylinder head) and/or radiated heat

(from intake/exhaust manifold) increases. Higher fuel pressure or lower fuel

volatility helps the situation, but fuel volatility is beyond the developers

control. Hot Injector Compensation has therefore been applied to the desired

fuel flow.

The engine-off soak timer is incorporated for those programs with this

hardware feature. Also, values of ACT and ECT are periodically updated in

KAM (when the HICOMP value has become sufficiently small), where they are

retained until the next power up. The implementation below uses the

following in the calculation of this enrichment factor.

- For ACT and ECT, the difference between the temperature during previous

run, and the current temperature. These values are used in FN1338, which

is used to calibrate the enrichment factor as a function of current

temperature vs. temperature change during soak.

- In FN1348, the enrichment factor is calibrated as a function of time

spent in run mode vs. current air mass.

- The engine-off soak timer is also used. FN1347 allows the enrichment

factor to be characterized as a function of soak time vs. temperature at

previous shut down.

The initial value of FN1338 is now used in the HICOMP calculation, insuring a

smooth ramp-down based solely upon FN1348 and FN1347. Using a

continuously-updated value of FN1338 leads to a faster ramp down of HICOMP,

and excessively lean operation.

CALIBRATION NOTES

If it is desired to update the ACT and ECT values in KAM (ACTOFF and ECTOFF)

continuously, set HICOMP\_MIN to the upper clip.

With the addition of the soak timer (FN1347), it may be possible to eliminate

FN1338 from the HICOMP calculation altogether. Assigning a value of 1.0 to

each component of this table will achieve this.

To reset the engine-off soak time, simply entering run mode should be

sufficient. A low value of SOAK\_RST\_TM (e.g., 0-5 seconds) should be

satisfactory for most applications.

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FUEL STRATEGY, HOT INJECTOR COMPENSATION - CDAN2

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DEFINITIONS

Registers:

- ACT = Air Charge Temperature, degrees F.

- ACTOFF = Air Charge Temperature last read during closed loop control,

degrees F.

- AM = Air mass flow, lb/min.

- ATMR3 = Time since entering RUN mode, seconds.

- ECT = Engine Coolant Temperature, degrees F.

- ECTOFF = Engine Coolant Temperature last read during closed loop control,

degrees F.

- HICOMP = Hot injector compensation enrichment factor.

- INITL\_FN1338 = The value of FN1338 taken at start-up. This value is

determined during the first pass through the background loop, and then

never again updated.

- SOAK\_HICOMP = Duration of last soak, in seconds. This is obtained from

the engine-off soak timer (ENG\_OFF\_TMR), and is reset when the vehicle

enters run mode. Retained in KAM.

- SOAK\_TIME = Local copy of SOAK\_HICOMP, used only in the HICOMP logic;

stored in RAM.

Bit Flags:

- HICOMP\_INIT = Flag indicating that the HICOMP strategy has been executed

since power-up. Use for one-time only initialization of HICOMP

registers.

- KAM\_ERROR = Indicates keep-alive RAM is invalid.

- UNDSP = Crank/underspeed mode flag; 0 -> run mode, 1-> crank or

underspeed mode.

Calibration Constants:

- FN001 = Delta temperature (actual minus shutdown) normalizing function

for HICOMP.

- FN001A = Absolute temperature normalizing function for HICOMP.

- FN001B = Key-off power-off engine temperature normalizing function for

HICOMP.

- FN007 = AM normalizing function.

- FN008 = ATMR3 normalizing function.

- FN008B = SOAK\_TIME normalizing function.

8-113

FUEL STRATEGY, HOT INJECTOR COMPENSATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FN1338 = HICOMP multiplier. X = FN001(delta\_temp) Y = FN001A(abs\_temp)

- FN1347 = HICOMP multiplier. X = FN008B(SOAK\_TIME) Y =

FN001B(power\_off\_temp)

- FN1348 = HICOMP multiplier. X = FN008(ATMR3) Y = FN007(AM)

- HC\_ACT\_MUL1 = ACT multiplier used in delta temperature computation,

unitless.

- HC\_ACT\_MUL2 = ACT multiplier used in absolute temperature computation,

unitless.

- HC\_ACT\_MUL3 = ACT multiplier used in computation involving engine

temperatures at the most recent key-off power-down event. Unitless.

Used to define a normalized combination of ECTOFF and ACTOFF.

- HC\_ECT\_MUL1 = ECT multiplier used in delta temperature computation,

unitless.

- HICOMP\_MIN = Minimum HICOMP value before HICOMP is reset.

- SOAK\_RST\_TM = Minimum time required in run mode to initiate an update of

the engine-off soak timer at next power up, in seconds (0-255).

8-114

FUEL STRATEGY, HOT INJECTOR COMPENSATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_HOT\_INJ\_COMP\_COM4

Initialize values of ACT and ECT stored in KAM, when KAM error is detected.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*\*\* NOTE: The values of registers ACT and ECT must be \*\*\*

\*\*\* established prior to executing the following \*\*\*

\*\*\* initialization of ACTOFF and ECTOFF during a \*\*\*

\*\*\* KAM reset \*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

KAM\_ERROR = 1 ---------------------| ACTOFF := ACT

| ECTOFF := ECT

On the first background pass, make a local copy of the soak-time accumulator

for HICOMP. The accumulator (SOAK\_HICOMP) is calculated in the soak timer

input processing logic. Upon each power-up, the actual soak time

(ENG\_OFF\_TMR) will be added to SOAK\_HICOMP. This HICOMP logic will clear

SOAK\_HICOMP when the engine has entered run mode for a significant period of

time (see below).

HICOMP\_INIT = 0 -------------------| SOAK\_TIME := SOAK\_HICOMP

Check if duration in run mode is sufficient to trigger a reset of the

engine-off soak timer accumulator for Hot Injector Compensation

(SOAK\_HICOMP).

ATMR3 > SOAK\_RST\_TM ---------------| SOAK\_HICOMP := 0

| ;Been in run mode long enough to reset

| ; the soak timer

Calculate intermediate values required for the hot injector compensation

enrichment factor.

Unconditionally -------------------| delta\_act := ACT - ACTOFF

| delta\_ect := ECT - ECTOFF

| delta\_temp := HC\_ECT\_MUL1 \* delta\_ect

| + HC\_ACT\_MUL1 \* delta\_act

|

| abs\_temp := ECT + HC\_ACT\_MUL2 \* ACT

| power\_off\_temp := ECTOFF +

| HC\_ACT\_MUL3 \* ACTOFF

Get the initial value of FN1338, and indicate that the HICOMP strategy has

been initialized this power up.

HICOMP\_INIT = 0 -------------------| INITL\_FN1338 := FN1338

| (delta\_temp,abs\_temp)

| HICOMP\_INIT := 1

8-115

FUEL STRATEGY, HOT INJECTOR COMPENSATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calculate the Hot Injector Compensation enrichment factor.

Unconditionally -------------------| HICOMP := INITL\_FN1338 \*

| FN1348(ATMR3,AM) \*

| FN1347(SOAK\_TIME,power\_off\_temp)

Reset HICOMP, as necessary.

HICOMP <= HICOMP\_MIN --------------| ACTOFF := ACT

| ECTOFF := ECT

|

| --- ELSE ---

|

| ;No change to ACTOFF or ECTOFF; use

| ; last value read while closed loop.

| ; ACTOFF and ECTOFF are stored in KAM.

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FUEL STRATEGY, INJECTOR DELAY LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.15 INJECTOR DELAY LOGIC (CDAK0)

OVERVIEW

Injector timing is the delay before each injector output is fired. The delay

is taken from TDC of the reference PIP signal for each injector output. The

units for injector timing are absolute engine crank degrees. The range is

clipped between 0 and 716 degrees ATDC with 4 degrees resolution.

Either edge (on or off) of the injector pulse can be timed. The calibration

switch INJREF defines the reference edge for injector timing.

INJREF = 0, Use start of fuel pulse.

INJREF = 1, Use end of fuel pulse.

Regardless of which edge is used, the injector delay is used only to start a

fuel pulse. Once started, pulsewidth accuracy has top priority.

When the fuel system is not in sync (SYNFLG = 0), the injector timing is

coincident with the relevant PIP signal. The injector outputs are fired in

sequence after receiving the rising edge of the reference PIP signals.

Actual timing will be the result of the random link between signature PIP

(cylinder #1) and #1 injector output.

During RAM initialization, the rolling average filter for INJDLY is loaded

with an initial value, INJIV. This action eliminates the excessive length of

time it used to take to filter INJDLY from its initial value of 0 to its

desired timing. Note: For 1989 Model year, because of a software

limitation, INJIV must be calibrated to less than ENGCYL \* 90 degrees. This

will be corrected for 1990.

When the fuel system is in sync (SYNFLG = 1), injector timing is based on the

calculation defined within this strategy module.

NOTES:

1. The final value of injector delay is limited to a range of greater than

or equal to 0, and less than 720, engine crank angle degrees. Intermediate

calculations and results are maintained in an unlimited fashion.

2. The user must set DEGPIP to match his engine. DEGPIP is the number of

engine crank degrees per PIP interval. (90 for 8-cylinder, 120 for

6-cylinder, 180 for 4-cylinder).

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FUEL STRATEGY, INJECTOR DELAY LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EXAMPLE - Injector Timing

INJDLY = 400 DEGREES

ENGINE CYCLE

TDC BDC TDC BDC

| | | | |

| | | | |

|<----POWER--->|<---EXHAUST-->|<---INTAKE---->|<-COMPRESSION-->|

| STROKE | STROKE | STROKE | STROKE |

| | | | |

0 180 360 540 720

| 1ST PIP

PIP SIGNAL

| #1 PIP

|

\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*

\* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \*

\* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \*

\* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \*

\*\* \*\*\*\* \*\*\*\*\*\* \*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\*\*

| | | | | | |

0 80 170 260 350 440 530

TDC |

| |

|<--------- INJDLY = 400 --------->|

| |

|ON INJECTOR 1 \*\*\*\*\*\*

| \* \*

| \* \*

|OFF INJREF = 1 \* \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

| |

| INJECTOR 1 |

| INJREF = 0 \*\*\*\*\*\*

| \* \*

| \* \*

| \* \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

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FUEL STRATEGY, INJECTOR DELAY LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- ATMR1 = Time since exiting crank mode, sec.

- ATMR2 = Time since engine coolant temperature became greater than TEMPFB,

sec.

- ECT = Engine Coolant Temperature, deg F.

- INJDLY = Injector delay in degrees.

- LOAD = Universal load as ratio of aircharge over standard.

- N = Engine speed, rpm.

- TCSTRT = Temperature of engine coolant (ECT) at initial startup, deg F.

Bit Flags:

- CRKFLG = Flag indicating when in CRANK mode; 1 -> crank.

- DNDSUP = Delayed Neutral/Drive flag; 0 -> neutral, 1 -> drive.

- IDLE\_TEMP\_SW = INJDLY temperature switch; 1 -> temperature compensation

in idle, 0 -> no temperature compensation in idle.

- IDLFLG = Flag indicating transmission in Drive and at Idle.

- TIM\_INT\_FLG = First pass injector timing calculation.

Calibration Constants:

- CIDRSW = Calibration switch to enable Special Fuel Timing at Idle,

unitless; 1 -> Enable, 0 -> Disable.

- CINTSW = Calibration switch to enable special fuel timing in Neutral,

unitless;

1 -> enable special neutral fuel timing.

- CINTV = Injector Timing Value in Neutral, deg F.

- CTHIGH = Coolant temperature at Hot start, deg F.

- CTLOW = Coolant temperature at Cold start, deg F.

- DEGPIP = Engine degrees per PIP period, deg. (90 deg = 8 cylinder;

120 deg = 6 cylinder; 180 = 4 cylinder)

- FN070 = Normalizing function for engine speed N as X-input to FN1315.

- FN085 = Normalizing function for LOAD as Y-input to FN1315.

- FN336(ECT) = Injector timing versus ECT (X-input).

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FUEL STRATEGY, INJECTOR DELAY LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FN1315 = An 10x8 table which gives injector delay as a function of

engine speed and load.

X = FN070(N)

Y = FN085(LOAD)

- IDKADD = Injector delay timing adder.

- IDKMUL = Injector delay timing multiplier.

- INJDLY\_MIN = Minimum allowable injector delay.

- INJREF = Indicates which edge of the fuel pulse is the reference edge for

fuel timing, INJDLY; 0 -> start edge.

- MIDTV = Injector timing value for Idle in Drive, deg. Range of 0 to 720.

- NITMR1 = ATMR1 timed delay to enter Closed Loop fuel after Cold start,

sec. Range of 0-255 sec., accuracy 1 sec.

- NITMR2 = ATMR1 timed delay to enter Closed Loop fuel after Medium start,

sec. Range of 0-255 sec., accuracy 1 sec.

- NITMR3 = ATMR1 timed delay to enter Closed Loop fuel after Hot start,

sec. Range of 0 to 255 sec., accuracy 1 sec.

- NITMR4 = ATMR2 timed delay to enter Closed Loop fuel after Cold start,

sec. Range of 0 to 255 sec., accuracy 1 sec.

- NITMR5 = ATMR2 timed delay to enter Closed Loop fuel after Medium start,

sec. Range of 0 to 255 sec., accuracy 1 sec.

- TCINJD = Time constant for INJDLY, sec.

OUTPUTS

Registers:

- INJDLY = Injector delay in degrees.

- INJDLY\_BETA = The injector timing in percent of PIP periods.

Bit Flags:

- TIM\_INT\_FLG = See above.

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FUEL STRATEGY, INJECTOR DELAY LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_INJDLY\_COM1

; Determine if the conditions to use special fuel timing in neutral are met.

TCSTRT >= CTHIGH -----------|

|AND -|

ATMR1 >= NITMR3 ------------| |

|

CTLOW < TCSTRT < CTHIGH ----| |

|AND -|

ATMR1 >= NITMR2 ------| | |OR --| "A"

|AND -| |

ATMR2 >= NITMR5 ------| |

|

TCSTRT <= CTLOW ------------| |

|AND -|

ATMR1 >= NITMR1 ------| |

|AND -|

ATMR2 >= NITMR4 ------|

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FUEL STRATEGY, INJECTOR DELAY LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

; Compute the desired value for injector delay. This is based on calibration

; values MIDTV and CINTV, ECT-based temperature compensation (FN336) and

; normalized speed/load compensation.

CRKFLG = 1 -----------------------------| Exit FUEL\_INJDLY

| ;Exit background injector timing

| ; calculation

|

| --- ELSE ---

DNDSUP = 0 -----------------------| |

| |

CINTSW = 1 -----------------------| |

|AND -| ;Neutral timing with temperature

"A" ------------------------------| | ; compensation

| | injdly := CINTV + FN336(ECT)

IDLE\_TEMP\_SW = 1 -----------------| |

| --- ELSE ---

DNDSUP = 0 -----------------------| |

| |

CINTSW = 1 -----------------------|AND -| ;Neutral timing without temperature

| | ; compensation

"A" ------------------------------| | injdly := CINTV

|

| --- ELSE ---

IDLFLG = 1 -----------------------| |

| |

CIDRSW = 1 -----------------------|AND -| ;Idle timing with temperature

| | ; compensation (in drive)

IDLE\_TEMP\_SW = 1 -----------------| | injdly := MIDTV + FN336(ECT)

|

| --- ELSE ---

IDLFLG = 1 -----------------------| |

|AND -| ;Idle timing without temperature

CIDRSW = 1 -----------------------| | ; compensation (in drive)

| injdly := MIDTV

|

| --- ELSE ---

|

| injdly :=

| IDKMUL \* (FN1315(N,LOAD)

| + FN336(ECT)) + IDKADD

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FUEL STRATEGY, INJECTOR DELAY LOGIC - CDAN2

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; The following section calculates the desired injector delay in absolute

; crank angle degrees after TDC of the cylinder associated with the

; reference PIP signal edge.

; Normalize the desired injector delay to be between 0° and 720°

unconditionally ---------------------| injdly := MOD(injdly,720)

; If this is the first pass through the background loop, store injdly as

; the 'old' value of INJDLY (required for the rolling average).

TIM\_INT\_FLG = 0 ------------------------| INJDLY := injdly

;First pass only | TIM\_INT\_FLG := 1

| ;TIM\_INT\_FLG remains set after the

| ; first execution of this block

| ; after RAM initialization

; Walk the injector timing INJDLY toward the desired value injdly, taking

; the shortest route. Note that this may go indirectly, through 0° and

; wrapping back to 720°, or vise versa.

ABS(injdly - INJDLY) > 360 ----|

|AND -| injdly := injdly - 720

injdly > INJDLY ---------------| | ;Adjust the rolling average in a

| ; negative direction, through 0°

|

| --- ELSE ---

ABS(injdly - INJDLY) > 360 ----| |

|AND -| injdly := injdly + 720

injdly < INJDLY ---------------| | ;Adjust the rolling average in a

| ; positive direction, through 720°

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FUEL STRATEGY, INJECTOR DELAY LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

; Use a first-order filter to "walk" the current injector delay INJDLY

; toward the desired value. Wrap the result from 0° to 720° or back,

; using modulo 720 arithmetic. Clip the final result to INJDLY\_MIN as

; a minimum.

unconditionally ----------------------| INJDLY := ROLAV(injdly,TCINJD)

| INJDLY := MOD(INJDLY,720)

| INJDLY := MAX(INJDLY,INJDLY\_MIN)

; The following section calculates the desired injector delay in units of

; percent of PIP period, "betas", relative to the associated PIP up-edge

; event. If the injector delay (INJDLY, in units of degrees after top

; dead center) plus the PIP offset before TDC (10 degrees) is greater than

; or equal to 720 degrees, then the requested delay will be past TDC and

; 720 can be subtracted to give the same delivered timing.

unconditionally ------------------------| temp := INJDLY + 10

temp < 720 -----------------------------| INJDLY\_BETA := temp/DEGPIP

|

| --- ELSE ---

|

| INJDLY\_BETA := (temp - 720)/DEGPIP

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FUEL STRATEGY, DECEL FUEL SHUT OFF LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.16 DECEL FUEL SHUT OFF LOGIC (CDAL0)

OVERVIEW

The Fuel Shutoff strategy is divided into two sub-strategies:

1) Decel Fuel Shut Off

2) Manual Transmission Shift Fuel Shut Off.

The Decel Fuel Shut Off strategy turns off the fuel flow during specific load

and rpm condition only during Closed Throttle Mode. The FUELPWs are zeroed

during a decel until the rpm is within the band created by [DFSRPM - DFSRPH]

of the idle rpm range.

The Manual Transmission Shift Fuel Shut Off strategy turns off fuel flow at

the beginning of the shift, until the rpm is within the band created by

[SHFRPM - SHFHYS] of the idle speed (or until the transmission has been in

Neutral for DSTM2 seconds).

Calibration Guide:

The use of Decel Fuel Shutoff can aggravate Clunk. Therefore, DFSO should

occur only at low airflow in order to minimize the rate of change of Torque.

CTDFSO can be used to delay DFSO.

CTEDSO should be greater than CTDFSO to prevent DFSO after Tip-in, Tip-out.

For MANUAL TRANSMISSIONS: SHFRPM should be greater than DFSRPM.

Notes on Alternate calibration for Misfire Profile Correction logic.

The normal Decel Fuel Shut Off sub-strategy can be controlled by two sets of

calibratable parameters, depending upon the state of the Profile Correction

logic. Whenever the appropriate KAM correction factors have not matured,

there exists the need to apply the DFSO strategy in a more aggressive manner

in order to allow adequate unfueled engine rotation to determine the

crankshaft profile signature. The RAM bit CF\_KAM\_MTR is utilized within this

strategy to indicate the state of the Profile Correction KAM maturity. The

more aggressive calibration constants will allow DFSO to occur in a wider

operating region than those assigned in the normal powertrain development

process. This alternate calibration is intended to occur for only a short

period of vehicle operation whenever KAM has been reset. The strategy will

automatically revert back to the normal DFSO calibration upon indication that

the Profile Correction factors have matured.

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FUEL STRATEGY, DECEL FUEL SHUT OFF LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- APT = At Part Throttle; -1 -> Closed throttle, 0 -> Part throttle,

1 -> Wide Open throttle.

- CTTMR = Time since entering Closed throttle mode, secs. CTTMR is used to

delay Decel Fuel Shutoff (DFSO).

- CYLARC\_BG = Air Charge Mass inducted per Intake Stroke, lbm/Intake.

- DSDRPM = Desired engine speed.

- ECT = Engine Coolant Temperature, deg F.

- LOAD = Normalized CYLARC\_BG divided by SARCHG.

- N = Engine speed, rpm.

- NDDTIM = Time since Transmission shift, sec. In the DFSO Strategy, this

timer is used to delay Decel Fuel Shutoff if a vehicle with a manual

transmission shifts into Neutral during the decel.

- NOVS = N/VSBAR to infer transmisssion gear.

- PPCTR = PIP counter for Fuel Ramp, unitless.

- VSBAR = Vehicle speed, mph.

Bit Flags:

- ALT\_DFSO\_FLG = Flip-flop flag used to enable alternate DFSO calibration

for profile correction strategy.

- CF\_KAM\_MTR = Profile Correction indicates that the KAM has matured

correction factors; 1 -> CF's are mature.

- COOL\_FLG = Flag indicating the lack of coolant strategy is active;

cylinder head overtemperature condition; 1 -> overtemperature.

- DCELQ4 = Flip flop state flag using engine speed to disable DFSO for

manual transmissions during gear shifts.

- DCELQ5 = Flip flop state flag using engine speed and load to engage DFSO

during closed throttle decelerations.

- DFSFLG = Indicates DECEL Fuel shutoff.

- DFSVS\_HYS\_FG = Flip flop state flag using vehicle speed to engage DFSO.

- FLG\_DFSO\_LOAD = Flip flop state flag using low load values to indicate a

hard decel to engage DFSO.

- FLG\_DFSO\_NOVS = Flip flop state flag using transmission gear to engage

DFSO.

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FUEL STRATEGY, DECEL FUEL SHUT OFF LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- NDSFLG = Neutral/Drive Flag; 1 -> Drive.

Calibration Constants:

- CTDFSO = Minimum time delay after entering Closed Throttle to enable

DFSO, sec.

- CTDFSO\_PC = Profile Correction - Minimum time delay after entering Closed

Throttle to enable DFSO, sec.

- CTEDSO = Decel Fuel Shutoff time delay during extended decels. This time

delay allows DFSO during extended decels (ie., down mountains), even if

times at Part Throttle are very short (light Tip-ins), sec.

- CTEDSO\_PC = Profile Correction - Decel Fuel Shutoff time delay during

extended decels. This time delay allows DFSO during extended decels

(ie., down mountains), even if times at Part Throttle are very short

(light Tip-ins), sec.

- DFHLOD = Minimum load for hard decel fuel shut off in lower gears.

- DFHLOD\_PC = Profile Correction - Minimum load for hard decel fuel shut

off in lower gears.

- DFHLODH = Hysteresis for DFHLOD.

- DFLOD = Maximum load to enable decel Fuel Shut-off.

- DFLOD\_PC = Profile Correction - Maximum load to enable decel Fuel

Shut-off.

- DFLODH = Hysteresis for DFLOD.

- DFNOVS = NOVS value below which DFSO permitted.

- DFNOVS\_PC = Profile Correction - NOVS value below which DFSO permitted.

- DFNOVH = Hysteresis for DFNOVS.

- DFSECT = Minimum ECT to allow Decel Fuel Shutoff.

- DFSECT\_PC = Profile Correction - Minimum ECT to allow Decel Fuel Shutoff.

- DFSO\_PC\_SW = Switch to allow use of alternate DFSO calibration for

Profile Correction strategy; 1 -> use alternative DFSO calibration.

- DFSVS = Minimum VSBAR for Decel fuel shut off, mph.

- DFSVS\_PC = Profile Correction - Minimum VSBAR for Decel fuel shut off,

mph.

- DFSVSH = Hysteresis for DFSVS.

- DFSRPH = Hysteresis for DFSRPM, unitless.

- DFSRPM = Minimum rpm for Decel fuel shutoff, rpm.

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FUEL STRATEGY, DECEL FUEL SHUT OFF LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- DFSRPM\_PC = Profile Correction - Minimum rpm for Decel fuel shutoff, rpm.

- DSTM2 = Maximum time that DFSO logic is enabled during manual

transmission shifts, secs.

- NDFSO = Neutral deceleration fuel shut off; 1 -> DFSO in neutral.

- PIPNUM = Number of PIPS to remain in Open Loop Fuel after DFSO. Prevents

LAMBSE from ramping rich due to normal transport delay time. Set to 1 to

calibrate out.

- SHFHYS = Hysteresis term, rev/min. If the rpm drops this amount, the

normal Fuel Strategy operates.

- SHFRPM = Minimum rpm at which DFSO logic is enabled, rev/min. (This

corresponds to the rpms during the shift.)

- TRLOAD = Transmission Load switch;

0 -> Manual Transmission, no clutch or gear switches,

forced neutral state (NDSFLG = 0).

1 -> Manual Transmission, no clutch or gear switch.

2 -> Manual Transmission, one clutch or gear switch.

3 -> Manual Transmission, both clutch and gear switches.

4 -> Auto Transmission, non-electronic, neutral drive switch.

5 -> Auto Transmission, non-electronic, neutral pressure

switch, (AXOD).

6 -> Auto Transmission, electronic, PRNDL sensor - park,

reverse, neutral, overdrive, manual 1, manual 2.

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FUEL STRATEGY, DECEL FUEL SHUT OFF LOGIC - CDAN2

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PROCESS

STRATEGY MODULE: FUEL\_DFSO\_COM9

BEGIN: alternate\_dfso\_calibration

;Execute prior to any DFSO logic service.

CF\_KAM\_MTR = 0 ----------------|

; Profile Correction Logic |

; indicates the correction |AND -|S Q -| ALT\_DFSO\_FLG

; factor KAM is NOT mature. | |

| |

DFSO\_PC\_SW = 1 ----------------| |

; Calibratable switch. |

|

|

CF\_KAM\_MTR = 1 ----------| |

; KAM is mature. |AND -| |

| | |

DFSFLG = 0 --------------| | |

; Out of DFSO. |OR --|C

|

DFSO\_PC\_SW = 0 ----------------|

; Calibratable switch.

ALT\_DFSO\_FLG = 1 --------------------| ctdfso = CTDFSO\_PC

; Use alternative DFSO for profile | ctedso = CTEDSO\_PC

; correction factor KAM update. | dfsvs = DFSVS\_PC

| dfhlod = DFHLOD\_PC

| dfnovs = DFNOVS\_PC

| dfsrpm = DFSRPM\_PC

| dflod = DFLOD\_PC

| dfsect = DFSECT\_PC

|

| --- ELSE ---

|

; Use normal DFSO calibration. | ctdfso = CTDFSO

| ctedso = CTEDSO

| dfsvs = DFSVS

| dfhlod = DFHLOD

| dfnovs = DFNOVS

| dfsrpm = DFSRPM

| dflod = DFLOD

| dfsect = DFSECT

END: alternate\_dfso\_calibration

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FUEL STRATEGY, DECEL FUEL SHUT OFF LOGIC - CDAN2

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Evaluate each flip flop each background pass:

VSBAR >= dfsvs ----------------------|S Q -| DFSVS\_HYS\_FG

|

VSBAR < dfsvs - DFSVSH --------------|C

LOAD <= dfhlod ----------------------|S Q -| FLG\_DFSO\_LOAD

(hard decel) |

|

LOAD > dfhlod + DFHLODH -------------|C

NOVS <= dfnovs ----------------------|S Q -| FLG\_DFSO\_NOVS

(in higher gear) |

|

NOVS > dfnovs + DFNOVH --------------|C

N - DSDRPM > SHFRPM -----------------|S Q -| DCELQ4

|

N - DSDRPM <= SHFRPM - SHFHYS -------|C

(Short rpm)

N - DSDRPM > dfsrpm -----------|

(RPM high enough) |AND -|S Q -| DCELQ5

| |

LOAD <= dflod -----------------| |

(Not making power) |

|

N - DSDRPM < dfsrpm - DFSRPH --| |

|OR --|C

LOAD > dflod + DFLODH ---------|

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FUEL STRATEGY, DECEL FUEL SHUT OFF LOGIC - CDAN2

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"A" LOGIC

MANUAL OR AUTO TRANS - DFSO DURING CLOSED THROTTLE DECEL

NDSFLG = 1 --------------------|

(Trans. in gear) |OR --|

| |

NDFSO = 1 ---------------------| |

|

CTTMR >= ctdfso ---------------------|

|

CTTMR > ctedso ----------------| |

(Extended decel) | |AND -| "A"

| |

FLG\_DFSO\_LOAD = 1 -------------|OR --|

| |

FLG\_DFSO\_NOVS = 1 -------------| |

|

DCELQ5 = 1 --------------------------|

"B" LOGIC

MANUAL TRANSMISSION - DFSO DURING GEAR CHANGE

TRLOAD <= 3 -------------------------|

(Manual transmission) |

|

NDSFLG = 0 --------------------------|

|AND -| "B"

NDDTIM < DSTM2 ----------------------|

|

DCELQ4 = 1 --------------------------|

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FUEL STRATEGY, DECEL FUEL SHUT OFF LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

"A" ---------------------------|

|OR --|

"B" ---------------------------| |

|

APT = -1 ----------------------------|

(Closed throttle) |

|

ECT >= dfsect -----------------------|AND -| TURN OFF FUEL

(Engine warmed up) | | D = 0

| | DFSFLG = 1

DFSVS\_HYS\_FG = 1 --------------------| | PPCTR = 0

| |

COOL\_FLG = 0 ------------------------| |

(no engine overheating) |

| --- ELSE ---

|

| TURN ON FUEL

| (Driver wants to

| accelerate)

| D = 1.0

| DFSFLG = 0

NOTE: PPCTR is incremented in the foreground.

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FUEL STRATEGY, FUEL PULSEWIDTH, BACKGROUND FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.17 BACKGROUND FUEL (CDAM0)

OVERVIEW

The desired fuel air ratio for each bank is calculated once per background

loop, under non-cranking conditions. In addition, a multiplier that contains

the decel fuel multiplier and the multiplier that indicates pulses per engine

event are calculated each time. Under underspeed conditions, the multiplier

also contains the underspeed fuel multiplier. In crank mode, a fuel

pulsewidth value is calculated based on number of PIP events in crank,

barometric pressure, and engine temperature.

NOTE: Bracketed parameters are non-displayable temporary registers.

DEFINITIONS

Registers:

- ACT = Air Charge Temperature, deg F.

- AHISL\_TICK = Dual slope high slope in lbs/tick, compensated for

temperature.

- ALOSL\_TICK = Dual slope low slope in lbs/tick, compensated for

temperature.

- BKPT\_PW = Dual slope fuel breakpoint divided by the low slope

(temperature compensation), ticks.

- BP = Barometric Pressure, " Hg.

- CRK\_FUL = Fuel pulsewidth used in crank mode.

- CRKPIP\_CTR\_BG = Background PIP counter for crank fuel.

- CRK\_PIP\_INJ = Number of PIP periods per injector firing.

- ECT = Engine Coolant Temperature, deg F.

- F\_A\_RATIOn = Desired fuel-to-air ratio for EGO-n.

- FB\_DIFF = Difference between FUEL\_BKPT divided by temperature compensated

high slope and FUEL\_BKPT divided by temperature compensated low slope,

ticks.

- FUELPW1 = Fuel pulsewidth in clock ticks (EGO-1).

- FUELPW2 = Fuel pulsewidth in clock ticks (EGO-2).

- HICOMP = Hot injector compensation enrichment factor.

- KAMRFn = Fuel correction factor obtained from the adaptive fuel tables

that use the EGO sensor(s) for input. KAMRFn = [0.5 + LTMTBn(r,c)],

where: c = column, r = row, n = bank number.

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FUEL STRATEGY, FUEL PULSEWIDTH, BACKGROUND FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- LAM\_FINAL1 = Commanded LAMBSE value for bank1. Summation of LAMBSE and

LAM\_MOD.

- LAM\_FINAL2 = Commanded LAMBSE value for bank2. Summation of LAMBSE and

LAM\_MOD.

- LAMBSE\_MOD1 = LAMBSE fuel modulation signal, added to LAMBSE1 to give

LAM\_FINAL1.

- LAMBSE\_MOD2 = LAMBSE fuel modulation signal, added to LAMBSE2 to give

LAM\_FINAL2.

- LAMBSEn = The stoichiometric equivalence value; n = bank number.

- LBMF\_INJn = Fuel mass injected when an injector is turned on, lbm.

- MINPW\_LBMF = MINPW \* ALOSL.

- MINPWT = Minimum fuel pulsewidth in ticks.

- PWOFF = Injector pulsewidth offset, clock ticks.

- PWOFS\_D = DISPLAY ONLY; injector pulsewidth offset - output of FN367,

msec.

- VBAT = Battery voltage inferred from IIVPWR, volts.

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

- CRKFLG = Engine mode flag; 1 -> crank mode, 0 -> underspeed/run mode.

- DFSFLG = Indicates DECEL Fuel shutoff is active; 1 -> DFSO requested.

- UNDSP = Engine mode flag; 1 -> crank/underspeed mode, 0 -> run mode.

Calibration Constants:

- AHISL = High fuel flow injector slope, lb/sec.

- ALOSL = Low fuel flow injector slope, lb/sec.

- FN023(CRKPIP\_CTR\_BG) = Normalizing function for number of PIP's since

start of crank.

- FN024(ACT) = Normalizing function for air charge temperature.

- FN348A(ECT) = Crank fuel pulsewidth multiplier as a function of ECT.

- FN348BP(BP) = Crank fuel pulsewidth multiplier as a function of BP.

- FN348RPM(RPM) = Cranking pulsewidth enleanment as a function of RPM.

- FN367(VBAT) = Injector offset as a function of battery voltage, msec.

- FN387A(ECT) = Fuel pulsewidth multiplier as a function of ECT.

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FUEL STRATEGY, FUEL PULSEWIDTH, BACKGROUND FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FN387\_ALT(ECT) = Alternate FN387A used when ALT\_CAL\_FLG = 1.

- FN1350 = Crank fuel pulsewidth

X = FN023(CRKPIP\_CTR\_BG)

Y = FN024(ACT)

- FUEL\_BKPT = The amount of fuel flow when transfer is made from the low

slope to the high slope.

- MINPW = Minimum pulsewidth for requested fuel.

- NOMINAL\_AFR = Nominal stoichiometric air/fuel ratio.

- NUMCYL = Number of cylinders for this engine.

- THBP\_DECH = Throttle breakpoint for dechoke control, counts.

Non-Calibratable Constants:

- [stcf] = Seconds-to-Ticks conversion factor.

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FUEL STRATEGY, FUEL PULSEWIDTH, BACKGROUND FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_BG\_CALC\_COM18

Calculate the following parameters for use in the foreground fuel

calculation.

always -------------------| AHISL\_TICK := AHISL / [(1 + HICOMP) \* [stcf]]

| ALOSL\_TICK := ALOSL / [(1 + HICOMP) \* [stcf]]

| := AHISL\_TICK \* ALOSL / AHISL

| BKPT\_PW := FUEL\_BKPT / ALOSL\_TICK

| FB\_DIFF := (FUEL\_BKPT / AHISL\_TICK) - BKPT\_PW

| MINPWT := MINPW \* [stcf]

| MINPW\_LBMF := MINPWT \* ALOSL\_TICK

CRKFLG = 1 ---------|

;in crank mode |AND -| CRK\_FUL := FN348A(ECT)

| | \* FN348BP(BP)

TP\_REL < THBP\_DECH -| | \* FN348RPM(N)

;below dechoke b/point | \* FN1350(CRKPIP\_CTR\_BG,ACT)

| \* CRK\_PIP\_INJ

|

| LBMF\_INJ1 := [(CRK\_FUL \* [stcf]) + FB\_DIFF] \*

| AHISL\_TICK

| LBMF\_INJ2 := LBMF\_INJ1

|

| ;Obtain the injector ON duration, representing a

| ;given cylinder's fuel flow requirement (units:

| ;seconds/cycle) during engine start conditions.

|

| crank\_fuel := CRK\_FUL \* (NUMCYL / CRK\_PIP\_INJ)

|

| ;Convert crank\_fuel to units of ticks/cycle and

| ;assign its value into FUELPW during crank.

| ;NOTE: The resulting value is clipped to one bit

| ;less than the maximum value, since the maximum

| ;value has a distinct meaning to the Foreground

| ;Fuel strategy (ie. 'Injector was not fueled for

| ;the last firing event for this cylinder').

|

| crank\_fuel := min(FFFEh , (crank\_fuel \* [stcf]))

|

| FUELPW1 := crank\_fuel

| FUELPW2 := crank\_fuel

|

| --- ELSE ---

|

CRKFLG = 1 ---------------| (de-choke)

| CRK\_FUL := 0

| LBMF\_INJ1 := 0

| LBMF\_INJ2 := 0

| FUELPW1 := 0

| FUELPW2 := 0

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FUEL STRATEGY, FUEL PULSEWIDTH, BACKGROUND FUEL - CDAN2

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Note: During EGO monitoring, intrusive fuel control actions are taken.

For the upstream EGO sensors monitoring requirements, a symmetric

modulation signal is superimposed over the normal closed loop

limit cycle. The limit cycle is not altered with the exception

that the EGO signals are forced to switch at a programmed frequency.

The term LAM\_MOD, shown in the logic below, carries the modulation

signal and is zero when not performing upstream EGO sensor monitoring.

unconditionally ----------| LAM\_FINAL1 := LAMBSE1 + LAMBSE\_MOD1

| LAM\_FINAL2 := LAMBSE2 + LAMBSE\_MOD2

ALT\_CAL\_FLG = 1-----------| fn387a := FN387\_ALT(ECT)

|

| --- ELSE ---

|

| fn387a := FN387A(ECT)

DFSFLG = 1 ---------------| F\_A\_RATIO1 := 0

;In Decel Fuel Shutoff | F\_A\_RATIO2 := 0

|

| --- ELSE ---

|

UNDSP = 1 ----------------| F\_A\_RATIO1 := (KAMRF1 \* fn387a) /

;in underspeed mode | (NOMINAL\_AFR \* LAMBSE1)

| F\_A\_RATIO2 := (KAMRF2 \* fn387a) /

| (NOMINAL\_AFR \* LAMBSE2)

| ;check for divide by zero

|

| --- ELSE ---

|

| F\_A\_RATIO1 := KAMRF1 /

| (NOMINAL\_AFR \* LAM\_FINAL1)

| F\_A\_RATIO2 := KAMRF2 /

| (NOMINAL\_AFR \* LAM\_FINAL2)

| ;check for divide by zero

Calculate the fuel pulsewidth offset from zero to low slope intercept in

milliseconds (PWOFS\_D) and in ticks (PWOFF). NOTE: The intermediate units

conversion calculation is for documentation purposes. It is not meant to

force a particular implementation of the conversion from PWOFS\_D to PWOFF,

except to ensure that the proper engineering units are maintained.

always -------------------| PWOFS\_D := FN367(VBAT)

|

| ;first convert PWOFF\_D from msec to seconds

| pwoff\_sec := PWOFF\_D / 1000

| ;then convert to ticks for PWOFF

| PWOFF := pwoff\_sec \* stcf

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FUEL STRATEGY, FUEL PULSEWIDTH, BACKGROUND FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DUAL SLOPE INJECTOR CALIBRATION PARAMETERS

FUEL MASS VERSUS FUEL PULSEWIDTH DIAGRAM

FUEL (lbm/injection)

3.0e-5 |

| ..

| ..

| ..

| ..

2.5e-5 | ..

| ..

| ..|

| .. |

| .. |

| .. | AHISL

| .. |

| ..\_\_\_\_\_\_\_\_\_\_|

| ..

| ..

1.5e-5 | ..

| ----------------->.<---- FUEL\_BKPT

| .

| .|

| . |ALOSL

1.0e-5 | . |

| .\_\_\_|

| .

| .

| |

| (.)|

| (.) |

| (.) |

| (.) |

| (.) |

0 .\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\*

| ^ | | | | | | | | Pulsewidth

0.5 | 1.5 2.5 3.5 4.5 5.5 (msec)

| |

|<---->|MINPW

|

FN367(VBAT)

NOTES: FN367 (a.k.a. PWOFF) is added into the pulsewidth in the

foreground in module FUEL\_INJ\_OUT\_COMx.

A calibration guide is available for determination of

ALOSL, AHISL, FN367, and FUEL\_BKPT from injector flow data.

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FUEL STRATEGY, FUEL PULSEWIDTH, BACKGROUND FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.18 FEATURE: FUEL PUMP - V2.1\_FPUMP (CDAN0)

8.18.1 FUEL PUMP SELECTION LOGIC (CDAN0)

OVERVIEW

This module determines which set of control and diagnostic strategy is

executed depending upon which type of fuel pump is being utilized. The

strategy supports single-speed (FP\_TYPE = 0), and dual speed (FP\_TYPE = 1)

fuel pump.

A single-speed fuel pump system is shown below. The EEC sends an on/off

(100%/0% PWM) signal (via FPUMP\_DC) to the fuel pump relay and reads the pump

secondary circuit monitor (F\_PUMP\_S\_MON).

+----------+ F\_PUMP\_S\_MON input

| |<---------------------+

| EEEC | | +------+

| |----+pump +----------| |

+----------+ |(PWM output) | fuel |

| +--------->| pump |

+---v---+ | | |

+12v >--|-o /o-|-------------+ +------+

+-------+

Fuel Pump

Relay

A dual-speed fuel pump system is shown below. The EEC sends an on/off

(100%/0% PWM) signal (via FPUMP\_DC) to the fuel pump relay and a high/low

signal (FPUMP\_SPEED) to a solid state relay which routes current either

directly to the fuel pump or through a dropping resistor. The FPUMP\_SPEED

command may also be sent via SCP for those applications using a VLCM. The

EEC reads the pump secondary circuit monitor (F\_PUMP\_S\_MON).

+----------+ F\_PUMP\_S\_MON input

| |<---------------------------------------------+

| EEEC | FPL output |

| |---------------------------+Solid State |

| |----+pump |Relay |

+----------+ |PWM output +--v----+ |

| +-----|-o---o-|-----+ |

+---v---+ | +-------+ | +--+---+

+12v >--|-o /o-|---------+ |--->| fuel |

+-------+ | | | pump |

Fuel Pump +-----|/|/|/|/------+ +------+

Relay Dropping

Resistor

8-139

FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP SELECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Calibration Constants:

- FP\_TYPE = Type of fuel pump: 0->ON/OFF, 1->2-speed,

PROCESS FLOW

+-------------+

FP\_TYPE=0 | fuel pump | FP\_TYPE=1

+------------| selection |-------------+

| +-------------+ |

| |

+------v------+ +------v------+

| pump on/off | | pump on/off |

| control | | control |

+------+------+ +------+------+

| |

| +------v------+

| | pump hi/lo |

| | speed cntrl |

| +------+------+

| |

+------v------+ +------v------+

| pump PWM | | pump PWM |

| output | | output |

+------+------+ +------+------+

| |

| +------v------+

| | pump hi/lo |

| | spd output |

| +------+------+

| |

+------v------+ +------v------+

| driver | | driver |

| circuit test| | circuit test|

+------+------+ +------+------+

| |

+------v------+ +------v------+

| secondary | | secondary |

| circuit test| | circuit test|

+------+------+ +------+------+

| |

| +------v------+

| | pump hi/lo |

| | circuit test|

| +------+------+

| +-------------+ |

+----------->| done |<------------+

+-------------+

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP SELECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FPUMP\_SELECT\_COM2

BEGIN: fuel\_pump\_control\_selection

; This module is executed once per background loop.

; Determine which fuel pump strategy to execute:

FP\_TYPE = 0 ---------------------| Do: fp\_on\_off\_control

; On/Off fuel pump | Do: fp\_pwm\_output

| Do: fp\_driver\_test

| Do: fp\_secondary\_test

|

| --- ELSE ---

|

FP\_TYPE = 1 ---------------------| Do: fp\_on\_off\_control

; Dual speed fuel pump | Do: fp\_hi\_lo\_control

| Do: fp\_pwm\_output

| Do: fp\_hi\_lo\_output

| Do: fp\_driver\_test

| Do: fp\_secondary\_test

| Do: fp\_hi\_lo\_test

END: fuel\_pump\_control\_selection

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.18.2 FUEL PUMP CONTROL LOGIC (CDAK0)

OVERVIEW

This module controls the on/off control of a single or dual speed fuel pump

(FP\_TYPE = 0 or 1). The output is specified as a duty cycle to make the

output compatible with strategies that are capable of modulating the fuel

pump output. Also, this utilizes the parallel control to the SSPOD/UPOD

driver, thereby eliminating unnecessary serial communications overhead.

The output duty cycles required to turn the fuel pump full ON or OFF are

specified by the scalars PUMP\_ON\_DC and PUMP\_OFF\_DC, respectively.

DEFINITIONS

INPUTS

Registers:

- FPMP\_ON\_TMR = Timer to limit the on time during engine off testing.

- TSLPIP = Teime since last PIP low-to-high transition, msec.

Bit Flags:

- FLG\_THFT\_FCO = Flag signalling when fuel is being cut out due to anti

theft system action; 1 -> cutting out fuel.

- OSM\_EO\_OFF = OFF state requested for outputs during engine off on-demand

test

- OSM\_EO\_ON = ON state requested for outputs during engine off on-demand

test

Calibration Constants:

- FPMP\_ON\_TM = Maximum time for fuel pump to be on during engine off

on-demand test.

- PUMP\_OFF\_DC = Output duty cycle required to command fuel pump full OFF.

- PUMP\_ON\_DC = Output duty cycle required to command fuel pump full ON.

OUTPUTS

Registers:

- FPMP\_ON\_TMR = See above.

- FPUMP\_DC = Desired fuel pump output duty cycle.

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FPUMP\_CTRL\_COM1

BEGIN: fp\_on\_off\_control

; This process is executed only when called.

OSM\_EO\_ON = 1 -------------------|

; On demand test - pump ON |

; state requested |AND -| fpump\_dc := PUMP\_ON\_DC

| | ; Command pump full ON

FPMP\_ON\_TMR < FPMP\_ON\_TM --------| |

; Time limit in ON state |

; not yet expired | --- ELSE ---

|

OSM\_EO\_ON = 1 -------------------------| fpump\_dc := PUMP\_OFF\_DC

; On demand test - pump ON state | ; Command pump full OFF

; requested. Time limit expired. |

|

| --- ELSE ---

OSM\_EO\_OFF = 1 ------------------| |

; On demand test - pump OFF | |

; state requested. | |

| |

TSLPIP >= 1000 ms ---------------|OR --| fpump\_dc := PUMP\_OFF\_DC

; Last PIP more than | |

; 1 second ago | | FPMP\_ON\_TMR := 0

| | ; Clear pump ON timer

FLG\_THFT\_FCO = 1 ----------------| |

;Theft condition exists |

| --- ELSE ---

|

| fpump\_dc := PUMP\_ON\_DC

|

unconditionally-------------------------| Do: substitute(19,fpump\_dc)

| FPUMP\_DC := fpump\_dc

END: fp\_on\_off\_control

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, TWO-SPEED FUEL PUMP CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.18.3 TWO-SPEED FUEL PUMP CONTROL LOGIC (CDAJ0)

OVERVIEW

This module is designed to determine the high/low speed for a two speed fuel

pump. Note that the on/off control is performed by another module

(FPUMP\_COMn).

For the two speed pump, the speed is selected by a Solid State Relay (SSR)

which either routes Vbat directly to the pump or through a dropping resistor

which results in a lower pump speed.

+----------+ FPL output

| |---------------------------+

| EEEC | |Solid State

| |----+pump |Relay

+----------+ |PWM output +--v----+

| +-----|-o---o-|-------+

+---v---+ | +-------+ |

+12v >--|-o /o-|---------+ +----> To fuel

+-------+ | | pump

Fuel Pump +-----|/|/|/|/--------+

Relay Dropping

Resistor

DEFINITIONS

INPUTS

Registers:

- AM = Air Mass flow, lb/min.

- N = Engine RPM.

- VBAT = Battery voltage, VDC.

- WRMEGO = EGO sensor should be warm flag; 1 -> EGO is warm.

Bit Flags:

- FP\_HI\_ENABL1 = Hi fuel-pump speed enable flag for AM > a function of

VBAT; 1 -> enable hi speed.

- FP\_HI\_ENABL2 = Hi fuel-pump speed enable flag due to sufficient RPM

regardless; 1 -> enable hi speed.

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, TWO-SPEED FUEL PUMP CONTROL LOGIC - CDAN2

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Calibration Constants:

- FNFP\_VBAT = AM hi-speed fuel-pump enabling function, lb/min.

- FP\_N\_ENA\_SH = RPM above which hi-speed fuel pump is enabled (set FF),

RPM.

- FP\_N\_ENA\_CL = RPM below which hi-speed fuel pump is disabled (clear FF),

RPM.

- FP\_AM\_HYS = Hysteresis used with FNFP\_VBAT to avoid flickering fuel pump

states, lb/min.

OUTPUTS

Bit Flags:

- FP\_HI\_ENABL1 = See above.

- FP\_HI\_ENABL2 = See above.

- FPUMP\_SPEED = Desired pump speed; 0 -> low speed, 1 -> high speed.

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, TWO-SPEED FUEL PUMP CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FPUMP\_2SPD\_CTRL\_COM1

BEGIN: fp\_hi\_lo\_control

; This process is executed only when called.

AM >= FNFP\_VBAT(VBAT) -----------|S Q -| FP\_HI\_ENABL1

| | ; AM high enough with respect to

AM < FNFP\_VBAT(VBAT)- FP\_AM\_HYS -|C | ; VBAT to require high pump speed

N >= FP\_N\_ENA\_SH -----------------|S Q -| FP\_HI\_ENABL2

| | ; RPM high enough to use

N < FP\_N\_ENA\_CL ------------------|C | ; require high pump speed

FP\_HI\_ENABL1 = 1 -----------------|

|

FP\_HI\_ENABL2 = 1 -----------------|OR --| fpump\_speed := 1

| | ; Command high speed

WRMEGO = 0 -----------------------| |

|

| --- ELSE ---

|

| fpump\_speed := 0

| ; Command low speed

unconditionally ------------------------| Do: substitute(20,fpump\_speed)

| FPUMP\_SPEED := fpump\_speed

END: fp\_hi\_lo\_control

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP OUTPUT CONTROL STRATEGY - CDAN2

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8.18.4 FUEL PUMP OUTPUT CONTROL STRATEGY (CDAL0)

OVERVIEW

This module controls the output for the fuel pump when it is driven by a DARC

PWM output. The desired signal period and pulsewidth are determined from a

specified duty cycle (FPUMP\_DC) and frequency (FPUMP\_FREQ) and are written to

memory-mapped DARC PWM registers. The DARC PWM signal is driven by one of

the "smart" drivers -- typically a UPOD, which returns driver fault

information via the SPI. See the Hardware Interface chapter for more

information. If the fuel pump is driven by a power amplifier rather than a

relay, the signal must be inverted.

DEFINITIONS

INPUTS

Registers:

- FPUMP\_DC = Fuel pump output duty cycle.

Calibration Constants:

- FP\_DRIVER = Fuel pump driver type; 0->relay, 1->power amp.

- FPUMP\_FREQ = Output frequency for fuel pump signal.

OUTPUTS

Registers:

- dtscf = DARC ticks to seconds conversion factor. Not displayable.

- fpump\_period = Output signal period for fuel pump. Not displayable.

- fpump\_pw = Output signal pulsewidth for fuel pump. Not displayable.

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP OUTPUT CONTROL STRATEGY - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FPUMP\_PWM\_OUTPUT\_COM1

BEGIN: fp\_pwm\_output

; This process is executed only when called.

FP\_DRIVER = 0 ---------------| fpump\_period :=

; Relay driver | dtscf / FPUMP\_FREQ

| ; Convert pump frequency

| ; to a period in DARC ticks.

|

| fpump\_pw :=

| FPUMP\_DC \* fpump\_period

| ; Calculate pump pulsewidth

|

| --- ELSE ---

|

| fpump\_period :=

| dtscf / FPUMP\_FREQ

| ; Convert pump frequency

| ; to a period in DARC ticks.

|

| fpump\_pw :=

| (1 - FPUMP\_DC) \* fpump\_period

| ; Calculate pump pulsewidth

| ; and invert for power amp

| ; driver.

unconditionally -------------| Output fpump\_period and fpump\_pw

| to appropriate DARC PWM registers.

END: fp\_pwm\_output

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP SPEED OUTPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.18.5 FUEL PUMP SPEED OUTPUT (CDAL0)

OVERVIEW

This module controls dual speed fuel pump (FP\_TYPE = 1) high/low speed

output. The desired fuel pump speed is output to a dedicated EEEC output.

The Fuel Pump Low (FPL) output controls a normally closed solid state relay

which is connected in parallel to a dropping resistor as shown below.

+----------+ FPL output

| |---------------------------+

| EEEC | |Solid State

| |----+pump |Relay

+----------+ |PWM output +--v----+

| +-----|-o---o-|-------+

+---v---+ | +-------+ |

+12v >--|-o /o-|---------+ +----> To fuel

+-------+ | | pump

Fuel Pump +-----|/|/|/|/--------+

Relay Dropping

Resistor

DEFINITIONS

Bit Flags:

- FPL = Fuel Pump Low commanded output; 0->High speed, 1->Low speed.

- FPUMP\_SPEED = 2-speed fuel pump desired speed; 1 -> high speed.

PROCESS

STRATEGY MODULE: FPUMP\_SPEED\_OUTPUT\_COM1

BEGIN: fp\_hi\_lo\_output

; This process is executed only when called.

FPUMP\_SPEED = 0 ------------------------| FPL := 1

; Low speed fuel pump requested | ; Energize normally closed

| ; relay. Route current

| ; through resistor.

|

| --- ELSE ---

|

| FPL := 0

| ; Close relay. Bypass

| ; dropping resistor.

END: fp\_hi\_lo\_output

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP PRIMARY CIRCUIT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.18.6 FUEL PUMP PRIMARY CIRCUIT TEST (CDAM0)

OVERVIEW

This module checks the output driver status returned from the UPOD/SSPOD

driver via the SPI. If a fault is present for a calibratible amount of time,

the appropriate malfunction code is set.

NOTE, for fuel pump output on an SSPOD:

This driver circuit test can only detect an open circuit or a short to ground

while the pump is requested OFF. If the pump is requested ON, all this test

can detect is a short to VBAT.

Since a failed fuel pump will result in a no-start, the ability to test the

fuel pump upon power-up can be calibrated in by setting FP\_PU\_DT\_SW = 1.

This allows testing whenever the key is ON, prior to any CCM test being

enabled. Should that feature be calibrated out, the KOEO and OTM diagnostics

can be calibrated in by setting FP\_EO\_DT\_SW and FP\_OT\_DT\_SW. These switches

allow the OSM\_EO\_ON and OSM\_EO\_OFF tests to be calibrated out individually,

which Mazda badge vehicles may want to do.

DEFINITIONS

Registers:

- PUTMR = Time after CPU power up.

- V\_FP\_ER\_TMR1 = Fuel pump monitor timer for primary circuit failure

(P0230).

Bit Flags:

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag. (1 =>

test enabled)

- F\_PUMP\_ERROR = Fuel pump driver circuit error status; 1->driver circuit

fault.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II scan tool

reset message.

- OSM\_EO\_OFF = OFF state requested for OSM outputs during engine off on

demand test.

- OSM\_EO\_ON = ON state requested for OSM outputs during engine off on

demand test.

Calibration Constants:

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP PRIMARY CIRCUIT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FP\_EO\_DT\_SW = Switch to enable FP primary circuit test during KOEO.

- FP\_ER\_DT\_SW = Switch to enable FP primary circuit test during KOER.

- FP\_OT\_DT\_SW = Switch to enable FP primary circuit test when OSM\_EO\_ON =

1.

- FP\_PU\_DT\_SW = Switch to enable FP primary circuit test on power-up.

- FP\_PU\_TM = EEC stabilization time before testing fuel pump.

- FPMP\_OSM\_ENA = Switch to enable fuel pump primary circuit test.

- PUMP\_OFF\_DC = Duty cycle to command to turn off the fuel pump.

- V\_FP\_ER\_TM1 = Time delay before setting fuel pump primary circuit

malfunction flag (P0230).

OTHER

- P0230 = Fuel pump primary circuit failure.

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP PRIMARY CIRCUIT TEST - CDAN2

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PROCESS

STRATEGY MODULE: FPUMP\_DRVR\_TST\_COM1

BEGIN: fp\_driver\_test

; This process is executed only when called.

; Check if all conditions are met to test fuel pump driver circuit.

OSM\_EO\_ON = 1 -----------------------|

;KOEO or OTM requests pump ON |AND -| fp\_dt\_ena := 0

| | ;Disable the test

FP\_OT\_DT\_SW = 0 ---------------------| |

;Disallow test with pump ON, |

;engine OFF | --- ELSE ---

|

OSM\_EO\_ON = 1 -----------------------| |

;KOEO or OTM requests pump ON | |

| |

FP\_PU\_DT\_SW = 1 ---------------| | |

;Test enabled | | |

;on power-up | | |

| | |

PUTMR > FP\_PU\_TM --------------|AND -| |

;EEC powered up long | | |

;enough to stabilize | | |

| | |

CCM\_TST\_ENA = 0 ---------------| | |

;Continuous test not running | |

| |

OSM\_EO\_OFF = 1 ----------------| | |

;KOEO or OTM requests | | |

;pump OFF |AND -| |

| | |

FP\_EO\_DT\_SW = 1 ---------------| | |

;FP primary test |OR --| fp\_dt\_ena := 1

;enabled in KOEO | | ;Enable the diagnostic test

| |

CCM\_ER\_ENA = 1 ----------------| | |

;KOER test in prog |AND -| |

| | |

FP\_ER\_DT\_SW = 1 ---------------| | |

;FP primary test | |

;enabled in KOER | |

| |

CCM\_TST\_ENA = 1 ---------------| | |

; CCM test in prog |AND -| |

| |

FPMP\_OSM\_ENA = 1 --------------| |

; FP primary circuit |

; test is enabled |

| --- ELSE ---

|

| fp\_dt\_ena := 0

| ;Disable the test

|

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP PRIMARY CIRCUIT TEST - CDAN2

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fp\_dt\_ena = 1 -----------------------|

|AND -| Do: fp\_test\_driver\_circuit

OBDII\_RESET = 0 ---------------------| |

|

| --- ELSE ---

|

| V\_FP\_ER\_TMR1 := 0

| ; Clear primary circuit

| ; test timer

|

| clear\_malf(P0230)

| ; Erase code

END: fp\_driver\_test

BEGIN: fp\_test\_driver\_circuit

; This process is executed only when called.

F\_PUMP\_ERROR = 0 ------------------------| V\_FP\_ER\_TMR1 := 0

; Driver circuit okay | ; Clear driver circuit

| ; error timer.

|

| Do: clear\_malf(P0230)

|

| --- ELSE ---

F\_PUMP\_ERROR = 1 ------------------| |

; Driver circuit fault exists |AND -| Do: store\_code(P0230)

| |

V\_FP\_ER\_TMR1 > V\_FP\_ER\_TM1 --------| |

; Sufficient time with fault | --- ELSE ---

|

| Allow V\_FP\_ER\_TMR1 to increment.

END: fp\_test\_driver\_circuit

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP SECONDARY CIRCUIT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.18.7 FUEL PUMP SECONDARY CIRCUIT TEST (CDAM0)

OVERVIEW

This module tests the fuel pump secondary circuit monitor. In a properly

functioning system, the fuel pump secondary circuit monitor input,

F\_PUMP\_S\_MON, is HIGH when the fuel pump is ON. If the fuel pump is

commanded on and F\_PUMP\_S\_MON remains low for a sufficient period of time,

code P0231 is set. This indicates a break in the line between the battery

and the F\_PUMP\_S\_MON input to the ECA or no contact inside the fuel pump

relay.

Conversely, F\_PUMP\_S\_MON should be LOW when the fuel pump is OFF. If the

fuel pump is commanded off and F\_PUMP\_S\_MON is high for a sufficient period

of time, code P0232 is set. This indicates that either the fuel pump relay

is stuck closed or there is an open circuit between the ECA and the fuel pump

ground allowing the ECA pull-up circuit to hold F\_PUMP\_S\_MON high.

Since a failed fuel pump will result in a no-start, the ability to test the

fuel pump upon power-up can be calibrated in. This allows testing when a

start is attempted, prior to any CCM test being enabled.

A Mazda requirement is that the test be disabled during KOEO or OTM if the

pump is requested ON. This is accomplished by setting FP\_OT\_ST\_SW = 0 and

FP\_EO\_ST\_SW = 1.

To run the diagnostics any time the pump is on with the engine off, calibrate

FP\_PU\_ST\_SW = 1. Mazda, as well as NAAO, may calibrate this test in, as the

test described in the previous paragraph takes precedence.

DEFINITIONS

Registers:

- FPUMP\_DC = Modulated Fuel Pump Duty cycle output.

- PUTMR = Time after CPU power up.

- V\_FP\_ER\_TMR2 = Fuel pump monitor timer for P0231MALF.

- V\_FP\_ER\_TMR3 = Fuel pump monitor timer for P0232MALF.

- VBAT = Battery voltage, volts.

Bit Flags:

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag. (1 =>

test enabled)

- F\_PUMP\_ERROR = Fuel pump driver circuit error status; 1 -> driver circuit

fault.

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP SECONDARY CIRCUIT TEST - CDAN2

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- F\_PUMP\_S\_MON = Fuel pump secondary monitor; 0 = pump off, 1 = pump on.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II scan tool

reset message.

- OSM\_EO\_OFF = OFF state requested for OSM outputs during engine off on

demand test.

- OSM\_EO\_ON = ON state requested for OSM outputs during engine off on

demand test.

Calibration Constants:

- FP\_EO\_ST\_SW = Switch to enable FP secondary circuit test during KOEO.

- FP\_ER\_ST\_SW = Switch to enable FP secondary circuit test during KOER.

- FP\_OT\_ST\_SW = Switch to enable FP secondary circuit test when OSM\_EO\_ON =

1.

- FP\_PU\_ST\_SW = Switch to enable FP secondary circuit test on power-up.

- FP\_PU\_TM = EEC stabilization time before testing fuel pump.

- FPMP\_SMON\_EN = Switch to enable fuel pump secondary circuit test.

- PUMP\_OFF\_DC = Output duty cycle required to command fuel pump full OFF.

- PUMP\_ON\_DC = Output duty cycle required to command fuel pump full ON.

- VBAT\_CCM\_MIN = Minimum voltage to perform circuit monitor test.

- V\_FP\_ER\_TM2 = Time delay before setting P0231MALF.

- V\_FP\_ER\_TM3 = Time delay before setting P0232MALF.

OTHER

- P0231 = Fuel pump secondary circuit monitor LOW with pump commanded ON.

- P0232 = Fuel pump secondary circuit monitor HIGH with pump commanded OFF.

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP SECONDARY CIRCUIT TEST - CDAN2

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PROCESS

STRATEGY MODULE: FPUMP\_SMON\_TST\_COM1

BEGIN: fp\_secondary\_test

; This process is executed only when called.

; Check if all conditions are met to test fuel pump secondary circuit.

OSM\_EO\_ON = 1 -----------------------|

;KOEO or OTM requests pump ON |AND -| fp\_st\_ena := 0

| | ;Disable the test

FP\_OT\_ST\_SW = 0 ---------------------| |

;Disallow test with |

;pump on, engine off | --- ELSE ---

|

OSM\_EO\_ON = 1 -----------------------| |

;KOEO or OTM requests pump ON | |

| |

FP\_PU\_ST\_SW = 1 ---------------| | |

;Test enabled | | |

;on power-up | | |

| | |

PUTMR > FP\_PU\_TM --------------|AND -| |

;EEC powered up long | | |

;enough to stabilize | | |

| | |

CCM\_TST\_ENA = 0 ---------------| | |

;Continuous test not running | |

| |

OSM\_EO\_OFF = 1 ----------------| |OR --| fp\_st\_ena := 1

;KOEO or OTM requests | | | ;Enable the diagnostic test

;pump OFF |AND -| |

| | |

FP\_EO\_ST\_SW = 1 ---------------| | |

;FP secondary test | |

;enabled in KOEO and OTM | |

| |

CCM\_ER\_ENA = 1 ----------------| | |

;KOER test in prog |AND -| |

| | |

FP\_ER\_ST\_SW = 1 ---------------| | |

;FP secondary test | |

;enabled in KOER | |

| |

CCM\_TST\_ENA = 1 ---------------| | |

; CCM test in prog |AND -| |

| |

FPMP\_SMON\_EN = 1 --------------| |

; FP Secondary circuit |

; test present |

| --- ELSE ---

|

| fp\_st\_ena := 0

| ;Disable the test

|

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP SECONDARY CIRCUIT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

fp\_st\_ena = 1 -----------------------|

|

VBAT > VBAT\_CCM\_MIN -----------------|

; Battery voltage stable |AND -| Do: fp\_test\_secondary\_circuit

| |

OBDII\_RESET = 0 ---------------------| |

| |

F\_PUMP\_ERROR = 0 --------------------| |

;Driver circuit OK |

|

| --- ELSE ---

|

| clear\_malf(P0231)

| clear\_malf(P0232)

| ; Clear pump codes

|

| V\_FP\_ER\_TMR2 := 0

| V\_FP\_ER\_TMR3 := 0

| ; Clear test timers

END: fp\_secondary\_test

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP SECONDARY CIRCUIT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: fp\_test\_secondary\_circuit

; This process is executed only when called.

FPUMP\_DC = PUMP\_ON\_DC ------------|

; Fuel pump ON |

|

F\_PUMP\_S\_MON = 0 -----------------|AND -| Do: store\_code(P0231)

; Secondary circuit monitor | | ; Indicate pump ON fault

; indicates pump OFF | |

| | Do: clear\_malf(P0232)

V\_FP\_ER\_TMR2 > V\_FP\_ER\_TM2 -------| | ; Erase any pump OFF fault

; Sufficient time with fault |

| V\_FP\_ER\_TMR3 := 0

| ; Clear pump OFF test timer

|

| --- ELSE ---

FPUMP\_DC = PUMP\_ON\_DC ------------| |

; Fuel pump ON |AND -| Do: clear\_malf(P0232)

| |

F\_PUMP\_S\_MON = 0 -----------------| | V\_FP\_ER\_TMR3 := 0

; Secondary circuit monitor | ; Clear pump OFF test timer

; indicates pump OFF |

| --- ELSE ---

FPUMP\_DC = PUMP\_OFF\_DC -----------| |

; Fuel pump OFF | |

| |

F\_PUMP\_S\_MON = 1 -----------------|AND -| Do: store\_code(P0232)

; Secondary circuit monitor | | ; Indicate pump OFF fault.

; indicates pump ON | |

| | Do: clear\_malf(P0231)

V\_FP\_ER\_TMR3 > V\_FP\_ER\_TM3 -------| | ; Clear any pump ON fault.

; Sufficient time with fault |

| V\_FP\_ER\_TMR2 := 0

| ; Clear pump ON test timer

|

| --- ELSE ---

FPUMP\_DC = PUMP\_OFF\_DC -----------| |

; Fuel pump OFF |AND -| Do: clear\_malf(P0231)

| |

F\_PUMP\_S\_MON = 1 -----------------| | V\_FP\_ER\_TMR2 := 0

; Secondary circuit monitor |

; indicates pump ON | --- ELSE ---

|

| V\_FP\_ER\_TMR2 := 0

| Do: clear\_malf(P0231)

|

| V\_FP\_ER\_TMR3 := 0

| Do: clear\_malf(P0232)

END: fp\_test\_secondary\_circuit

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP SPEED CIRCUIT TEST - CDAN2

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8.18.8 FUEL PUMP SPEED CIRCUIT TEST (CDAM0)

OVERVIEW

This module checks the fuel pump speed driver status returned from the

UPOD/SSPOD driver via the SPI. If a fault is present for a calibratible

amount of time, the appropriate malfunction code is set.

DEFINITIONS

Registers:

- PUTMR = Time after CPU power up.

- V\_FP\_ER\_TMR4 = Fuel pump speed monitor timer for primary circuit failure

(P1232).

Bit Flags:

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled.

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag. (1 =>

test enabled)

- FPMP\_OSM\_ENA = Switch to enable Fuel Pump OSM test.

- FP\_2SPD\_ERR = Fuel pump high-speed driver circuit fault flag.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II scan tool

reset message.

Calibration Constants:

- FP\_EO\_HL\_SW = Switch to enable FP hi-speed primary circuit test during

KOEO.

- FP\_ER\_HL\_SW = Switch to enable FP hi-speed primary circuit test during

KOER.

- V\_FP\_ER\_TM4 = Time delay before setting fuel pump speed primary circuit

malfunction (P1232)

OTHER

- P1232 = Fuel pump speed primary circuit malfunction.

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FUEL STRATEGY, FUEL DELIVERY SYSTEM, FUEL PUMP SPEED CIRCUIT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FPUMP\_HI\_LO\_TST\_COM1

BEGIN: fp\_hi\_lo\_test

; This process is executed only when called.

CCM\_EO\_ENA = 1 -------|

;KOEO test in prog |AND -|

| |

FP\_EO\_HL\_SW = 1 ------| |

;FP hi-lo test |

;enabled in KOEO |OR --|

| |

CCM\_ER\_ENA = 1 -------| | |

;KOER test in prog |AND -| |

| | |

FP\_ER\_HL\_SW = 1 ------| | |

;FP hi-lo test | |

;enabled in KOER | |

| |

CCM\_TST\_ENA = 1 ------| | |AND -| No action

; CCM test in prog |AND -| | | ;Allow V\_FP\_ER\_TMR4 to

| | | ;increment as a free-running

FPMP\_OSM\_ENA = 1 -----| | | ;timer.

; FP hi-lo test | |

; present | |

| |

OBDII\_RESET = 0 ------------------| |

| |

FP\_2SPD\_ERR = 1 ------------------| |

;primary hi speed monitor |

;indicates error |

| --- ELSE ---

|

| V\_FP\_ER\_TMR4 := 0

| ;no errors

V\_FP\_ER\_TMR4 > V\_FP\_ER\_TM4 -------------| store\_code(P1232)

;fault present long enough | ;pump speed primary circuit

| ;failure.

|

| --- ELSE ---

|

| Do: clear\_malf(P1232)

END: fp\_hi\_lo\_test

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FUEL STRATEGY, PPCTR CONTROL - CDAN2

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8.19 PPCTR CONTROL (CDAA0)

OVERVIEW

This counter counts PIPs when not in Decel Fuel Shut-Off. PPCTR is updated

at PIP rising edge before injector pulsewidth is calculated and output.

DEFINITIONS

INPUTS

Bit Flags:

- DFSFLG = Decel Fuel Shut-Off flag; 1 -> the decel fuel multiplier is not

one.

Calibration Constants:

- PIPNUM = Number of PIPs to remain in Open Loop fuel after DFSO. Prevents

LAMBSE from ramping off rich due to normal transport delay time. Set to

1 to calibrate out.

OUTPUTS

Registers:

- PPCTR = PIP counter; updated at PIP rising edge before injector

pulsewidth is calculated and output.

PROCESS

STRATEGY MODULE: FUEL\_PPCTR\_COM1

DFSFLG = 0 ----------------------| Increment PPCTR every PIP

| (Clip at PIPNUM)

|

| --- ELSE ---

|

| PPCTR = 0

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FUEL STRATEGY, RPM LIMITER LOGIC - CDAN2

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8.20 RPM LIMITER LOGIC (CDAN0)

OVERVIEW

The RPM limiter logic turns off the fuel if the engine RPM exceeds its

"red-line" limit. Note that the parameter DT12SH represents the PIP delta

time value which exceeds the specified range of the byte-length parameter

DT12S. For this reason, if the parameter DT12SH contains a value greater

than zero, the speed limiting logic need not cut out fuel - since the PIP's

are much farther apart than DT12S (ie. slow engine speed).

DEFINITIONS

Registers:

- DT12S = The period of time between two adjacent rising edges of PIP.

- DT12SH = Hi byte of DT12S - stores overflow of PIP delta time.

- DT23S = Last DT12S time.

- PIPLMT\_HIG = Stage 3 rev limit in use.

- PIPLMT\_LOW = Stage 2 rev limit in use.

Bit Flags:

- FOFFLG2 = Stage 2 alternate fire VS exceeded.

- FOFFLG3 = Stage 2 alternate fire TP exceeded (engine oil temp

protection).

- FUEL\_CUT = Fuel cutout active. Set in foreground for continuous self

test

- HALF\_FUEL = Flag which indicates one-half of the injections are to be

cut-out; 1 -> half fuel.

- MLUS\_HF\_FLG = Converter Clutch Failed flag; 1 => Enter Half Fuel.

- NLMT\_FLG2 = Stage 3 no fuel VS exceeded.

- NO\_FUEL = Flag which indicates that all injections are to be cut-out; 1

-> no fuel.

- OFM\_FMEM = ETV overcurrent based alternate fire request flag; 1->

Alternate fire requested, 0 -> Normal fire.

- PIP\_ST2\_FLG = Flag indicating Stage 2 rev limiting required due to PIP

condition.

Calibration Constants:

- MNPIPn = Minimum PIP period, clock ticks; n = 4 (4-cylinder engine), 6

(6-cylinder engine), or 8 (8-cylinder engine).

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FUEL STRATEGY, RPM LIMITER LOGIC - CDAN2

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- PIPLIMHYT = Rev limiter hystersis, clock ticks.

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FUEL STRATEGY, RPM LIMITER LOGIC - CDAN2

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PROCESS

STRATEGY MODULE: FUEL\_RPM\_LIM\_FG\_COM4

BAD PIP DETERMINATION (done in PIP\_DATA on PIP\_HIGH)

dt12s < MNPIPn -------------------------| Exit PIP\_DATA routine

(RPM higher than PIP noise filter) | (ignore this PIP)

|

| --- ELSE ---

|

| DT23S = DT12S

| DT12S = Low word (dt12s)

| DT12SH = Hi byte (dt12s)

DT12SH <> 0 ----------------------------| HALF\_FUEL = 0

;PIP time very long | NO\_FUEL = 0

| EXIT this module.

DT12S < PIPLMT\_LOW ---------|

|AND -|S Q -| PIP\_ST2\_FLG

DT23S < PIPLMT\_LOW ---------| |

|

DT12S > PIPLMT\_LOW + |

PIPLIMHYT ---------| |

|AND -|C

DT23S > PIPLMT\_LOW + |

PIPLIMHYT ---------|

DT12S < PIPLMT\_HIG ---------|

|AND -|

DT23S < PIPLMT\_HIG ---------| |OR --| HALF\_FUEL = 0

| | NO\_FUEL = 1

NLMT\_FLG2 = 1 --------------------| | FUEL\_CUT = 1

|

| --- ELSE ---

PIP\_ST2\_FLG = 1 ------------------| |

| |

FOFFLG2 = 1 ----------------------| |

| |

FOFFLG3 = 1 ----------------------|OR --| HALF\_FUEL = 1

| | NO\_FUEL = 0

MLUS\_HF\_FLG = 1 ------------------| | FUEL\_CUT = 1

| |

OFM\_FMEM = 1 ---------------------| |

| --- ELSE ---

|

| HALF\_FUEL = 0

| NO\_FUEL = 0

The flag, FUEL\_CUT, is cleared in Background by the continuous selftest

routine.

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FUEL STRATEGY, DIS INJECTOR SYNCHRONIZATION - CDAN2

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8.21 DIS INJECTOR SYNCHRONIZATION (CDAK0)

OVERVIEW

The mechanism used for fuel synchronization is the Camshaft I.D. (CID)

sensor for non VCT engine and CID1 and CID2 for engine with VCT. Engine with

variable cam logic and hardware will bypass the FUEL\_CID\_SYNC\_COM1 and the

FUEL\_PIP\_INT\_SYNC\_COM2 modules. The CIDn, VCT and SYNC\_CTR positions are

determined in the VCT\_CID\_SYNC\_COM1 and the VCT\_INPUT\_COM1 modules. VCAMHP

is used to determine when VCT hardware and software is used.

VCAMHP is set to zero for engine without VCT hardware or logic. The signal

from the CID sensor is used together with the PIP signal to locate a

particular cylinder (generally #1). The CID signal indicates the cycle of

the cylinder while the PIP signal indicates the crank position. Once the

first cylinder is located, a register called the SYNC\_CTR is used to indicate

the position and cycle of the remaining cylinders.

HP\_CIDSEL is the calibration constant set by the calibrator to indicate which

type of CID hardware is present, Hall Effect sensing or Variable Reluctance

sensing (Hall = 0 and VRS = 1). Figure 1 shows the CID signal of a Hall

system. Figure 2 shows the CID signal of a VRS system after the raw signal

(a single sinusoidal pulse every two crank revolutions) is processed. When

Hall CID hardware is present the signal has a 50 percent duty cycle and the

low-to-high transition is positioned at a nominal 26 degrees (crank) ATDC for

cylinder #1. With VRS CID hardware present the high-to-low transition of the

signal is positioned at a nominal 22.5 degrees (crank) ATDC for cylinder #1.

For a Hall system, the CID signal is processed when either a low-to-high or

high-to-low transition is recognized. For a VRS system processing only

occurs after recognition of a high-to-low transition. Regardless of which

system is employed, processing involves synchronizing the SYNC\_CTR to the CID

signal.

Figure 1 shows how synchronization is accomplished when Hall sensing hardware

is present. The SYNC\_CTR is incremented by the low-to-high transition (up

edge) of the PIP signal. To accomplish synchronization, the SYNC\_CTR is set

to 0 when the up edge of the CID signal occurs or it is set to ENGCYL (3 in

this case) when the down edge (high-to-low transition) occurs. The SYNC\_CTR

is always reset to 0 when the up edge of the CID signal is recognized.

Figure 2 shows that synchronization of the SYNC\_CTR occurs similarly when VRS

hardware is present. The difference is that the VRS CID signal allows the

SYNC\_CTR to be synchronized at only one point (the reset point) in the engine

cycle.

The CID\_PROCESSING strategy is designed such that if the SYNC\_CTR is

synchronized and the engine is in the run mode, the request to synchronize

fuel with PIP is issued.

If the CID signal is lost, the value of SYNC\_CTR will become greater than

NUMCYL after the engine cycle (720 degrees crank) is completed. The strategy

executed during the PIP interrupt checks if the CID signal is lost by

determining if SYNC\_CTR is greater than NUMCYL. If a CID signal is not seen

for two cycles (1440 degrees) of the engine, the system will assume CID

failure and revert to injector on-edge timing at the nearest PIP edge.

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FUEL STRATEGY, DIS INJECTOR SYNCHRONIZATION - CDAN2

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|<-- TDC CYL #1 - BEGINNING POWER STROKE

|

|<--10° BTDC

PIP \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_

SIGNAL: \_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_

SYNC\_CTR | | | | | | |

VALUE: 6-->0 1 2 3 4 5 6-->0

SYNC\_CTR = 0 (RESET) IF SYNC\_CTR <> 3

| THEN SYNC\_CTR = 3

|<--26° ATDC |

CID \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

SIGNAL: \_\_\_| |\_\_\_\_\_\_\_\_\_\_ nominal for CIDSEL = 0

and ENGCYL = 3

Condition A = CID High

Figure 1: SYNC\_CTR Values for a Six Cylinder Engine with a Hall CID Sensor

|<-- TDC CYL #1 - BEGINNING POWER STROKE

|

|<--10° BTDC

PIP \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_

SIGNAL: \_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_

SYNC\_CTR | | | | | | |

VALUE: 6-->0 1 2 3 4 5 6-->0

SYNC\_CTR = 0 (RESET)

|

|<--22.5° ATDC

CID \_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ nominal for CIDSEL = 1

SIGNAL: ||

--

Condition A = CID Low

Figure 2: SYNC\_CTR Values for a Six Cylinder Engine with a VRS CID Sensor

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FUEL STRATEGY, DIS INJECTOR SYNCHRONIZATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- SYNC\_CTR = Counter which counts cylinders from the PIP signal and resets

when equal to the number of cylinders in the engine.

Bit Flags:

- CID\_HIGH = CID input level; 1 -> high state, 0 -> low state.

Calibration Constants:

- ENGCYL = Number of cylinders that fire during one engine revolution.

- HP\_CIDSEL = CID Hardware select switch; 0 -> Hall Effect present, 1 ->

VRS sensor.

- NUMCYL = Number of cylinders in the engine.

- VCAMHP = Variable CAM timing hardware present; 1 - VCT present.

OUTPUTS

Registers:

- SYNC\_CTR = See above.

Bit Flags:

- FUEL\_IN\_SYNC = Fuel synchronized with PIP.

- SYNC\_FAIL = Indicates sync signal has been lost or was incorrectly placed

after system was in sync; 0 -> sync okay, 1 -> bad or lost sync signal.

- FIRST\_SYNC = Indicates whether the first CID edge has been detected; 1->

the first CID edge has been detected.

- SYNFLG = Cylinder #1 correctly identified flag; 1 -> SYNC\_CTR aligned

with cylinder #1, 0 -> SYNC\_CTR not aligned with cylinder #1.

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FUEL STRATEGY, DIS INJECTOR SYNCHRONIZATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_CID\_SYNC\_COM1

CID\_PROCESSING

HP\_CIDSEL = 0 ---------|

;Hall effect sensor |AND -|

| |

CID\_HIGH = 1 ----------| |

;Rising edge of signal |OR --| Condition A

|

HP\_CIDSEL = 1 ---------| |

;VRS sensor |AND -|

|

CID\_HIGH = 0 ----------|

;Falling edge of signal

VCAMHP = 0 ------------------|

|

Condition A -----------------|AND -| SYNC\_CTR = 0

| | SYNFLG = 0

FIRST\_SYNC = 1 --------------| | FUEL\_IN\_SYNC = 0

| | ;Sync pulse rec'd, not the first

SYNC\_CTR <> NUMCYL ----------| | ; one, and SYNC\_CTR is incorrect

|

| --- ELSE ---

Condition A -----------------| |

|AND -| SYNC\_CTR = 0

VCAMHP = 0 ------------------| | SYNFLG = 1

| FIRST\_SYNC = 1

| SYNC\_FAIL = 0

| ;In sync or first sync pulse

|

| --- ELSE ---

HP\_CIDSEL = 0 ---------------| |

| |

CID\_HIGH = 0 ----------------| |

|AND -| SYNC\_CTR = NUMCYL/2

SYNC\_CTR <> NUMCYL/2 --------| | SYNFLG = 0

;Counter out of phase | | FUEL\_IN\_SYNC = 0

| |

VCAMHP = 0 ------------------| |

|

| --- ELSE ---

HP\_CIDSEL = 0 ---------------| |

| |

CID\_HIGH = 0 ----------------| |

|AND -| FIRST\_SYNC = 1

SYNC\_CTR = NUMCYL/2 ---------| | SYNFLG = 1

|

VCAMHP = 0 ------------------|

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FUEL STRATEGY, FOREGROUND FUEL CALCULATIONS EXECUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.22 FOREGROUND FUEL CALCULATIONS EXECUTION CONTROL (CDAL0)

OVERVIEW

This module specifies execution conditions and required execution sequence

for certain PIP interrupt foreground fuel routines that are external to this

module. The execution hierarchy of relevant strategy modules is as follows.

- FUEL\_PIP\_INT\_SYNC

- FTRAN\_XTMODEL (foreground portion only)

- FUEL\_FG\_CALC

- FUEL\_TOTAL\_DELAY\_CALC

- FUEL\_INJ\_UPDATE\_REQUEST

- FUEL\_MAIN\_OFF (see notes below)

- FUEL\_SERVICE

- FUEL\_IBETA\_CALC

- FUEL\_SCHEDULE

- FUEL\_INJ\_OUT

- FUEL\_DYN\_CALC

- FUEL\_DYN\_FIT

- FUEL\_DYN\_OFF

The FUEL\_PIP\_INT\_SYNC logic, which is responsible for maintaining SYNC\_CTR,

is executed only on the rising-edge of the PIP signal. The Fuel Service

routine is always executed on every PIP edge (on both rising and falling PIP

edge).

All other routines are executed on the PIP edge specified by AIR\_DOWN\_CAL.

Furthermore, execution of transient fuel, dynamic fuel, and the fuel

pulsewidth calculations may be restricted to every-other PIP at high RPM.

This RPM threshold is specified by the calibration constant FULPIPALT\_DT,

which is compared with DT12S.

NOTES:

1. The FUEL\_MAIN\_OFF strategy module is called from the

FUEL\_INJ\_UPDATE\_REQUEST strategy module, and also from an interrupt

service routine. This interrupt is enabled within the FUEL\_INJ\_OUT

module, and is configured to execute when the pulsewidth on-edge is

issued.

2. The FUEL\_MAIN\_OFF module may also be invoked from the FUEL\_INJ\_OUT

module, in the case of a short pulse (where both edges are to be

scheduled at the same time).

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FUEL STRATEGY, FOREGROUND FUEL CALCULATIONS EXECUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- DATA\_TIME = Time of the current PIP edge, in ticks.

- DT12S = The period of time between two adjacent rising edges of PIP,

ticks/pip.

- LAST\_HI\_PIP = Time of the latest low-to-high PIP transition, in ticks.

Bit Flags:

- ALT\_PIP\_MODE = Flag indicating that fuel and air foreground calculations

are occurring every-other PIP.

- PIP\_HIGH = PIP Input level; 1 -> the most recent PIP signal transition

was a rising edge; 0 -> the most recent PIP signal transition was a

falling edge.

- SYNC\_CTR = Counter which counts cylinders from the PIP signal and resets

when equal to the number of cylinders in the engine.

- SYNFLG = 1 -> SYNCTR values are synchronized with signature PIP.

Calibration Constants:

- AIR\_DOWN\_CAL = Indicates on which PIP edge to calculate Cylinder Air

Charge; 0 -> use PIP up-edge; 1 -> use PIP down-edge.

- FULPIPALT\_DT = DT12S value below which some fuel calculations occur on

every-other PIP edge.

STRATEGY MODULES

Entry Points:

- FUEL\_FG\_PIPEDG = The main entry point to this strategy module.

External Routines:

- fuel\_fg\_transient\_calculations = Routine which performs the necessary

foreground transient fuel calculations, located in strategy module

FTRAN\_XTMODEL\_COMn.

- FUEL\_DYN\_CALC = Routine which performs the foreground dynamic fuel

calculations, located in strategy module FUEL\_DYN\_CALC\_COMn.

- FUEL\_FG\_CALC = Routine which performs the necessary foreground fuel

pulsewidth calculations, located in strategy module FUEL\_FG\_CALC\_COMn.

- FUEL\_PIP\_INT\_SYNC = Routine which updates SYNC\_CTR, and checks for loss

of injector synchronization.

- FUEL\_SERVICE = Routine for foreground injector output calculations and

scheduling, located in strategy module FUEL\_SERVICE\_COMn.

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FUEL STRATEGY, FOREGROUND FUEL CALCULATIONS EXECUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_FG\_PIPEDG\_COM3

BEGIN: FUEL\_FG\_PIPEDG

Execute this routine at each rising PIP edge and at each falling PIP edge.

This strategy module corresponds to a portion of the PIP\_DATA module in

software.

NOTE: The calibration flag AIR\_DOWN\_CAL also determines on which edge the

cylinder air charge calculation is performed. The air charge calculation

must occur before this routine begins.

PIP\_HIGH = 1 ---------------------------| LAST\_HI\_PIP := DATA\_TIME

| ;Store the time of each rising

| ; PIP edge

| Do: FUEL\_PIP\_INT\_SYNC

Transient fuel, fuel pulsewidth, and dynamic fuel are always calculated on

the rising PIP edge when injectors are not synchronized. When synchronized,

these calculations are made on the PIP edge specified by AIR\_DOWN\_CAL (if

AIR\_DOWN\_CAL = 0, calculations occur on the rising PIP edge). Fuel Service

is execution on every PIP edge, regardless of the calibrated value of

AIR\_DOWN\_CAL, and regardless of the value of SYNFLG.

This logic determines if this PIP edge is the correct edge for foreground

fuel processing. If not, execute only the Fuel Service routine and exit.

PIP\_HIGH = 0 ---------------|

;Falling PIP edge |

|AND -|

SYNFLG = 0 -----------| | |

;Not in sync |OR --| |

| |

AIR\_DOWN\_CAL = 0 -----| |

;Execute on pip up-edge |

|OR --| Do: FUEL\_SERVICE

PIP\_HIGH = 1 ---------------| | | Exit: FUEL\_FG\_PIPEDG

;Rising PIP edge | | | ;On the wrong PIP edge

| |

SYNFLG = 1 -----------------|AND -|

;Fuel in sync |

|

AIR\_DOWN\_CAL = 1 -----------|

;Execute on PIP down-edge

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FUEL STRATEGY, FOREGROUND FUEL CALCULATIONS EXECUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

This is the correct edge for foreground fuel processing. Determine whether

limited foreground processing should be employed due to high RPM.

At high RPM, execute the transient fuel and fuel pulsewidth calculations on

every-other PIP. At high RPM, dynamic fuel calculations are disabled. The

Fuel Service routine is executed every PIP, regardless of RPM.

DT12S >= FULPIPALT\_DT ------------------| ALT\_PIP\_MODE := 0

;Low RPM value | Do: fuel\_fg\_transient\_calculations

| Do: FUEL\_FG\_CALC

| Do: FUEL\_SERVICE

| Do: FUEL\_DYN\_CALC

| Exit: FUEL\_FG\_PIPEDG

|

| --- ELSE ---

|

DT12S < FULPIPALT\_DT -------------| |

;Higher RPM value |AND -| ALT\_PIP\_MODE := 1

| | Do: fuel\_fg\_transient\_calculations

SYNC\_CTR is even -----------------| | Do: FUEL\_FG\_CALC

;Alternate PIP up-edges or | Do: FUEL\_SERVICE

; alternate PIP down-edges | Exit: FUEL\_FG\_PIPEDG

|

| --- ELSE ---

|

| ALT\_PIP\_MODE := 1

| Do: FUEL\_SERVICE

END: FUEL\_FG\_PIPEDG

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FUEL STRATEGY, PIP INTERRUPT LOGIC FOR FUEL SYNCHRONIZATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.23 PIP INTERRUPT LOGIC FOR FUEL SYNCHRONIZATION (CDAH0)

OVERVIEW

The synchronization logic processed during the PIP high interrupt is

responsible for incrementing the SYNC\_CTR and determining if the CID signal

is lost. The SYNC\_CTR is a register used to identify the position and cycle

of the engine's cylinders. When the CID signal is lost the SYNC\_CTR is not

reset to 0 by the CID\_PROCESSING logic. If the PIP high interrupt logic

observes that the counter has not been reset, i.e., SYNC\_CTR is greater than

NUMCYL (the number of cylinders), it resets the counter and sets a flag

(SYNC\_FAIL). If the counter does not get reset by the CID\_PROCESSING logic a

second time, the command to synchronize fuel is canceled.

DEFINITIONS

INPUTS

Registers:

- SYNC\_CTR = Counter which counts cylinders from the PIP signal and resets

when equal to the number of cylinders in the engine.

Bit Flags:

- SYNC\_FAIL = Indicates sync signal has been lost or was incorrectly placed

after system was in sync; 0 -> sync okay, 1 -> bad or lost sync signal.

Calibration Constants:

- NUMCYL = Number of cylinders in the engine.

- VCAMHP = Variable CAM timing hardware present; 1 -> VCT present.

OUTPUTS

Registers:

- SYNC\_CTR = See above.

Bit Flags:

- FUEL\_IN\_SYNC = Fuel synchronized with PIP.

- SYNC\_FAIL = See above.

- SYNFLG = Cylinder 1 correctly identified flag; 1 -> SYNC\_CTR aligned with

cylinder 1, 0 -> SYNC\_CTR not aligned with cylinder 1.

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FUEL STRATEGY, PIP INTERRUPT LOGIC FOR FUEL SYNCHRONIZATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_PIP\_INT\_SYNC\_COM2

PIP INTERRUPT PROCESSING

(processed during the PIP high interrupt)

VCAMHP = 0 ----------------------------------| SYNC\_CTR = SYNC\_CTR + 1

VCAMHP = 0 ----------------------------|

|

SYNC\_CTR > NUMCYL ---------------------|AND -| SYNC\_CTR = 0

| | SYNC\_FAIL = 1

SYNC\_FAIL = 0 -------------------------| |

| --- ELSE ---

SYNC\_CTR > NUMCYL ---------------------| |

|AND -| SYNC\_CTR = 0

VCAMHP = 0 ----------------------------| | SYNFLG = 0

| FUEL\_IN\_SYNC = 0

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FUEL CONTROL STRATEGY, FUEL PULSEWIDTH, FOREGROUND FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.24 FOREGROUND FUEL PULSEWIDTH CALCULATION (CDAL0)

OVERVIEW

This module is designed to calculate updated main fuel pulsewidth for each

engine bank, using the latest air charge value calculated upon completion of

the air charge computation during the PIP interrupt. Included within this

module are: 1) minimum and maximum pulsewidth clips; 2) a check for a change

greater than a calibrated amount (PW\_MIN\_PCT) in computed pulsewidth to

determine whether to update previously-scheduled fuel pulsewidth off-edges

(if the injectors are synchronized with the prior request); and 3) a request

for a new computation of the injector timing, performed by the strategy

module FUEL\_INJ\_UPDATE\_REQUEST.

PURGE COMPENSATION (PCOMP)

The Purge Compensation (PCOMP) is a new type of adaptive routine which is

used to correct for errors in the fuel calculation that are induced by the

introduction of purge vapors into the engine. The PCOMP strategy operates

only during closed loop engine operation with the canister purge enabled.

The PCOMP register, PCOMP\_LBM, is reset to "0" during open loop operation and

when key power is turned off.

PCOMP corrects for errors in the fuel calculation by subtracting the PCOMP

term from the base fuel equation:

base fuel = (CYL\_AIR\_CHG \* F\_A\_RATIO[n]) + TFC\_HR

new base fuel = base fuel - PCOMP\_LBM

PCOMP will increment or decrement to keep LAMBSE at a value of "1". A

calibratable PCOMP Integrator Scaling factor (PC\_SCALE) is used to control

the rate at which PCOMP responds to LAMBSE deviations from "1". A typical

PC\_SCALE value is 0.0015. PCOMP is calculated as follows:

PCOMP\_LBM = PCOMP\_LBM + PC\_SCALE \* [(LAMBSE1 - 1) \*

(CYL\_AIR\_CHG \* F\_A\_RATIO1)]

The PCOMP\_LBM computation is done in the background in the CANP\_PCOMP\_COMn

module.

NOTE: Parameters whose alphabetic characters are in the lower case are

non-displayable temporary registers.

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FUEL CONTROL STRATEGY, FUEL PULSEWIDTH, FOREGROUND FUEL - CDAN2

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DEFINITIONS

INPUTS

Registers:

- AHISL\_TICK = Dual slope high slope in lbs/tick, compensated for

temperature.

- ALOSL\_TICK = Dual slope low slope in lbs/tick, compensated for

temperature.

- CYL\_AIR\_CHG = Current cylinder air charge used in fuel calculation, lbm.

- DT12S = The period between the last two PIP low-to-high transitions.

- DT12SH = The high byte in the three byte time between PIP up-edges.

- F\_A\_RATIO[n] = Desired fuel/air ratio for the identified engine bank

number n, where n = 1, 2.

- FAR\_MUL = Multiplier to the fuel-air ratio, used to introduce a fuel

system error. This value is set in the background fuel strategy module

FUEL\_BG\_CALC\_COMx.

- FB\_DIFF = Difference between FUEL\_BKPT divided by temperature compensated

high slope and FUEL\_BKPT divided by temperature compensated low slope,

ticks.

- FUELPW[n] = The previous injector pulsewidth (in clock ticks) for the

identified engine bank number n, where n = 1, 2.

- MINPWT = Minimum desired fuel pulsewidth, ticks.

- MINPW\_LBMF = Fuel Mass at minimum fuel pulsewidth, LBM.

- PCOMP\_LBM = Purge compensation, lbs mass/cylinder.

- PWOFF = Injector pulsewidth offset, clock ticks.

- TFC\_HR = Fuel mass per injection from transient fuel compensation,

lbs/cylinder.

Bit Flags:

- CHANGE\_FUELPW = A flag that indicates that the desired pulsewidth for

in-progress fuel injections needs to be modified because the latest

calculated fuel pulsewidth value for that injection has changed by more

than the percent amount calibrated as PW\_MIN\_PCT.

- CRKFLG = Flag indicating when in CRANK mode; 1 -> crank.

- FAR\_MUL\_FLG = Flag indicating the an error should be introduced into the

fuel system, via the fuel-air ratio multiplier FAR\_MUL.

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FUEL CONTROL STRATEGY, FUEL PULSEWIDTH, FOREGROUND FUEL - CDAN2

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Calibration Constants:

- FUEL\_BKPT = The amount of fuel flow when transfer is made from the low

slope to the high slope.

- NUMCYL = Number of cylinders in the engine.

- NUMEGO = Switch indicating number of HEGO sensors present.

- PW\_MIN\_PCT = Minimum percent change in FUELPW (PIP-to-PIP) to trigger a

pulsewidth update to the injector event presently in-progress.

OUTPUTS

Registers:

- FUELPW[n] = See above.

- LBMF\_INJ[n] = Two registers which contain the fuel mass per injection for

each engine bank; n = 1, 2.

Bit Flags:

- CHANGE\_FUELPW = See above.

TEMPORARY REGISTERS

- fgbeta[n] = The fuel pulsewidth in percent of a PIP period. This is a

temporary register that will be used to calculate injector on-edge time.

- fuel\_bk[n] = A temporary register that contains the fuel mass required

for the identified engine bank number n, where n = 1, 2.

- fuelpw[n] = A temporary register that contains the interim value of fuel

pulsewidth (in ticks) for the identified engine bank number n, where n =

1, 2.

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FUEL CONTROL STRATEGY, FUEL PULSEWIDTH, FOREGROUND FUEL - CDAN2

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STRATEGY MODULES

Entry Points:

- FUEL\_FG\_CALC = Main entry point for the foreground fuel pulsewidth

calculation strategy module.

Local Routines:

- compute\_fuel\_pulsewidth(n) = Routine to compute the fuel mass and

corresponding pulsewidth for the desired bank.

External Routines:

- FUEL\_INJ\_UPDATE\_REQUEST = Injector update request logic; located in

strategy module FUEL\_INJ\_UPDATE\_REQUEST\_COMn.

- FUEL\_TOTAL\_DELAY\_CALC = Computes new values for TOTAL\_DELAY1 and

TOTAL\_DELAY2; located in strategy module FUEL\_TOTAL\_DELAY\_CALC\_COMn.

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FUEL CONTROL STRATEGY, FUEL PULSEWIDTH, FOREGROUND FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_FG\_CALC\_COM14

BEGIN: FUEL\_FG\_CALC

; Called from within the FUEL\_FG\_PIPEDG strategy module, and executed on

; either the rising or falling PIP edge.

; This strategy module corresponds to the FRGRND\_FUEL\_CALC module in

; software.

; This foreground fuel calculation is not required during crank mode.

CRKFLG = 1 -----------------------------| Exit FUEL\_FG\_CALC

;In crank mode |

| --- ELSE ---

|

| Continue FUEL\_FG\_CALC

; For each engine bank, compute the fuel required by a cylinder in that bank,

; and compute the corresponding pounds mass per injection.

Unconditionally ------------------------| Call: compute\_fuel\_pulsewidth(1)

| Call: FUEL\_TOTAL\_DELAY\_CALC(1)

NUMEGO > 1 -----------------------------| Call: compute\_fuel\_pulsewidth(2)

| Call: FUEL\_TOTAL\_DELAY\_CALC(2)

; Update the injector off-edge times that are already scheduled in the

; high-speed output carousel. Whether the update is performed is

; dependent upon the state of the flag CHANGE\_FUELPW.

CHANGE\_FUELPW = 1 ----------------------| Call: FUEL\_INJ\_UPDATE\_REQUEST

| CHANGE\_FUELPW := 0

END: FUEL\_FG\_CALC

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FUEL CONTROL STRATEGY, FUEL PULSEWIDTH, FOREGROUND FUEL - CDAN2

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BEGIN: compute\_fuel\_pulsewidth(n)

; Compute the fuel mass required for this bank.

Unconditionally ------------------------| fuel\_bk[n] := (CYL\_AIR\_CHG \*

| F\_A\_RATIO[n]) + TFC\_HR

| - PCOMP\_LBM

| fuel\_bk[n] := MAX(fuel\_bk[n],0)

FAR\_MUL\_FLG = 1 ------------------------| fuel\_bk(n) := fuel\_bk(n) \* FAR\_MUL

| ;Introduce a fuel system error

; Save the fuel mass value, and determine the corresponding pulsewidth

; using the piecewise-linear model of fuel delivery.

fuel\_bk[n] < FUEL\_BKPT -----------------| LBMF\_INJ[n] := fuel\_bk[n]

;Run mode and low slope | fuelpw[n] := fuel\_bk[n] /

| ALOSL\_TICK

|

| --- ELSE ---

|

;Run mode and high slope | LBMF\_INJ[n] := fuel\_bk[n]

| fuelpw[n] := (fuel\_bk[n] /

| AHISL\_TICK) - FB\_DIFF

; The fuel pulsewidth is checked to ensure that it exceeds some minimum

; value, and if it does not, the minimum pulsewidth is output. The only

; exception to this is if the pulsewidth is zero, in which case no fuel

; is output.

fuelpw[n] < MINPWT -------------|

|AND -| fuelpw[n] := MINPWT

F\_A\_RATIO[n] <> 0 --------------| | LBMF\_INJ[n] := MINPW\_LBMF

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FUEL CONTROL STRATEGY, FUEL PULSEWIDTH, FOREGROUND FUEL - CDAN2

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; Check to see if the pulsewidth would require the injector to be on more

; than all the time, in which case, clip the injector 'on' time to be 1/32

; of a PIP period less than 'full on'.

DT12SH = 0 ---------------------|

;Time is in 2 bytes |

|AND -| fuelpw[n] := (NUMCYL - 0.03125) \*

(fuelpw[n] / | | DT12S

DT12S) >= NUMCYL -------------| | fgbeta[n] := (NUMCYL - 0.03125)

;Fuel is on too long | + (PWOFF / DT12S)

| LBMF\_INJ[n] := (fuelpw[n] +

| FB\_DIFF) \* AHISL\_TICK

|

| --- ELSE ---

|

DT12SH = 0 ---------------------------| fgbeta[n] := (fuelpw[n] / DT12S)

| + (PWOFF / DT12S)

|

| --- ELSE ---

|

| fgbeta[n] := 0

; If the currently calculated fuel pulsewidth, fuelpw[n], has changed by more

; than PW\_MIN\_PCT from the last computed value (stored in FUELPW[n]), and if

; the last computed value is not zero (e.g., as in the case of fuel cut-off),

; then set the CHANGE\_FUELPW flag. At the next check of the output queue, if

; any injector has a pulse in progress with the off-edge in the queue, then

; the off-edge will be updated to provide the latest pulsewidth. In the case

; of a reduction in pulsewidth size, the off-edge will not be scheduled to be

; any earlier than the current time.

FUELPW[n] <> 0 ---------------------|

|AND -| CHANGE\_FUELPW := 1

ABS(fuelpw[n] - FUELPW[n]) |

/ FUELPW[n] > PW\_MIN\_PCT -------|

; Set the stored pulsewidth equal to the currently calculated pulsewidth.

Unconditionally --------------------------| FUELPW[n] := fuelpw[n]

END: compute\_fuel\_pulsewidth

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FUEL STRATEGY, INJECTOR TIMING CALCULATION, FOREGROUND FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.25 FOREGROUND INJECTOR TIMING - TOTAL DELAY CALCULATION (CDAI0)

OVERVIEW

The total delay calculation is part of the foreground fuel software module,

largely because TOTAL\_DELAY[n] is most sensitive to FUELPW[n] changes when

off-edge timing is requested. Another reason is that fgbeta, the new

FUELPW[n] in terms of beta units (PIP fractions) is calculated as a temporary

register in the foreground fuel calculation and is required for the total

delay calculation.

Injection events need to be timed to occur at some point before the intake

cycle occurs for a cylinder. Because an engine is cyclical, the injector

timing may also be considered as a delay after an identifying cylinder event.

Because the SYNC\_CTR mechanism readily identifies Top Dead Center (TDC)

between the compression and power strokes for each cylinder, it is useful to

identify injection events in terms of delay after TDC rather than as a time

before an intake event.

In general, it is desirable to specify an end of pulse position for a fuel

pulse, to ensure proper placement before an intake cycle. However, the

accurate delivery of the off edge at the desired engine position requires

some tradeoffs at any unsteady state:

- The on edge time is determined by the desired off edge position (in

degrees converted to time, based on the angular velocity at the time the

on edge was scheduled) minus the fuel pulsewidth.

- Accurate fuel pulsewidth delivery has priority over off edge placement.

- The angular velocity may change between the time the on edge was

scheduled and the time the off edge occurs.

- The fuel pulsewidth requested may change between the time the on edge was

scheduled and the time the off edge is scheduled.

The term TOTAL\_DELAY is used to describe the whole and fractional PIP periods

from TDC to the start of the fuel pulse for a cylinder. One difficulty in

using angular displacement from TDC for fuel pulses is that the desired

placement for on edges frequently crosses TDC in normal operation. A change

in TOTAL\_DELAY from just greater than 0 to just less than NUMCYL is actually

a very small change in injector timing.

TOTAL DELAY CALCULATION NOTES:

1. The change in injector timing between consecutive injector firings is

limited to a maximum of one PIP period. This has the effect of walking

the injector timing for large timing changes.

2. Synchronized operation is implicit, since the fuel service module will

not set FUEL\_IN\_SYNC when the system is not synchronized.

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FUEL STRATEGY, INJECTOR TIMING CALCULATION, FOREGROUND FUEL - CDAN2

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3. Adjusting INJ\_PIP\_CNT[n] for changes to TOTAL\_DELAY[n] results in faster

response for more accurate fuel pulse placement and scheduling under

dynamic conditions.

DEFINITIONS

INPUTS

Registers:

- INJDLY\_BETA = The injector timing in percent of PIP periods after the top

dead center PIP. Depending on INJREF, this may be a request for

placement of either the ON edge or the OFF edge to the specified engine

rotational position.

- INJ\_PIP\_CNT[n] = Injector PIP counter for bank n, which tracks the number

of PIP edges until an injector in bank n is due to be serviced.

- TOTAL\_DELAY[n] = Delay in percent of PIP period from the reference PIP to

the starting edge of the fuel pulse, for bank n.

Bit Flags:

- FUEL\_IN\_SYNC = Indicates whether TOTAL\_DELAY1 and TOTAL\_DELAY2 have been

assigned initial calculated values; 0 -> initial values not yet assigned,

1 = values have been assigned.

- SYNFLG = Indicates that SYNC\_CTR is aligned with the engine so that fuel

may be synchronized to the desired position with respect to the engine.

Calibration Constants:

- INJREF = Indicates which edge is to be scheduled by INJDLY\_BETA; 0 -> ON

edge of fuel pulse should be at INJDLY\_BETA past TDC; 1 -> OFF edge

should be at INJDLY\_BETA past TDC.

- NUMCYL = Number of cylinders in the engine.

OUTPUTS

Registers:

- INJ\_PIP\_CNT[n] = See above.

- TOTAL\_DELAY[n] = See above.

TEMPORARY REGISTERS

- bank\_num = The EGO bank number currently being processed, either bank 1

or bank 2.

- delta\_delay = Temporary register containing total\_delay - TOTAL\_DELAY[n]

value

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FUEL STRATEGY, INJECTOR TIMING CALCULATION, FOREGROUND FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- fgbeta = The fuel pulsewidth in percent of a PIP period.

- total\_delay = Temporary working location for new TOTAL\_DELAY[n] value

STRATEGY MODULES

Entry Points:

- FUEL\_TOTAL\_DELAY\_CALC(n) = The main entry point for this module, which

computes the TOTAL\_DELAY value for bank n.

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FUEL STRATEGY, INJECTOR TIMING CALCULATION, FOREGROUND FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_TOTAL\_DELAY\_CALC\_COM1

BEGIN: FUEL\_TOTAL\_DELAY\_CALC(bank\_num)

; Called from within the FUEL\_FG\_CALC strategy module.

; This strategy module corresponds to a portion of the FRGRND\_FUEL\_CALC

; software module.

; Determine if a new total delay is to be calculated for the bank

; specified by bank\_num. Do not calculate TOTAL\_DELAY[n] until an

; initial value has been assigned to it at the first sequential

; fuel event.

FUEL\_IN\_SYNC = 0 -----------------------| Exit FUEL\_TOTAL\_DELAY\_CALC

| ;Wait for first

| ; sequential event

;Calculate the new total delay.

;NOTE: With delay in percent of PIP period and if fuel timing reference

; is off-edge, then subtract FUELPW in percent of PIP units.

INJREF = 1 -----------------------------| total\_delay := INJDLY\_BETA

| - fgbeta

| ;Off-edge timing, subtract

| ; FUELPW in PIP periods to get

| ; the on edge

|

| --- ELSE ---

|

| total\_delay := INJDLY\_BETA

;If delay is negative, delay + NUMCYL gives positive delay and

;same position.

;NOTE: Use modulo NUMCYL arithmetic.

total\_delay < 0 ------------------------| total\_delay :=

| total\_delay + NUMCYL

| total\_delay :=

| MOD(total\_delay, NUMCYL)

;Compute the difference between the old and new delays.

Unconditionally ------------------------| delta\_delay := total\_delay

| - TOTAL\_DELAY[bank\_num]

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FUEL STRATEGY, INJECTOR TIMING CALCULATION, FOREGROUND FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;If delta is too large, reverse direction by adding or subtracting

;NUMCYL, 2 engine revolutions, from delta\_delay.

|delta\_delay| >= NUMCYL/2 --------|

|AND -| delta\_delay :=

delta\_delay > 0 ------------------| | delta\_delay - NUMCYL

| ;If positive delta and more

| ; than one engine revolution

| ; difference, subtract NUMCYL

| ; for shortest path to

| ; synchronization.

|

| --- ELSE ---

|

|delta\_delay| >= NUMCYL/2 --------| |

|AND -| delta\_delay :=

delta\_delay < 0 ------------------| | delta\_delay + NUMCYL

| ;If large negative delta, make

| ; positive by adding two

| ; rotations

;Clip the change in TOTAL\_DELAY[n] to 1.0 PIP maximum, and adjust

;INJ\_PIP\_CNT[n] by the number of half PIPs that TOTAL\_DELAY[n] has

;changed.

;NOTE: TOTAL\_DELAY[n] is in full PIP units, while INJ\_PIP\_CNT[n] is in

; half PIPs.

|delta\_delay| <= 1.0 -------------------| TOTAL\_DELAY[bank\_num] :=

| total\_delay

| INJ\_PIP\_CNT[bank\_num] :=

| INJ\_PIP\_CNT[bank\_num]

| + (2 \* delta\_delay)

|

| --- ELSE ---

|

delta\_delay > 0 ------------------------| TOTAL\_DELAY[bank\_num] :=

| TOTAL\_DELAY[bank\_num] + 1.0

| INJ\_PIP\_CNT[bank\_num] :=

| INJ\_PIP\_CNT[bank\_num] + 2

|

| --- ELSE ---

|

delta\_delay < 0 ------------------------| TOTAL\_DELAY[bank\_num] :=

| TOTAL\_DELAY[bank\_num] - 1.0

| INJ\_PIP\_CNT[bank\_num] :=

| INJ\_PIP\_CNT[bank\_num] - 2

;NOTE: Use modulo NUMCYL arithmetic.

TOTAL\_DELAY[bank\_num] < 0 --------------| TOTAL\_DELAY[bank\_num] :=

| TOTAL\_DELAY[bank\_num] + NUMCYL

END: FUEL\_TOTAL\_DELAY\_CALC

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FUEL STRATEGY, FUEL PULSEWIDTH, INJECTOR UPDATE REQUEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.26 INJECTOR UPDATE REQUEST (CDAM0)

OVERVIEW

This module is executed when one or more injectors have an off edge scheduled

in the output carousel, and it has been determined that the fuel pulsewidth

used to compute the off-edge timing is in error with respect to the current

pulsewidth calculation. The amount of error causing this recalculation is

specified in the FUEL\_FG\_CALC strategy module. This condition is denoted by

setting the CHANGE\_FUELPW flag in the FUEL\_FG\_CALC strategy module before

calling this module.

The injector off-edge is initially entered into the carousel when the

pulsewidth on-edge is issued, at which time an interrupt generates a call to

the FUEL\_MAIN\_OFF strategy module. When an update has been requested to the

injector off-edge timing, this module will recalculate the off-edge time for

each scheduled pulse, and overwrite the existing time in the appropriate

reserved slot of the carousel.

SOFTWARE NOTES

The state of HSO output pins can be checked using the following flag

definitions, where HSO\_PIN\_STATE is defined as a word representing the HSO

STATES REGISTER:

INJ1\_PIN\_STATE FLAG ^01,HSO\_PIN\_STATE

INJ2\_PIN\_STATE FLAG ^02,HSO\_PIN\_STATE

INJ3\_PIN\_STATE FLAG ^04,HSO\_PIN\_STATE

INJ4\_PIN\_STATE FLAG ^08,HSO\_PIN\_STATE

INJ5\_PIN\_STATE FLAG ^10,HSO\_PIN\_STATE

INJ6\_PIN\_STATE FLAG ^20,HSO\_PIN\_STATE

INJ7\_PIN\_STATE FLAG ^40,HSO\_PIN\_STATE

INJ8\_PIN\_STATE FLAG ^80,HSO\_PIN\_STATE

Pending HSO interrupts can be checked via the bits of the word register

HSO\_INT\_1\_PEND.

DEFINITIONS

INPUTS

Calibration Constants:

- NUMCYL = Number of cylinders in the engine.

OUTPUTS

Bit Flags:

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FUEL STRATEGY, FUEL PULSEWIDTH, INJECTOR UPDATE REQUEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- LONG\_PULSE = Flag indicating that at least one of the requested off-edge

times is more than a clock roll-over into the future, and so cannot be

scheduled at this time.

TEMPORARY REGISTERS

- i = Injector number to have fuel pulse off-edge time updated.

STRATEGY MODULES

Entry Points:

- FUEL\_INJ\_UPDATE\_REQUEST = The main entry point for this strategy module.

Local Routines:

- update\_injector(i) = Conditionally update the off-edge time for injector

i, only if the corresponding HSO output pin is high.

External Routines:

- FUEL\_MAIN\_OFF(i) = Strategy routine which reschedules the off-edge timing

of the pulse for injector i (i = 0..NUMCYL-1).

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FUEL STRATEGY, FUEL PULSEWIDTH, INJECTOR UPDATE REQUEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_INJ\_UPDATE\_REQUEST\_COM1

BEGIN: FUEL\_INJ\_UPDATE\_REQUEST

Called from within the FUEL\_FG\_CALC strategy module.

This strategy module corresponds to the INJECTOR\_UPDATE\_REQUEST module in

software.

Clear the LONG\_PULSE flag, which is set in the FUEL\_MAIN\_OFF strategy module.

unconditionally ------------------------| LONG\_PULSE := 0

Update off-edge timing for each injector. These off-edge times were

initially computed and entered into the high-speed output carousel when the

on-edge was issued, at which time an interrupt service routine called the

FUEL\_MAIN\_OFF strategy module.

FOR i := 0 TO NUMCYL - 1 ---------------| Do: update\_injector(i)

| ;Attempt to reschedule the off-

| ; edge time for each injector

END: FUEL\_INJ\_UPDATE\_REQUEST

BEGIN: update\_injector(i)

Update only those injectors which are presently actuated. The state of each

HSO output pin is available through the HSO state register. Pending HSO

interrupts are indicated by the HSO\_INT\_1\_PEND register in software.

HSO for injector i active --------|

|AND -| Do: FUEL\_MAIN\_OFF(i)

HSO interrupt not pending for i --| | ;Only called if output is high

| ; and HSO interrupt not pending

END: update\_injector

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FUEL STRATEGY, FUEL PULSEWIDTH, MAIN FUEL OFF - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.27 FUEL PULSEWIDTH, MAIN FUEL OFF (CDAI0)

OVERVIEW

This module is executed for each non-zero main fuel pulse. This routine is

called before a main fuel pulse off-edge is placed in the output carousel for

a high speed output port. The routine calculates the off-edge time from the

on-edge time and the fuel pulsewidth. If there is sufficient space to insert

the off-edge into the carousel and the off-edge time is within the early

limit (i.e., there is not enough time to first place it into the software

queue), then the edge is placed in the carousel. Otherwise, the direction of

the edge transition and the edge time are placed in the software queue.

LST\_PWx, LBMF\_TABx, and FUEL\_SUM are also updated by this routine. LST\_PWx

is a table containing the main pulsewidths output to each of the engine's

cylinders by the most recent of their respective main fuel pulses. It is

used by the Dynamic Fuel strategy. LBMF\_TABx is a table containing the mass

of fuel injected to each of the engine's cylinders by the most recent of

their respective main fuel pulses. FUEL\_SUM keeps track of the total fuel

consumption for the trip computer.

NOTE: Parameters whose alphabetic characters are in the lower case are

non-displayable temporary registers.

SOFTWARE NOTES

1. The arrays on\_edge\_time and off\_edge\_time correspond to the arrays

LAST\_ON\_INJ and LAST\_OFF\_INJ in software, respectively. This information is

also written to the high-speed output carousel, when an on-edge or off-edge

is scheduled.

2. As a potential chronometric thrift, temporary registers may be used for

updating FUEL\_SUM. When CHANGE\_FUELPW is set, the change in fuel mass can be

added to a temporary register (by adding the new fuel mass, and subtracting

out the previous fuel mass). When CHANGE\_FUELPW is not set, the value in the

temporary register can be transferred into the FUEL\_SUM register. See the

INJECTOR\_OFF code segment in [LIBRARY.EOS]INJ\_OUT\_CG56K\_EOS\_1.AST;(3) for an

example.

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FUEL STRATEGY, FUEL PULSEWIDTH, MAIN FUEL OFF - CDAN2

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DEFINITIONS

INPUTS

Registers:

- CRK\_FUL = Fuel pulsewidth used in crank mode, sec.

- FPW\_FG\_ISF\_A = Term added to the fuel pulsewidth to compensate for an

injector which did not fire in the previous cycle, in ticks. This value

is determined within the transient fuel strategy modules.

- FUELPW[bank\_num] = The main fuel pulsewidth (in ticks, not including

PWOFF) most recently calculated for a cylinder in the engine bank whose

'bank number' is bank\_num, where bank\_num is 1 or 2.

- FUEL\_SUM = An accumulator which stores the total amount of fuel

delivered; lbm.

- LBMF\_INJ[bank\_num] = The Fuel Mass (lbm) of the main fuel pulse most

recently delivered by a SEFI injection to a cylinder in the engine bank

whose 'bank number' is bank\_num, where bank\_num is 1 or 2.

- PCOMP\_LBM = Purge compensation, in pounds mass per cylinder.

- PWOFF = Injector pulsewidth offset, clock ticks.

Bit Flags:

- CHANGE\_FUELPW = Flag indicating that the desired pulsewidth for

in-progress fuel injections needs to be updated because the latest

calculated fuel pulsewidth value has changed by more than a calibrated

amount.

- CRKFLG = Engine Mode Flag; 1 -> Crank Mode, 0 -> Not in Crank Mode.

- PCOMP\_ENA = Purge compensation strategy enabled flag; 1 -> PCOMP enabled.

Non-Calibratable Constants:

- stcf = Seconds-to-ticks conversion.

OUTPUTS

Registers:

- FUEL\_SUM = See above.

- LBMF\_TAB[inj\_num] = The fuel mass of the main fuel pulse most recently

delivered by the injector whose 'injector number' is inj\_num. (One of

the registers in an array of registers composed of one register for each

injector on the engine.)

- LST\_PW[inj\_num] = The main fuel pulsewidth (in ticks) (not including

PWOFF) most recently scheduled for the injector whose 'injector number'

is inj\_num. (One of the registers in an array of registers composed of

one register for each injector on the engine.)

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FUEL STRATEGY, FUEL PULSEWIDTH, MAIN FUEL OFF - CDAN2

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TEMPORARY REGISTERS

- mainpw\_bank\_num = The bank number of the engine bank for which the

subject main fuel pulsewidth was calculated; can equal either 1 or 2.

This temporary variable is calculated elsewhere in a part of the

foreground fuel strategy that executes synchronously with this module.

- mainpw\_inj\_num = The 'injector number' of the injector for which the

subject main fuel pulse is scheduled. (Note: An injector's 'injector

number' is NOT the same as its 'firing sequence number'.) This temporary

variable is calculated elsewhere in a part of the foreground fuel

strategy that executes synchronously with this module.

- off\_edge\_time[i] = The time at which the fuel off-edge command is to be

executed to turn off the fuel on the injector for which the main fuel

pulse is to be scheduled; clock ticks. (The information in this

temporary register is to be transformed as appropriate and communicated

to the appropriate hardware structure, in a manner consistent with all

required h/w and opsys protocol, so that the off-edge event is correctly

scheduled.)

- on\_edge\_time[i] = The time at which the injector is to be turned on for

the cylinder for which the main fuel pulse is to be scheduled; clock

ticks. This temporary variable is calculated elsewhere in a part of the

foreground fuel strategy that executes synchronously with this module.

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FUEL STRATEGY, FUEL PULSEWIDTH, MAIN FUEL OFF - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_MAIN\_OFF\_COM11

BEGIN: FUEL\_MAIN\_OFF(i)

; Invoked from within the FUEL\_INJ\_UPDATE\_REQUEST strategy module, and from

; the interrupt service routine invoked when the fuel pulse on-edge is

; issued. May also be invoked from FUEL\_INJ\_OUT for short pulses.

; This strategy module corresponds to the INJECTOR\_OFF module in software.

; Calculate and schedule the pulsewidth off-edge.

CRKFLG = 1 -----------------------------| off\_temp = on\_edge\_time[i]

| + (CRK\_FUL \* stcf) + PWOFF

|

| --- ELSE ---

|

| off\_temp = on\_edge\_time[i]

| + FUELPW[mainpw\_bank\_num]

| + PWOFF

; Compensate for an injector which was cut-out during the previous cycle.

CRKFLG = 0 -----------------------|

|AND -| off\_temp =

LST\_PW[mainpw\_inj\_num] = ^FFFF ---| | off\_temp + FPW\_FG\_ISF\_A

; Check that the requested off-edge is not more than 1 clock roll-over into

; the future, and set the LONG\_PULSE flag if it is. Recompute all scheduled

; off-edges in 50 milliseconds.

off\_temp - clock > 65535 ---------------| LONG\_PULSE = 1

| Enable a 50ms interrupt to invoke

| module FUEL\_INJ\_UPDATE\_REQUEST

| Exit: FUEL\_MAIN\_OFF

|

| --- ELSE ---

|

| off\_edge\_time[i] = off\_temp

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FUEL STRATEGY, FUEL PULSEWIDTH, MAIN FUEL OFF - CDAN2

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; Update last pulsewidth, last fuel mass, and adjust the running fuel sum.

Unconditionally ------------------------| LST\_PW[mainpw\_inj\_num] =

| FUELPW[mainpw\_bank\_num]

| LBMF\_TAB[mainpw\_inj\_num] =

| LBMF\_INJ[mainpw\_bank\_num]

| FUEL\_SUM = FUEL\_SUM +

| LBMF\_INJ[mainpw\_bank\_num]

CHANGE\_FUELPW = 0 ----------------|

|AND -| FUEL\_SUM = FUEL\_SUM

PCOMP\_ENA = 1 --------------------| | + PCOMP\_LBM

END: FUEL\_MAIN\_OFF

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FUEL STRATEGY, FUEL SERVICE LOGIC - CDAN2

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8.28 FUEL SERVICE LOGIC (CDAI0)

OVERVIEW

This module contains the control strategy necessary to request the output of

fuel injection events at the desired injector timing. In consists of entry

logic and fuel scheduling control logic. This module operates in conjunction

with the IBETA calculation module, and the fuel scheduling module.

INTENT

The primary purpose of the fuel service module is to deliver fuel pulses at

the appropriate requested timing. There are several basic modes of

operation:

1. Crank fuel - When in crank mode, all injectors are fired simultaneously.

The amount of fuel on each pulse, the interval between pulses, and the

PIP edge on which crank fuel is delivered are all determined by

calibration constants.

2. Unsynchronized fuel - If the strategy is unable to recognize

synchronization before leaving crank mode, injectors are fired

simultaneously every NUMCYL number of PIPs. If synchronization has still

not been detected after a specified amount of time is spent in run mode

(determined by the calibration constant MAX\_RM\_SIMUL), operation reverts

to unsynchronized sequential mode.

3. Transition from simultaneous to synchronized sequential fuel - When the

CID (or signature PIP) is recognized, the actual engine position is known

to the fuel strategy. The flag SYNFLG is set, to communicate this

recognition.

When out of crank mode and SYNFLG is set, the first sequential fuel event

is scheduled. The flag FIRST\_SEQNTL indicates that this event has been

scheduled. The injector serviced by the first event is the one at the

top dead center of its intake stroke. This is accomplished by

initializing INJ\_BANK1 and INJ\_BANK2 to select the cylinder whose firing

order sequence number is the current value of SYNC\_CTR + NUMCYL/2 (using

modulo NUMCYL arithmetic). TOTAL\_DELAY1 and TOTAL\_DELAY2 are initialized

to NUMCYL/2 to reflect the placement of the first pulse, and the flag

FUEL\_IN\_SYNC is set to allow new TOTAL\_DELAY values to be calculated.

4. Synchronized sequential fuel - Once initial synchronization is attained,

TOTAL\_DELAYn changes are clipped to 1.0 per fuel event. Changes to

TOTAL\_DELAYn of more than one PIP cause immediate adjustments to

INJ\_PIP\_CNTn, the number of PIP edges until the fuel injection event is

scheduled on bank n. The IBETA calculation logic makes small adjustments

to IBETAn and INJ\_PIP\_CNTn to keep the fuel synchronized to the requested

TOTAL\_DELAYn value.

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FUEL STRATEGY, FUEL SERVICE LOGIC - CDAN2

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DEFINITIONS

INPUTS

Registers:

- ATMR3 = Time since entering RUN mode, seconds.

- CRK\_PIP\_INJ = Number of PIP periods per injector firing.

- FUELPW1 = HEGO11 injector pulsewidths, clock ticks.

- FUELPW2 = HEGO21 injector pulsewidths, clock ticks.

- INJ\_BANK1 = Bank 1 injector pointer, in terms of firing order sequence

(modulo NUMCYL).

- INJ\_BANK2 = Bank 2 injector pointer, in terms of firing order sequence

(modulo NUMCYL).

- INJ\_PIP\_CNT1 = Injector PIP counter for bank 1, which tracks the number

of PIP edges until an injector in bank 1 is due to be serviced.

- INJ\_PIP\_CNT2 = Injector PIP counter for bank 2, which tracks the number

of PIP edges until an injector in bank 2 is due to be serviced.

- SYNC\_CTR = Counter which counts cylinders from the PIP signal and resets

when equal to the number of cylinders in the engine.

Bit Flags:

- CRKFLG = Crank flag; 1 -> engine in crank mode.

- FIRST\_PIP = Flag indicating whether the first low PIP has been received;

1 -> first low PIP has been received.

- FIRST\_SEQNTL = Flag which indicates whether sequential mode has been

entered; 1 -> the first sequential event has occurred.

- PIP\_HIGH = Indicates that the most recent PIP transition was low to high.

- SYNFLG = Indicates when number one cylinder has been identified and the

SYNC\_CTR has been aligned with number one cylinder.

Calibration Constants:

- EDSEL = Switch for selective crank fuel timing at falling-edge of PIP.

- FN1327 = Fuel pulsewidth register map;, used to determine which fuel

register is used.

X = Injector output number.

Y = Null.

- FN1329 = Injector firing order used for correcting INJ\_BANKn to correct

the firing order.

X = INJ\_BANKn.

Y = Null.

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FUEL STRATEGY, FUEL SERVICE LOGIC - CDAN2

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- MAX\_RM\_SIMUL = Maximum amount of time that simultaneous fuel scheduling

may be used after entering run mode.

- NUMCYL = Number of cylinders in the engine.

- NUMEGO = Number of EGO sensors present, either stereo or mono.

OUTPUTS

Registers:

- IBETA1 = The injector delay time in PIP deltas, bank 1. This value is to

be used by the next injection event on bank 1.

- IBETA2 = The injector delay time in PIP deltas, bank 2. This value is to

be used by the next injection event on bank 2.

- INJ\_BANK1 = See above.

- INJ\_BANK2 = See above.

- INJ\_PIP\_CNT1 = See above.

- INJ\_PIP\_CNT2 = See above.

Bit Flags:

- CRK\_PIP\_INT = CRK\_PIP\_INJ initialization indicator; 1 -> CRK\_PIP\_INJ has

been initialized.

- FIRST\_SEQNTL = See above.

- FUEL\_IN\_SYNC = Fuel synchronized with PIP.

- SIMULTANEOUS = Simultaneous injection in progress flag.

TEMPORARY REGISTERS

- bank\_num = The EGO bank number currently being processed, either bank 1

or bank 2.

- lcl\_inj\_bank = A temporary holding register to retain the current value

of INJ\_BANK1 during simultaneous injector scheduling.

- mainpw\_inj\_num = The injector number of the injector for which the main

fuel pulsewidth is calculated.

- mainpw\_bank\_indicator = A numeric indicator of the engine bank for which

the main fuel pulsewidth is calculated. NOTE: This is not equal to the

engine bank number, but rather a value of 0 corresponds to engine bank 1,

and a value of 2 corresponds to engine bank 2.

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FUEL STRATEGY, FUEL SERVICE LOGIC - CDAN2

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STRATEGY ROUTINES

Entry Points:

- FUEL\_SERVICE = Main entry point for the fuel service logic.

Local Routines:

- fuel\_service\_entry\_logic = The front-end of the fuel service module.

- fuel\_service\_exit\_check = Routine used to determine whether to execute

the fuel service module for a second EGO bank.

- sequential\_fuel = Routine to handle sequential fuel scheduling, the

normal mode of operation.

- simultaneous\_fuel = Routine to handle simultaneous fuel scheduling, which

applies only during crank mode.

- simultaneous\_fuel\_scheduling = This routine is called from

simultaneous\_fuel, and will invoke the fuel scheduling routine for all

injectors in the engine.

External Routines:

- FUEL\_IBETA\_CALC = Performs the computation of IBETA1 and IBETA2; located

in strategy module FUEL\_IBETA\_CALC\_COMx.

- FUEL\_SCHEDULE = Routine to schedule the main fuel pulse for each

injection event; located in strategy module FUEL\_SCHEDULE\_COMx.

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FUEL STRATEGY, FUEL SERVICE LOGIC - CDAN2

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PROCESS

STRATEGY MODULE: FUEL\_SERVICE\_COM1

(Performed in the FUEL\_SERVICE software module)

BEGIN: FUEL\_SERVICE

;Initialize the fuel service bank index, and execute the entry logic for

;EGO bank 1. Subsequent calls to the routine fuel\_service\_exit\_check will

;determine if the fuel service routine must also be performed on EGO

;bank 2.

unconditionally ------------------------| bank\_num := 1

| DO: fuel\_service\_entry\_logic

END: FUEL\_SERVICE

BEGIN: fuel\_service\_entry\_logic

;Determine whether to use simultaneous or sequential fuel scheduling.

;Use simultaneous fuel scheduling of in crank mode. Also use

;simultaneous scheduling if not synchronized, not already using

;sequential scheduling, and in run mode for less than MAX\_RM\_SIMUL

;seconds.

CRKFLG = 1 -----------------------|

|

SYNFLG = 0 -----------------| |OR --| SIMULTANEOUS := 1

;Not in sync | | | FIRST\_SEQNTL := 0

| | | FUEL\_IN\_SYNC := 0

FIRST\_SEQNTL = 0 -----------|AND -| | IBETA2 := 0

;Not in sequential mode | | DO: simultaneous\_fuel

| |

ATMR3 < MAX\_RM\_SIMUL -------| |

| --- ELSE ---

|

| SIMULTANEOUS := 0

| DO: sequential\_fuel

END: fuel\_service\_entry\_logic

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FUEL STRATEGY, FUEL SERVICE LOGIC - CDAN2

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BEGIN: simultaneous\_fuel

;Injectors are fired simultaneously in crank mode, or in underspeed or run

;mode for up to MAX\_RM\_SIMUL seconds if sync has not been recognized.

INJ\_PIP\_CNT1 > 1 -----------------------| INJ\_PIP\_CNT1 := INJ\_PIP\_CNT1 - 1

| INJ\_PIP\_CNT2 := INJ\_PIP\_CNT2 - 1

| Exit simultaneous\_fuel

|

| --- ELSE ---

|

CRKFLG = 1 -----------------------| |

|AND -| INJ\_PIP\_CNT1 := 1

FIRST\_PIP = 0 --------------------| | INJ\_PIP\_CNT2 := 1

| Exit simultaneous\_fuel

| ;Wait for next PIP edge

|

| --- ELSE ---

|

CRKFLG = 1 -----------------------| |

| |

EDSEL = 0 ------------| | |

|AND -| |AND -| INJ\_PIP\_CNT1 := 1

PIP\_HIGH = 1 ---------| | | | INJ\_PIP\_CNT2 := 1

|OR --| | CRK\_PIP\_INT := 1

EDSEL = 1 ------------| | | Exit simultaneous\_fuel

|AND -| | ;Wait for next PIP edge

PIP\_HIGH = 0 ---------| |

| --- ELSE ---

|

CRKFLG = 1 -----------------------------| INJ\_PIP\_CNT1 := CRK\_PIP\_INJ

| INJ\_PIP\_CNT2 := CRK\_PIP\_INJ

| CRK\_PIP\_INT := 1

| DO: simultaneous\_fuel\_scheduling

|

| --- ELSE ---

|

PIP\_HIGH = 1 ---------------------------| INJ\_PIP\_CNT1 := NUMCYL \* 2

;Not in crank mode - use | INJ\_PIP\_CNT2 := NUMCYL \* 2

; simultaneous scheduling | DO: simultaneous\_fuel\_scheduling

; each NUMCYL PIPs |

| --- ELSE ---

|

PIP\_HIGH = 0 ---------------------------| INJ\_PIP\_CNT1 := NUMCYL \* 2 - 1

;Adjust so next event | INJ\_PIP\_CNT2 := NUMCYL \* 2 - 1

; occurs on high PIP | DO: simultaneous\_fuel\_scheduling

END: simultaneous\_fuel

8-200

FUEL STRATEGY, FUEL SERVICE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: simultaneous\_fuel\_scheduling

;Schedule all injectors for simultaneous firing. For each injector,

; set INJ\_BANK1 to the appropriate value and invoke the fuel schedule

;module. The Duce and watchdog timer must be serviced upon scheduling

;every-other injector.

unconditionally ------------------------| lcl\_inj\_bank := INJ\_BANK1

| IBETA1 := 0

| IBETA2 := 0

| INJ\_BANK1 := 0

while INJ\_BANK1 < NUMCYL ---------------| DO: FUEL\_SCHEDULE

| ;Service Duce HLOS and watchdog

| ; after each even sequence

| ; numbered injector

| INJ\_BANK1 := INJ\_BANK1 + 1

unconditionally ------------------------| INJ\_BANK1 := lcl\_inj\_bank

END: simultaneous\_fuel\_scheduling

8-201

FUEL STRATEGY, FUEL SERVICE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: sequential\_fuel

;Schedule only the current injector for sequential firing.

INJ\_PIP\_CNT[bank\_num] > 1 --------------| INJ\_PIP\_CNT[bank\_num] :=

| INJ\_PIP\_CNT[bank\_num] - 1

| DO: fuel\_service\_exit\_check

|

| --- ELSE ---

|

FIRST\_SEQNTL = 0 -----------------| |

|AND -| INJ\_BANK1 := SYNC\_CTR

FUELPW[bank\_num] <> 0 ------------| | - NUMCYL/2 - 1

| INJ\_BANK2 := SYNC\_CTR

| - NUMCYL/2 - 1

| INJ\_BANK1 := MOD(INJ\_BANK1,NUMCYL)

| INJ\_BANK2 := MOD(INJ\_BANK2,NUMCYL)

| INJ\_PIP\_CNT[bank\_num] :=

| INJ\_PIP\_CNT[bank\_num] + 1

| FIRST\_SEQNTL := 1

|

| --- ELSE ---

|

FIRST\_SEQNTL = 0 -----------------------| INJ\_PIP\_CNT1 := 1

;FUELPWn is zero | INJ\_PIP\_CNT2 := 1

| Exit sequential\_fuel

unconditionally ------------------------| INJ\_BANK[bank\_num] :=

| INJ\_BANK[bank\_num] + 1

| INJ\_BANK[bank\_num] :=

| MOD(INJ\_BANK[bank\_num],NUMCYL)

| mainpw\_inj\_num :=

| FN1329(INJ\_BANK[bank\_num],0)

| mainpw\_bank\_indicator :=

| FN1327(mainpw\_inj\_num,0)

8-202

FUEL STRATEGY, FUEL SERVICE LOGIC - CDAN2

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;The index, bank\_num, of the bank being processed must match the bank

;indicator for the injector. If not, exit without servicing the injector.

;It must only be serviced using its own banks TOTAL\_DELAYn, IBETAn etc.

;For a stereo ego system, half the time the injector will be on the wrong

;bank, because each INJ\_BANKn increments through all the injectors. The

;FN1327 run time check is the only way to tell which injectors are on which

;bank.

mainpw\_bank\_indicator = 0 --|

|AND -|

bank\_num = 1 ---------------| |

|OR --| DO: FUEL\_IBETA\_CALC

mainpw\_bank\_indicator = 2 --| | | DO: FUEL\_SCHEDULE

|AND -| | DO: fuel\_service\_exit\_check

bank\_num = 2 ---------------| |

|

| --- ELSE ---

|

| DO: fuel\_service\_exit\_check

END: sequential\_fuel

BEGIN: fuel\_service\_exit\_check

;Repeat fuel service routine for second EGO bank, if necessary

bank\_num = 1 ---------------------|

|AND -| bank\_num := 2

NUMEGO = 2 -----------------------| | DO: fuel\_service\_entry\_logic

|

| --- ELSE ---

|

| Exit fuel\_service\_exit\_check

END: fuel\_service\_exit\_check

8-203

FUEL STRATEGY, FOREGROUND INJECTOR TIMING - IBETA CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.29 FOREGROUND INJECTOR TIMING - IBETA CALCULATION (CDAI0)

OVERVIEW

Fuel is synchronized to engine events so that an injection event for a given

cylinder is started some amount of engine rotation after top dead center of

the PIP on its compression stroke 10 degrees before its power stroke. This

PIP is the identifying PIP for the cylinder. Once SYNFLG is set, SYNC\_CTR

tracks which cylinder is identified by the last high PIP. TOTAL\_DELAYn is

the number of whole and fractional PIPs from the identifying PIP to the

desired start of the injection event for that cylinder on ego bank n. The

most common reason why TOTAL\_DELAY1 may differ from TOTAL\_DELAY2 is that

FUELPW1 and FUELPW2 are different, and that off-edge timing has been selected

by calibrating INJREF = 1.

IBETAn is an offset from the LAST high PIP to the start of the next injection

event on bank n. IBETAn has an allowable range of 0 - 1.5 PIPs. If the new

IBETAn falls out of the range 0.5 - 1.5, an adjustment is made to

INJ\_PIP\_CNTn to lengthen or shorten the number of PIP edges to the next

injection event on the bank to bring IBETAn back into this range. The

TOTAL\_DELAYn calculation is performed at each FUELPWn calculation. It will

attempt to keep IBETAn in range by adjusting INJ\_PIP\_CNTn whenever

TOTAL\_DELAYn changes by 1/2 PIP or more.

APPROACH

To calculate a new IBETAn, it is essential to know which cylinder's injector

is to be serviced next. INJ\_BANKn tracks the injectors on a bank in terms of

firing order sequence. Each INJ\_BANKn counts from 0 to NUMCYL - 1, as if the

engine only has one bank, incrementing each time an injection event would be

due if all cylinders were on the bank. In fact, for stereo ego systems, half

the cylinders are on the other bank so no actual injection event occurs, but

this method of accounting is useful, because it is not known which cylinders

are actually on which bank until the firing sequence number is converted to

an injector number via FN1329, and the actual bank of the injector is looked

up in FN1327. The INJ\_BANKn mechanism assures that all injectors are

serviced in order, regardless of abrupt timing changes.

The new IBETAn, in PIPs from last high PIP, is determined by the equation

IBETAn = INJ\_BANKn + TOTAL\_DELAYn - SYNC\_CTR (modulo NUMCYL)

where INJ\_BANKn is the cylinder to be serviced, TOTAL\_DELAYn is the delay in

PIPs after TDC PIP, and SYNC\_CTR is the cylinder for which the last high PIP

is TDC PIP.

This equation may also be expressed as

IBETAn = TOTAL\_DELAYn - (SYNC\_CTR - INJ\_BANKn) (modulo NUMCYL)

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FUEL STRATEGY, FOREGROUND INJECTOR TIMING - IBETA CALCULATION - CDAN2

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Pictorially, the relationship between TOTAL\_DELAYn, SYNC\_CTR, IBETAn,

INJ\_BANKn, and the fuel pulse is shown below. The example shown is for the

number 3 cylinder in the firing order with a TOTAL\_DELAYn = 2.7. The IBETA

value will be calculated to be 0.7.

TDC for cylinder 3

\

SYNC\_CTR |-----2-----|-----3-----|-----4-----|-----5-----|-----6-----|-----

INJ\_BANKn |-----0-----|-----1-----|-----2-----|-----3-----|-----4-----|-----

+-----+ +-----+ +-----+ +-----+ +-----+ +----

PIP | | | | | | | | | | |

-----+ +-----+ +-----+ +-----+ +-----+ +-----+

| | |

|<--------TOTAL\_DELAYn---------->|

| | |

|\_(SYNC\_CTR-INJ\_BANKn)\_\_|\_IBETAn\_|

\ \

\ Fuel pulse turns on here

\

Fuel pulse is scheduled here

This module contains the calculation of IBETA. Injections are scheduled on

either PIP edge, based on the previous IBETAn and INJ\_PIP\_CNTn calculations.

8-205

FUEL STRATEGY, FOREGROUND INJECTOR TIMING - IBETA CALCULATION - CDAN2

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DEFINITIONS

INPUTS

Registers:

- INJ\_BANK1 = Bank 1 injector pointer, in terms of firing order sequence

(modulo NUMCYL). This logic assumes all injectors are on bank 1.

- INJ\_BANK2 = Bank 2 injector pointer, in terms of firing order sequence.

(modulo NUMCYL). This logic assumes all injectors are on bank 2.

- INJ\_PIP\_CNT1 = Number of PIP edges until an injector is due to be

serviced on Bank 1. This logic assumes all injectors are on bank 1.

- INJ\_PIP\_CNT2 = Number of PIP edges until an injector is due to be

serviced on Bank 2. This logic assumes all injectors are on bank 2.

- SYNC\_CTR = Counter of cylinder events; reset upon identification of

cylinder one, counts up to NUMCYL - 1.

- TOTAL\_DELAYn = Delay from PIP near TDC on compression stroke until start

of injection for cylinders on bank n.

Bit Flags:

- FIRST\_SEQNTL = Flag which indicates whether sequential mode fuel

scheduling has been entered; 1 -> the first sequential event has

occurred.

- FUEL\_IN\_SYNC = Fuel synchronized with PIP.

- PIP\_HIGH = Indicates that the most recent PIP transition was low to high.

- SYNFLG = Indicates when number one cylinder has been identified and the

SYNC\_CTR has been aligned with number one cylinder.

Calibration Constants:

- NUMCYL = Number of cylinders in the engine.

OUTPUTS

Registers:

- IBETA1 = The injector delay time in PIP deltas, bank 1. This value is to

be used by the next injection event on bank 1.

- IBETA2 = The injector delay time in PIP deltas, bank 1. This value is to

be used by the next injection event on bank 1.

- INJ\_PIP\_CNT1 = See above.

- INJ\_PIP\_CNT2 = See above.

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FUEL STRATEGY, FOREGROUND INJECTOR TIMING - IBETA CALCULATION - CDAN2

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- TOTAL\_DELAY1 = See above.

- TOTAL\_DELAY2 = See above.

Bit Flags:

- FUEL\_IN\_SYNC = See above.

TEMPORARY REGISTERS

- bank\_num = The EGO bank number currently being processed, either bank 1

or bank 2.

- lcl\_ibeta = A temporary holding register to hold the newly-calculated

IBETAn until the current injector output is scheduled, to ensure the use

of the previous data for the current event.

STRATEGY MODULES

Entry Points:

- FUEL\_IBETA\_CALC = The main entry point for the IBETA calculation module.

8-207

FUEL STRATEGY, FOREGROUND INJECTOR TIMING - IBETA CALCULATION - CDAN2

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PROCESS

STRATEGY MODULE: FUEL\_IBETA\_CALC\_COM1

BEGIN: FUEL\_IBETA\_CALC

;This module is called from the FUEL\_SERVICE strategy module.

FUEL\_IN\_SYNC = 0 -----------------|

|

FIRST\_SEQNTL = 1 -----------------|AND -| FUEL\_IN\_SYNC := 1

| | TOTAL\_DELAY1 := SYNC\_CTR

SYNFLG = 1 -----------------------| | - INJ\_BANK[bank\_num]

| TOTAL\_DELAY2 := TOTAL\_DELAY1

| lcl\_ibeta := 0

|

| --- ELSE ---

|

FIRST\_SEQNTL = 1 -----------------| |

|AND -| lcl\_ibeta := INJ\_BANK[bank\_num]

SYNFLG = 1 -----------------------| | + TOTAL\_DELAY[bank\_num]

| - SYNC\_CTR

| lcl\_ibeta := MOD(lcl\_ibeta,NUMCYL)

|

| --- ELSE ---

|

| IBETA[bank\_num] := 0.0

| Exit FUEL\_IBETA\_CALC

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FUEL STRATEGY, FOREGROUND INJECTOR TIMING - IBETA CALCULATION - CDAN2

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;If more than 1 engine revolution error, assume timing is actually too late

lcl\_ibeta > NUMCYL/2 -------------------| lcl\_ibeta := 0.0

lcl\_ibeta > 1.5 ------------------------| IBETA[bank\_num] := 1.5

;Too early, adjust next | INJ\_PIP\_CNT[bank\_num] :=

;event timing | INJ\_PIP\_CNT[bank\_num] + 2

| ;Wait longer before next injector

|

| --- ELSE ---

|

lcl\_ibeta >= 1.0 -----------------| |

|AND -| IBETA[bank\_num] := lcl\_ibeta

PIP\_HIGH = 1 ---------------------| | INJ\_PIP\_CNT[bank\_num] :=

;On high PIP edge | INJ\_PIP\_CNT[bank\_num] + 1

| ;Schedule next pulse on low PIP

| ; if 1.0 <= lcl\_ibeta <=1.5 for

| ; 0.5 to 1.0 PIP lead time

|

| --- ELSE ---

|

0.5 < lcl\_ibeta < 1.0 ------------| |

|AND -| IBETA[bank\_num] := lcl\_ibeta

PIP\_HIGH = 0 ---------------------| | INJ\_PIP\_CNT[bank\_num] :=

;On Low PIP edge | INJ\_PIP\_CNT[bank\_num] - 1

| ;Service next event on high PIP

| ; for 0.5 to 1.0 PIP lead time

|

| --- ELSE ---

|

lcl\_ibeta < 0.5 ------------------------| IBETA[bank\_num] := lcl\_ibeta

;Too late, schedule next | INJ\_PIP\_CNT[bank\_num] :=

; event one PIP edge sooner | INJ\_PIP\_CNT[bank\_num] - 1

|

| --- ELSE ---

|

| IBETA[bank\_num] := lcl\_ibeta

END: FUEL\_IBETA\_CALC

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FUEL STRATEGY, FUEL SCHEDULING LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.30 FUEL SCHEDULING LOGIC (CDAM0)

OVERVIEW

This module is executed for each main fuel pulse. Based on the engine bank

for which the main fuel pulse was calculated, this module determines the

injector for which the main pulse would normally be scheduled in the absence

of any injector cut-out requirements.

Then, based on the current status of the various injector cut-out conditions,

the module determines whether the main pulse is actually to be delivered. If

the main pulse is to be output, then this module directs the main pulse's

on-edge to be scheduled for the correct injector.

Note: Parameters whose alphabetic characters are in lower case are

non-displayable temporary registers.

DEFINITIONS

Registers:

- CRK\_FUL = Fuel pulsewidth used in crank mode, in seconds.

- DT12S = The most recent PIP Period, i.e., the elapsed time, in clock

ticks, between the most recent rising edge of the PIP signal and the

rising edge immediately prior to that one.

- DT23S = The previous value of DT12S, i.e., the value of DT12S prior to

the most recent rising edge of the PIP signal.

- FUELPW1 = HEGO11 injector pulsewidths, in clock ticks.

- FUELPW2 = HEGO21 injector pulsewidths, in clock ticks.

- INJ\_BANK1 = The firing sequence number of the SEFI injector in cylinder

Bank 1 for which the next main fuel pulse for that bank would normally be

scheduled.

- INJ\_BANK2 = The firing sequence number of the SEFI injector in cylinder

Bank 2 for which the next main fuel pulse for that bank would normally be

scheduled.

- INJOFF = A word whose bits are used as flags that are associated with the

fuel injectors. A SET flag indicates that its associated injector is not

to be fired. The bit that is identified is the flag whose bit number

equals the value of the indexing variable (where the bit number of the

least significant bit is zero).

- INJ\_ACTUAL = A word whose bits represent disabled cylinder events is used

to track when cylinder actually are turned off in the forground.

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FUEL STRATEGY, FUEL SCHEDULING LOGIC - CDAN2

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- LST\_PW[inj\_num] = The main fuel pulsewidth (in ticks) (not including

PWOFF) most recently scheduled for the injector whose 'injector number'

is inj\_num. (It is one of the registers in an array of registers

composed of one register for each SEFI injector on the engine.) (NOTE:

This table is used exclusively by the Dynamic Fuel strategy to determine

whether the currently calculated main fuel pulsewidth is greater than the

pulsewidth that was previously calculated and scheduled as the main pulse

to the cylinder that is currently on its intake stroke.)

- PIPLMT\_HIG = The PIP Period value (in clock ticks) corresponding to an

engine RPM above which the main pulsewidth is not to be delivered

(regardless of the injector for which it would normally be scheduled).

(Note: An engine RPM ABOVE the RPM breakpoint corresponds to a PIP

Period value LESS than PIPLMT\_HIG.

Bit Flags:

- CRKFLG = Crank flag.

- FLG\_THFT\_FCO = Flag signaling when fuel is being cut out due to

anti-theft system action; 1 -> cutting out fuel.

- NO\_FUEL\_SCP = SCP logic indicates that injectors should be disabled

(Latched bit); 1 -> DO NOT deliver any fuel to the engine.

Calibration Constants:

- FN1329 = A single-row table that maps an injector's 'firing sequence

number' to its 'injector number'. Arranged in firing sequence number

order.

X input = 'firing sequence number'

Y input = Null

Output = 'injector number'

- SW\_ANTI\_THFT = Calibration switch to enable the EEC controlled vehicle

anti-theft strategy.

TEMPORARY REGISTERS

- mainpw\_inj\_num = The injector number of the injector for which the

subject main fuel pulse would normally be scheduled. For a SEFI

injector, it identifies the location in the engine of the injector's

corresponding cylinder. (Note: An injector's 'injector number' is NOT

the same as its 'firing sequence number'.)

- mainpw\_seq\_num = The firing sequence number of the injector for which the

subject MAIN fuel Pulse would normally be scheduled. (Note: An

injector's 'firing sequence number' is NOT the same as its 'injector

number'.)

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FUEL STRATEGY, FUEL SCHEDULING LOGIC - CDAN2

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PROCESS

STRATEGY MODULE: FUEL\_SCHEDULE\_COM13

BEGIN: FUEL\_SCHEDULE

; This module is invoked from within the FUEL\_SERVICE strategy module.

; This strategy module corresponds to the FUEL\_OUTPUT code segment in

; the FUEL\_SERVICE software module.

unconditionally ------------------------| mainpw\_seq\_num :=

| INJ\_BANK[bank\_num]

| mainpw\_inj\_num :=

| FN1329[mainpw\_seq\_num,0]

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FUEL STRATEGY, FUEL SCHEDULING LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Do not allow fuel pulsewidth delivery to injector #"mainpw\_inj\_num" if bit

#"mainpw\_seq\_num" in INJOFF is set. (Note: The FIRING SEQUENCE number of

injector #"mainpw\_inj\_num" is "mainpw\_seq\_num".) Also, check for an engine

overspeed condition, an SCP-commanded cut-out, and activation of the Passive

Anti-Theft System.

INJOFF[mainpw\_seq\_num] = 1 -------|

;Cut this injector |

|

DT12S < PIPLMT\_HIG ---------| |

|AND -|

DT23S < PIPLMT\_HIG ---------| |

;RPM too high |

|

FLG\_THFT\_FCO = 1 -----------| |

|AND -|OR --| ;Do NOT schedule the

SW\_ANTI\_THFT = 1 -----------| | | ; main fuel pulse's on-edge

;PATS is cal'd in and active | | ;STORE the current clock time

| | ; as the previous off-edge time

CRKFLG = 1 -----------------| | |

|AND -| | LST\_PW[mainpw\_inj\_num] := ^FFFF

CRK\_FUL = 0 ----------------| | | ;Mislead the dynamic fuel

| | ; strategy to prevent it from

CRKFLG = 0 -----------------| | | ; subsequently scheduling a

|AND -| | ; fuel pulse for that injector

FUELPW[bank\_num] = 0 -------| | |

| | INJ\_ACTUAL =

NO\_FUEL\_SCP = 1 ------------------| | (INJ\_ACTUAL + INJ\_ACTUAL) + 1

| ;Rotate a bit into inj\_actual,

| ; allowing high bit to overflow

|

| --- ELSE ---

|

| INJ\_ACTUAL =

| INJ\_ACTUAL + INJ\_ACTUAL

| ;rotate inj\_actual left one bit.

|

| Call: FUEL\_INJ\_OUT

| ;SCHEDULE the main fuel pulse's

| ; on-edge for injector number

| ; mainpw\_inj\_num

END: FUEL\_SCHEDULE

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FUEL STRATEGY, INJECTOR OUTPUT CONTROL - CDAN2

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8.31 INJECTOR OUTPUT CONTROL (CDAI0)

OVERVIEW

This module should be invoked when the on-edge of a new injector pulse is to

be scheduled. The edge will be scheduled, by issuing an appropriate command

to the high-speed output (HSO) hardware. This will result in the on-edge

time being entered into a carousel slot which has been reserved for this

injector. This command will also direct the HSO hardware to generate an

interrupt when this on-edge is issued. The interrupt service routine, when

invoked, will generate a call to the FUEL\_MAIN\_OFF strategy module, which

will schedule the off-edge for this pulse (i.e., load the off-edge time into

the carousel slot reserved for this injector).

In the case of short pulsewidths (i.e., less than 300 ticks), it becomes

necessary to schedule both the on edge and the off edge at the same time. In

this case, the interrupt described above is not enabled for either edge.

This strategy module, in conjunction with other foreground fuel modules, is

intended to satisfy the following requirements:

1. The injector pulse start should be based on pulsewidth and timing values

calculated from the most recent input data (PIP, LOAD, lambda, etc.).

2. The injector timing value is used only to start the injector pulse,

regardless of which edge is used as the reference.

3. Pulsewidth accuracy has top priority after an injector pulse is started.

4. If possible, the pulsewidth should be updated while in progress to take

advantage of the most recent input data. That is, the injector pulse can

end early or extend later as conditions change.

CALIBRATION NOTES

Injector Output Load:

On stereo HEGO applications, each injector output must be linked to the

proper HEGO sensor. FN1327 is a 1x9 table that is used to match injector

output to HEGO sensor. Each slot in the table corresponds to an individual

injector output. The table value is an address offset to select between

FUELPW1 and FUELPW2.

If FN1327(i,0) = 0, then use FUELPW1 for injector i.

If FN1327(i,0) = 2, then use FUELPW2 for injector i.

For this register addressing scheme, FUELPW1 and FUELPW2 must be consecutive

word registers and FUELPW1 must be first.

The FN1327 table reserves space to control up to 8 injector outputs (the zero

slot is never referenced). The actual number is determined by NUMCYL, which

is the number of cylinders in the engine. The user must fill the table

locations to match NUMCYL. The FN1327 table must be calibrated for all

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FUEL STRATEGY, INJECTOR OUTPUT CONTROL - CDAN2

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applications, regardless of the system (stereo- or mono-HEGO). NOTE that if

NUMEGO = 1 (mono-HEGO), all values in FN1327 must be zero (corresponding to

FUELPW1), or no fuel will be sent to bank 2.

5.0L Injector Output Load Examples:

SEFI SEFI

STEREO EGO MONO-EGO

NUMCYL=8,NUMEGO=2 NUMCYL=8,NUMEGO=1

TABLE INJECTOR ------------------ ------------------

SLOT OUTPUT FN1327 PULSEWIDTH FN1327 PULSEWIDTH

------ -------- ------ ----------- ------ -----------

0 NOT USED 0 FILLER 0 FILLER

1 INJ-1 0 FUELPW2 0 FUELPW1

2 INJ-2 0 FUELPW2 0 FUELPW1

3 INJ-3 0 FUELPW2 0 FUELPW1

4 INJ-4 0 FUELPW2 0 FUELPW1

5 INJ-5 2 FUELPW1 0 FUELPW1

6 INJ-6 2 FUELPW1 0 FUELPW1

7 INJ-7 2 FUELPW1 0 FUELPW1

8 INJ-8 2 FUELPW1 0 FUELPW1

Injector Firing Order:

On SEFI applications, each injector output is linked to it's matching engine

cylinder. The injector output number is the cylinder number. The injectors

must be fired in the proper order to achieve sequential operation.

FN1329 is a 1x8 table which is used to control the injector firing order.

The table contains the firing order of the engine.

5.0L INJECTOR FIRING ORDER EXAMPLE

SEFI

FN1329 NUMCYL = 8

TABLE ---------------

SLOT FN1329 OUTPUT

------ ------ --------

0 1 INJ-1

1 5 INJ-5

2 4 INJ-4

3 2 INJ-2

4 6 INJ-6

5 3 INJ-3

6 7 INJ-7

7 8 INJ-8

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FUEL STRATEGY, INJECTOR OUTPUT CONTROL - CDAN2

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SOFTWARE NOTES

1. Overview of 8065 injector output structure:

The 8065 carousel structure allows reserving carousel slots for explicit use

by certain functions. The injector output procedure utilizes one reserved

slot per injector output, which is typically used for scheduling both the

on-edge and the off-edge of a pulse. The advantage of this scheme is that

the location of all injector commands is readily discernible in case update

of a command time is required by the strategy.

The on edge is scheduled into the reserved slot for the injector, and the

load command requests that an interrupt be generated when this on edge is

issued. At that time, the off edge for the pulse will be scheduled into the

reserved slot, which has been vacated. An exception to this scheme is used

when the pulsewidth is small (less than 300 ticks). Both the on edge and the

off edge are scheduled at the same time; the on edge is scheduled using the

auto-load feature, while the off-edge is manually loaded into the reserved

slot.

The 3 byte time of the last scheduled on and off transition is maintained in

tables so time conflicts can be identified before a new command is issued. A

table documenting the last FUELPW issued by an injector is maintained by the

off-edge scheduling procedure FUEL\_MAIN\_OFF. It is used by the dynamic fuel

procedures to determine if a dynamic make-up pulse is required. A table of

fuel mass delivered in the last main fuel pulse is also maintained for the

benefit of the tripminder computer FUEL\_SUM calculation.

The tables for injector last on and off times, the carousel slot to be used

by and injector edge command, and the last pulsewidth and pounds mass tables

are all readily indexed by a common pointer based on the injector number.

The injectors bank number can be looked up readily in FN1327 using this same

injector pointer allowing bank specific parameters to also be readily

derived. This approach reduces the arguments which need to be passed to the

procedures to essentially only the injector number. In some cases, it is

convenient to pass additional information which is already in temporary

registers due to previous calculations.

2. Loading the carousel in manual mode:

The 8065 CPU provides two modes for loading command and time data into the

carousel. These modes, automatic and manual, are selected via bits 6 and 7

in the CAM\_SLOT\_SELECT special function register (SFR). Manual mode is

selected when bit 6, defined in strategies as MANUAL\_MODE, is set to 1.

Automatic mode is selected whenever MANUAL\_MODE is not set. This is most

commonly accomplished by clearing byte CAM\_SLOT\_SELECT.

In the automatic mode, as in the 8061, data is loaded into the next available

carousel slot as soon as the output command holding buffer, commonly known as

HSO\_CMD, has a command written to it. The CPU continuously steps through the

carousel slots completing one complete cycle each 32 machine states, or 1

tick.

Manual mode allows a command and time tag to be written to a user specified

slot in the carousel. A slot may be reserved to prevent automatic mode from

writing to it, i.e. a reserved slot may only be loaded by writing to it in

manual mode.

To write to a slot in manual mode, the MANUAL\_MODE flag must be set in

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FUEL STRATEGY, INJECTOR OUTPUT CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CAM\_SLOT\_SELECT. Both the hardware and software manual recommend that the

target carousel slot number also should be specified in CAM\_SLOT\_SELECT at

this time, although the examples shown do not appear to require it. Next,

the target time and command values are written to the holding buffer

registers HSO\_TIME and HSO\_CMD. Finally, CAM\_SLOT\_SELECT is written with the

slot number in bits 0-4, bit 5 cleared, and with both MANUAL\_MODE (bit 6),

and MANUAL\_WRITE (bit 7) set.

Data will not be transferred from the holding buffer registers to the

carousel until up to 32 machine states after MANUAL\_WRITE is set. In both

manual and auto mode, care must be taken to ensure that data in the holding

buffer is not overwritten with new data before it is transferred into the

carousel. Bit 7 in the IO\_STATUS register, defined as OUTPUT\_BUFFER\_FULL in

most strategies, when set indicates that the output buffer is still occupied

with data awaiting loading into the carousel. The CAM\_SLOT\_SELECT register

also must not be altered until the output buffer is vacated.

Finally, reserved slots may add to the time required for data to be

transferred from the holding buffer to the carousel in automatic mode (up to

32 machine states, or 1 tick, after HSO\_CMD is loaded). In some strategies,

an additional tick may be added to some immediate commands to prevent the

edges from going out 350 milliseconds late.

3. Reserving a carousel slot:

A slot is reserved by loading it when the RESERVE\_SLOT flag (bit 7 of SFR

CAM\_SLOTS\_AVBL) is set. Manual mode must be used to specify which slot to

reserve. A slot may not be unreserved, once reserved, except through

hardware reset. If RESERVE\_SLOT is set during auto load mode, whichever

available slot received the command will become reserved, thereby removing it

from availability for further auto loads. Ultimately, a deadlock may result

in which all slots are reserved, but the holding buffer remains full with an

auto load command.

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FUEL STRATEGY, INJECTOR OUTPUT CONTROL - CDAN2

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DEFINITIONS

INPUTS

Registers:

- DT12S = The period between the last two PIP low-to-high transitions, in

clock ticks.

- FUELPW1 = The HEGO11 injector pulsewidth, in clock ticks.

- FUELPW2 = The HEGO21 injector pulsewidth, in clock ticks.

- IBETA1 = The injector delay time in PIP deltas, bank 1.

- IBETA2 = The injector delay time in PIP deltas, bank 2.

- LAST\_HI\_PIP = Time of latest low-to-high transition, in clock ticks.

- PWOFF = Injector pulsewidth offset, clock ticks.

OUTPUTS

Registers:

- LAST\_ON\_INJ[i] = The time at which the most recently scheduled on-edge

for injector i is to be issued.

TEMPORARY REGISTERS

- bank\_num = The EGO bank number currently being processed, either bank 1

or 2.

- mainpw\_inj\_num = The injector number of the injector for which the main

fuel pulsewidth is calculated.

- off\_edge\_time[i] = Array containing the most recently scheduled off-edge

time for injector i. This value is written both to the RAM register pair

LAST\_OFF\_HI[i] and LAST\_OFF\_IN[i], and to the HSO carousel when the

off-edge is scheduled.

- on\_edge\_time[i] = Similar to off\_edge\_time[i], but contains the injector

on-edge time. This value is written both to the RAM register pair

LAST\_ON\_HI[i] and LAST\_ON\_INJ[i], and to the HSO carousel when the

on-edge is scheduled.

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FUEL STRATEGY, INJECTOR OUTPUT CONTROL - CDAN2

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PROCESS

STRATEGY MODULE: FUEL\_INJ\_OUT\_COM12

BEGIN: FUEL\_INJ\_OUT

; Called from within the FUEL\_SCHEDULE strategy module.

; This strategy module correspond to the INJECTOR\_EDGE routine

; in the INJECTOR\_OUTPUT software module.

; Determine the injector on-edge time.

Unconditionally ----------------| i = mainpw\_inj\_num

| on\_edge\_time[i] = LAST\_HI\_PIP

| + (IBETA[bank\_num] \* DT12S)

; Check that the on-edge time is in the future, and that there

; is sufficient time to load the carousel.

on\_edge\_time[i] < clock + 10 ---| on\_edge\_time[i] = clock + 10

| ;Start pulse in 10 clock ticks

; If an off-edge has been previously loaded for this injector, and has

; not yet been issued, determine whether the resulting two pulses will

: be distinct or combined.

off-edge scheduled for

mainpw\_inj\_num ---------|

|AND -| Cancel old off edge

on\_edge\_time[i] < | | LAST\_ON\_INJ[i] = on\_edge\_time[i]

off\_edge\_time[i] -------| | Load new on-edge into carousel

| using the auto-load feature

|

| --- ELSE ---

off-edge scheduled for |

mainpw\_inj\_num ---------| |

|AND -| LAST\_ON\_INJ[i] = on\_edge\_time[i]

on\_edge\_time[i] >= | | + PWOFF

off\_edge\_time ----------| | Load new on-edge into carousel

| using the auto-load feature

; Enable an HSO interrupt, to occur when the on-edge is issued, or

; schedule the off-edge now for a short pulse.

FUELPW[bank\_num] > 300 ---------| Enable the HSO interrupt for

| injector mainpw\_inj\_num

|

| --- ELSE ---

|

| Do: FUEL\_MAIN\_OFF(i)

END: FUEL\_INJ\_OUT

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FUEL STRATEGY, CALCULATE DYNAMIC FUEL CORRECTION - CDAN2

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8.32 CALCULATE DYNAMIC FUEL CORRECTION (CDAI0)

OVERVIEW

The dynamic fuel correction is a fuel pulse that is injected into the open

valve of the cylinder that is currently on its intake stroke. This fuel

pulse is the result of the difference between: (1) the air charge used in

the main fuel pulsewidth calculation most recently performed for that

cylinder, and (2) the air charge used in the current calculation of the main

fuel pulsewidth (being performed for a cylinder that is later in the firing

sequence, and earlier in its cycle, than is the cylinder currently on its

intake stroke).

The dynamic fuel correction is limited to MINPW for a minimum; for a maximum,

it is limited so that it will not extend past the point in time when the

cylinder will no longer induct the fuel injected on this intake event.

NOTE: Parameters whose alphabetic characters are in the lower case are

non-displayable temporary registers.

DEFINITIONS

INPUTS

Registers:

- CYL\_AIR\_CHG = Current cylinder air charge used in fuel calculation, lbm.

- DYNPW = Dynamic fuel correction pulsewidth, clockticks.

- ENABLE\_DYNAM = Counter that enables the dynamic fuel make-up pulse four

engine revolutions after the strategy has identified number one cylinder.

- FUELPWn = The previous injector pulsewidth (in clock ticks) for the

identified engine bank number (n); n = 1,2.

- LST\_PW(x) = The array of registers containing the fuel pulsewidths (in

units of clockticks) most recently delivered by each of the individual

injectors; indexed by 'injector number'.

- MINPWT = Minimum allowed pulsewidth for requested fuel; ticks.

- SYNC\_CTR = Counter that counts occurrences of successive engine cylinders

being at 10-deg BTDC, by incrementing at every PIP rising edge, and then

resets when equal to the number of cylinders in the engine.

Bit Flags:

- SYNFLG = Flag which indicates when number one cylinder has been

identified and the SYNC\_CTR has been aligned with the occurance of PIP

for number one cylinder.

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FUEL STRATEGY, CALCULATE DYNAMIC FUEL CORRECTION - CDAN2

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Calibration Constants:

- AIR\_DOWN\_CAL = A switch that indicates when to perform the cylinder air

charge calculation: 0 -> perform calculation on PIP up-edge; 1 ->

perform calculation on PIP down-edge.

- DYN\_MIN\_ARC = Minimum air charge value below which dynamic make-up fuel

is disabled. This parameter should be used to prevent dynamic fuel upon

recoveries from decels.

- ENGCYL = Number of intake strokes per engine revolution.

- FN1327 = A single-row table that maps an injector's 'injector number' to

a numeric indicator of the engine bank in which the injector's

corresponding cylinder is located. (NOTE: This numeric indicator is NOT

equal to the engine bank's 'bank number'; a table output of 0 (zero)

corresponds to engine bank #1; a table output of 2 corresponds to engine

bank #2.)

X input = 'injector number'

Y input = Null

table output = 'engine bank indicator'

- FN1329 = A single-row table that maps an injector's 'firing sequence

number' to its 'injector number'. Arranged in firing sequence number

order.

X input = 'firing sequence number'

Y input = Null

Output = 'injector number'

- PWCAL = Value above which the ratio of the current fuel pulsewidth to the

previous main fuel pulsewidth will produce a dynamic fuel correction.

OUTPUTS

Registers:

- DYNPW = See above.

- ENABLE\_DYNAM = See above.

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FUEL STRATEGY, CALCULATE DYNAMIC FUEL CORRECTION - CDAN2

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TEMPORARY REGISTERS

- current\_time = The value in the 'master I/O timer' (a h/w-dedicated

register); unreferenced relative time (not a time interval referenced to

any event(s)); rolls-over after attaining maximum possible value;

increments by 1 (one) every '(clock)tick', where a '(clock)tick' is the

elapsed time equal to the product: (period\_of\_CPU\_machine\_state)\*

(the\_number\_of\_slots\_in\_the\_output\_carousel).

- dyn\_on\_edge = Time that the dynamic fuel pulse is to begin.

- int\_inj\_num = The 'INJector NUMber' of the injector whose corresponding

cylinder is currently on its INTake stroke. (NOTE: This temporary

register, calculated in this module, is used in this module and also

input by other foreground fuel modules.) (Note: An injector's 'injector

number' identifies the location in the engine of its corresponding

cylinder; it is NOT the same as its 'firing sequence number'.)

- int\_seq\_num = The 'firing SEQuence NUMber' of the injector whose

corresponding cylinder is currently on its INTake stroke. Updated when a

new air charge is to be calculated. (NOTE: This temporary register,

calculated in this module, is used in this module and also input by other

foreground fuel modules.) (Note: An injector's 'firing sequence number'

is NOT the same as its 'injector number' which identifies the location in

the engine of the injector's corresponding cylinder.)

- intcyl\_bank\_indicator = A numeric indicator of the engine bank in which

the cylinder currently on its intake stroke is located. (Note: This

numeric indicator is NOT equal to the engine bank's 'bank number'; a

numeric value of 0 (zero) corresponds to engine bank #1; a numeric value

of 2 corresponds to engine bank #2.)

- off\_edge\_time = Time of the off-edge of the main fuel pulsewidth

(previously calculated) for the cylinder that is currently on its intake

stroke.

- t\_current\_pw = Value of the currently calculated main fuel pulsewidth;

ticks.

STRATEGY MODULES

Entry Points:

- FUEL\_DYN\_CALC

External Routines:

- FUEL\_DYN\_FIT

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FUEL STRATEGY, CALCULATE DYNAMIC FUEL CORRECTION - CDAN2

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PROCESS

STRATEGY MODULE: FUEL\_DYN\_CALC\_COM3

BEGIN: FUEL\_DYN\_CALC

; Called from the FUEL\_FG\_PIPEDG strategy module; executed in the foreground.

; Determine if the dynamic fuel calculation should be performed.

SYNFLG = 0 -----------------------------| ENABLE\_DYNAM = ENGCYL \* 4

| Exit FUEL\_DYN\_CALC

|

| --- ELSE ---

SYNFLG = 1 -----------------------| |

|AND -| ENABLE\_DYNAM = ENABLE\_DYNAM - 1

ENABLE\_DYNAM <> 0 ----------------| | (decrement enabling counter)

| Exit FUEL\_DYN\_CALC

|

| --- ELSE ---

|

CYL\_AIR\_CHG < DYN\_MIN\_ARC --------------| Exit FUEL\_DYN\_CALC

; Next, identify the firing sequence number of the cylinder that is currently

; on its intake stroke.

ENGCYL = 4 ------------------------|

|AND -| int\_seq\_num = SYNC\_CTR - ENGCYL

AIR\_DOWN\_CAL = 0 ------------------| |

| --- ELSE ---

|

| int\_seq\_num =

| SYNC\_CTR - (ENGCYL - 1)

int\_seq\_num <= 0 ------------------------| int\_seq\_num =

| int\_seq\_num + (ENGCYL \* 2)

; Next, identify the engine bank that contains the cylinder that is currently

; on its intake stroke.

Unconditionally ------------------------| int\_inj\_num = FN1329(int\_seq\_num,0)

| intcyl\_bank\_indicator =

| FN1327(int\_inj\_num,0)

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FUEL STRATEGY, CALCULATE DYNAMIC FUEL CORRECTION - CDAN2

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; Then obtain the latest pulsewidth calculated for the engine bank that

; contains the cylinder currently on its intake stroke.

intcyl\_bank\_indicator = 0 --------------| t\_current\_pw = FUELPW1

|

| --- ELSE ---

|

| t\_current\_pw = FUELPW2

; The dynamic fuel correction is calculated for the cylinder that is

; currently on the intake stroke of its cycle.

; Determine if there is a need for the dynamic pulse:

Unconditionally -------------------------| ratio\_puls\_width = t\_current\_pw

| / LST\_PW[int\_inj\_num]

| delta\_puls\_width = t\_current\_pw

| - LST\_PW[int\_inj\_num]

ratio\_puls\_width > PWCAL ----------|

|

delta\_puls\_width > 0 --------------|AND -| DYNPW = delta\_puls\_width

| | (need normal dynamic pulse)

delta\_puls\_width > MINPWT ---------| |

| --- ELSE ---

ratio\_puls\_width > PWCAL ----------| |

|AND -| DYNPW = MINPWT

delta\_puls\_width > 0 --------------| | (need minimum dyn PULSE)

|

| --- ELSE ---

|

| DYNPW = 0

| (no pulse needed)

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FUEL STRATEGY, CALCULATE DYNAMIC FUEL CORRECTION - CDAN2

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Determine if the dynamic pulse can be output immediately or whether it must

wait for the main fuel pulse to complete. If the main fuel pulse has not

completed, then determine if the off-edge is in the queue or the carousel and

schedule the dynamic pulse on-edge appropriately.

DYNPW > 0 -------------------------|

|AND -| dyn\_on\_edge = current\_time

off\_edge\_time < current\_time ------| | Call FUEL\_DYN\_FIT

| (send out dyn pulse now)

|

| --- ELSE ---

|

DYNPW > 0 -------------------------------| dyn\_on\_edge = off\_edge\_time

| Call FUEL\_DYN\_FIT

|

| --- ELSE ---

|

| Exit FUEL\_DYN\_CALC

END: FUEL\_DYN\_CALC

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FUEL STRATEGY, DYNAMIC FUEL, SCHEDULE PULSE ON-EDGE - CDAN2

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8.33 SCHEDULE DYNAMIC FUEL PULSE ON-EDGE (CDAK0)

OVERVIEW

This routine uses the current dynamic fuel pulsewidth value, together with

the time of its on-edge, to calculate the desired time of its off-edge. This

routine then determines if the dynamic fuel pulse will be able to fit between

the time of its on-edge and the time that the cylinder currently on its

intake stroke will stop inducting charge. If the entire pulse will not fit,

then the routine will determine if the minimum allowed pulse will fit. If

the minimum pulse will not fit, then no dynamic pulse will be output; if the

minimum pulse will fit, then the time of the off-edge for the maximum pulse

that will fit is determined.

If a (non-zero) pulse is to be output, then this routine: 1) schedules the

pulse's on-edge, and then 2) calls a routine which will schedule the

off-edge.

The graph shown below illustrates the three mutually exclusive cases defined

by the conditions specified in the routine.

The assumptions shown below derive from the routine's assumption that MINPWT

<= DYNPW and that off\_edge\_time[i] <= dyn\_on\_edge, together with the

equations defining dyn\_min\_tim and dyn\_off\_tim in the above routine.

Assumptions: dyn\_on\_edge < dyn\_min\_tim <= dyn\_off\_tim

V V V

----------|---------------|-------------------|--------------->time

dyn\_tim\_limit dyn\_tim\_limit dyn\_tim\_limit

Cases: (III) (II) (I)

Case I: dyn\_on\_edge < dyn\_min\_tim <= dyn\_off\_tim <= dyn\_tim\_limit

Case II: dyn\_on\_edge < dyn\_min\_tim <= dyn\_tim\_limit < dyn\_off\_tim

Case III: dyn\_on\_edge <= dyn\_tim\_limit < dyn\_min\_tim <= dyn\_off\_tim

Note: Parameters whose names are alphabetic characters are in lower case are

non-displayable temporary registers.

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FUEL STRATEGY, DYNAMIC FUEL, SCHEDULE PULSE ON-EDGE - CDAN2

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DEFINITIONS

INPUTS

Registers:

- DT12S = Time period between the latest two PIP low-to-high transitions,

in clock ticks.

- DYNPW = Pulsewidth of the dynamic fuel pulse, in clock ticks.

- LAST\_HI\_PIP = Time of the latest PIP low-to-high transition.

- MINPWT = Minimum allowed fuel pulsewidth, in clock ticks.

- PWOFF = Injector pulsewidth offset, on clock ticks.

Calibration Constants:

- CALCLP = Percent of a PIP period, from the PIP up-edge at the start of an

intake stroke to the point when fuel will no longer be inducted on the

current intake event.

OUTPUTS

Registers:

- DYNPW = see above.

TEMPORARY REGISTERS

- dyn\_min\_tim = Time that the injector would turn off if delivering the

minimum allowed fuel pulsewidth.

- dyn\_off\_tim = Time that the injector will turn off the dynamic fuel

pulse.

- dyn\_on\_edge = Time that the injector is to turn on for the current

dynamic fuel pulse.

- dyn\_tim\_limit = Calculated time when no additional fuel can be inducted

by the cylinder that is currently on its intake stroke.

- off\_edge\_time[i] = Array containing the most recently scheduled off-edge

time for injector number i. This value is written both to the RAM

register pair LAST\_OFF\_HI[i] and LAST\_OFF\_IN[i], and to the HSO carousel

when the off-edge is scheduled.

- separate\_pulse = A local flag which specifies whether the dynamic pulse

will be appended directly to a main fuel pulse in progress, or issued as

a distinct make-up pulse after the completion of the main pulse.

ROUTINES CALLED

- FUEL\_DYN\_OFF = Routine to schedule the dynamic fuel pulse off-edge.

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FUEL STRATEGY, DYNAMIC FUEL, SCHEDULE PULSE ON-EDGE - CDAN2

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PROCESS

STRATEGY MODULE: FUEL\_DYN\_FIT\_COM2

BEGIN: FUEL\_DYN\_FIT

; Called from the FUEL\_DYN\_CALC strategy module.

; This strategy module corresponds to the WILL\_PULS\_FIT and PUT\_OUT\_PULSE

; routines in the DYNAMIC\_FUEL software module.

; Note: This routine assumes that MINPWT <= DYNPW and that off\_edge\_time[i]

; <= dyn\_on\_edge. (Ref.: See the graph on the following page.)

Unconditionally ------------------------| dyn\_tim\_limit :=

| LAST\_HI\_PIP + (DT12S \* CALCLP)

| i := int\_inj\_num

dyn\_on\_edge = off\_edge\_time[i] --------| dyn\_off\_tim := dyn\_on\_edge + DYNPW

;The dynamic fuel pulse is to | ;Do not include the pulsewidth

; be contiguous in time with | ; offset when the dynamic fuel

; the main fuel pulse | ; pulse will be contiguous with

| ; the main fuel pulse

|

| dyn\_min\_tim := dyn\_on\_edge

| ;There need not be a non-zero

| ; minimum duration of the dynamic

| ; pulse when the dynamic pulse will

| ; be contiguous with the main pulse

|

| separate\_pulse := 0

|

| --- ELSE ---

|

| dyn\_off\_tim := dyn\_on\_edge +

| DYNPW + PWOFF

| dyn\_min\_tim := dyn\_on\_edge +

| MINPWT + PWOFF

| separate\_pulse := 1

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FUEL STRATEGY, DYNAMIC FUEL, SCHEDULE PULSE ON-EDGE - CDAN2

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dyn\_off\_tim <= dyn\_tim\_limit -----------| SCHEDULE dynamic fuel on-edge

| to occur at dyn\_on\_edge.

(Case I) | Call: FUEL\_DYN\_OFF

| ;Dynamic fuel pulse will fit, so

| ; maintain current desired values

| ; of DYNPW and dyn\_off\_tim

|

| --- ELSE ---

|

dyn\_min\_tim <= dyn\_tim\_limit -----| |

|AND -| dyn\_off\_tim := dyn\_tim\_limit

separate\_pulse = 1 ---------------| | DYNPW := (dyn\_off\_tim - dyn\_on\_tim)

;Normal dynamic pulse is | - PWOFF

; distinct from main pulse | SCHEDULE dynamic fuel on-edge

| to occur at dyn\_on\_edge.

(Case IIa) | Call: FUEL\_DYN\_OFF

| ;Normal dynamic pulse won't fit,

| ; but the minimum pulse will fit;

| ; determine maximum allowed pulse

|

|

| --- ELSE ---

|

dyn\_min\_tim <= dyn\_tim\_limit -----------| dyn\_off\_tim := dyn\_tim\_limit

;Dynamic pulse is appended to | DYNPW := dyn\_off\_tim

; the main fuel pulse | - dyn\_on\_edge

| SCHEDULE dynamic fuel on-edge

(Case IIb) | to occur at dyn\_on\_edge.

| Call: FUEL\_DYN\_OFF

| ;Normal dynamic pulse won't fit,

| ; but the minimum pulse will fit;

| ; determine maximum allowed pulse

|

|

| --- ELSE ---

(Case III) |

| DYNPW := 0

| Exit FUEL\_DYN\_FIT

| ;The minimum allowed pulse will

| ; not fit, so cancel dynamic fuel

| ; pulse

END: FUEL\_DYN\_FIT

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FUEL CONTROL STRATEGY, FUEL PULSEWIDTH, DYNAMIC FUEL OFF - CDAN2

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8.34 DYNAMIC FUEL OFF (CDAI0)

OVERVIEW

This routine is called after: (1) a dynamic fuel pulse on-edge for the

injector whose corresponding cylinder is currently on its intake stroke has

been scheduled, AND (2) the fuel pulse's off-edge has been calculated. This

routine schedules the fuel pulse off-edge for the injector.

NOTE: Parameters whose alphabetic characters are in the lower case are

non-displayable temporary registers.

DEFINITIONS

INPUTS

Registers:

- AHISL\_TICK = Temperature compensated high slope for a dual slope

characterization of injector flow, lbm/tick.

- ALOSL\_TICK = Temperature compensated low slope for a dual slope

characterization of injector flow, lbm/tick.

- BKPT\_PW = Dual slope breakpoint in lbm divided by temperature compensated

low slope (lbm/tick), ticks.

- DYNPW = Dynamic fuel correction pulsewidth, ticks.

- FB\_DIFF = Difference between FUEL\_BKPT divided by temperature compensated

high slope and FUEL\_BKPT divided by temperature compensated low slope,

ticks.

- FUEL\_SUM = An accumulator which stores the total amount of fuel output,

lbm.

- PWOFF = Injector pulsewidth offset, ticks.

Calibration Constants:

- FUEL\_BKPT = The amount of fuel flow when transfer is made from the low

slope to the high slope, lbm/injection.

OUTPUTS

Registers:

- FUEL\_SUM = See above.

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FUEL CONTROL STRATEGY, FUEL PULSEWIDTH, DYNAMIC FUEL OFF - CDAN2

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TEMPORARY REGISTERS

- dyn\_off\_tim = The desired time that the dynamic fuel pulse is to end;

i.e., the time at which the injector is to turn-off.

- inj\_dyn = Fuel mass delivered by the dynamic fuel pulse, lbm.

PROCESS

STRATEGY MODULE: FUEL\_DYN\_OFF\_COM2

BEGIN: FUEL\_DYN\_OFF

; Invoked from within the FUEL\_DYN\_FIT strategy module.

Unconditionally -------------------| Schedule the dynamic fuel off-edge

| to occur at time dyn\_off\_tim

| (calculated elsewhere).

; Determine the mass of fuel that has been injected and update certain

; registers. (FUEL\_SUM maintains the total fuel injected, for the DOL

; calculation.)

DYNPW < BKPT\_PW -------------|

|AND -| inj\_dyn = DYNPW \* ALOSL\_TICK

DYNPW > 0 -------------------| |

| --- ELSE ---

|

DYNPW > 0 -------------------------| inj\_dyn = (DYNPW + FB\_DIFF)

| \* AHISL\_TICK

Unconditionally -------------------| FUEL\_SUM = FUEL\_SUM + inj\_dyn

END: FUEL\_DYN\_OFF

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FUEL STRATEGY, BACKGROUND INJECTOR CUTOUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.35 BACKGROUND INJECTOR CUTOUT (CDAM0)

OVERVIEW

Turning off injectors must be done in a specific order depending on how many

injectors are requested to be on. Generally the highest frequency is desired

for turning off a portion of injectors( i.e. 1 off, 1 on, 1 off, etc. not 4

on 4 off). Once an injector is turned off it may be desirable to keep that

injector off to minimize transient fuel effects. However, this may have

adverse affects on cylinder valve temperatures and possibly catalyst midbed

temperatures.

To avoid a possible exhaust valve overtemp condition, this logic allows the

injector cutout bit pattern to be rotated to ensure that all cylinders are

equally cooled. Every INJ\_HOLD number of engine events, the bit pattern is

shifted left one bit. Pattern shifting is conducted in the background, thus

providing one BG loop resolution on pattern rotation. A calibratable switch

is provided to enable this round-robin type of cylinder rotation, or the

default is a set pattern (non-rotating).

8 Cylinder pattern example:

EXAMPLE:

======== =====================================

Value of INJ\_BANKn: 7 6 5 4 3 2 1 0

Injector number: [8] [4] [5] [6] [2] [7] [3] [1] (4.6L FIRING ORDER)

bit position value: 128 64 32 16 8 4 2 1

-------------------------------

INJ\_ON=8 -> INJ\_OFF := | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

-------------------------------

INJ\_ON=7 -> INJ\_OFF := | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | = INJ\_7ON = 1

-------------------------------

INJ\_ON=6 -> INJ\_OFF := | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | = INJ\_6ON = 17

-------------------------------

INJ\_ON=5 -> INJ\_OFF := | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | = INJ\_5ON = 22

-------------------------------

INJ\_ON=4 -> INJ\_OFF := | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | = INJ\_4ON = 85

-------------------------------

INJ\_ON=3 -> INJ\_OFF := | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | = INJ\_3ON = 117

-------------------------------

INJ\_ON=2 -> INJ\_OFF := | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | = INJ\_2ON = 119

-------------------------------

INJ\_ON=1 -> INJ\_OFF := | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | = INJ\_1ON = 127

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INJ\_ON=0 -> INJ\_OFF := | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | = INJ\_0ON = 255

-------------------------------

(0 = ON)

(1 = OFF)

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FUEL STRATEGY, BACKGROUND INJECTOR CUTOUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

6 Cylinder pattern example:

EXAMPLE:

======== =====================================

Value of INJ\_BANKn: 5 4 3 2 1 0

Injector number: [5] [6] [2] [4] [3] [1] (3.0L FIRING ORDER)

bit position value: 32 16 8 4 2 1

-------------------------------

INJ\_ON=6 -> INJ\_OFF := | x | x | 0 | 0 | 0 | 0 | 0 | 0 |

-------------------------------

INJ\_ON=5 -> INJ\_OFF := | x | x | 0 | 0 | 0 | 0 | 0 | 1 | = INJ\_5ON = 1

-------------------------------

INJ\_ON=4 -> INJ\_OFF := | x | x | 0 | 0 | 1 | 0 | 0 | 1 | = INJ\_4ON = 9

-------------------------------

INJ\_ON=3 -> INJ\_OFF := | x | x | 0 | 0 | 1 | 0 | 1 | 1 | = INJ\_3ON = 11

-------------------------------

INJ\_ON=2 -> INJ\_OFF := | x | x | 0 | 1 | 1 | 0 | 1 | 1 | = INJ\_2ON = 27

-------------------------------

INJ\_ON=1 -> INJ\_OFF := | x | x | 0 | 1 | 1 | 1 | 1 | 1 | = INJ\_1ON = 31

-------------------------------

INJ\_ON=0 -> INJ\_OFF := | x | x | 1 | 1 | 1 | 1 | 1 | 1 | = INJ\_0ON = 63

-------------------------------

(0 = ON) ( INJ\_6ON = 0 ; INJ\_7ON = 0 )

(1 = OFF)

(x = don't care, assume 0)

4 Cylinder pattern example:

EXAMPLE:

======== =====================================

Value of INJ\_BANKn: 3 2 1 0

Injector number: [4] [2] [3] [1] (1.9L FIRING ORDER)

bit position value: 8 4 2 1

-------------------------------

INJ\_ON=4 -> INJ\_OFF := | x | x | x | x | 0 | 0 | 0 | 0 |

-------------------------------

INJ\_ON=3 -> INJ\_OFF := | x | x | x | x | 0 | 0 | 0 | 1 | = INJ\_3ON = 1

-------------------------------

INJ\_ON=2 -> INJ\_OFF := | x | x | x | x | 0 | 1 | 0 | 1 | = INJ\_2ON = 5

-------------------------------

INJ\_ON=1 -> INJ\_OFF := | x | x | x | x | 0 | 1 | 1 | 1 | = INJ\_1ON = 7

-------------------------------

INJ\_ON=0 -> INJ\_OFF := | x | x | x | x | 1 | 1 | 1 | 1 | = INJ\_0ON = 15

-------------------------------

(0 = ON) ( INJ\_4ON = 0 ; INJ\_5ON = 0 ;

(1 = OFF) INJ\_6ON = 0 ; INJ\_7ON = 0 )

(x = don't care, assume 0)

8-233

FUEL STRATEGY, BACKGROUND INJECTOR CUTOUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- DISCUTOUT1 = One of the injectors that should not be fueled due.

- DISCUTOUT2 = One of the injectors that should not be fueled due.

- INJ\_CTR = Number of pip up edges since last bit pattern change.

- INJ\_OFF = A byte containing bit flags indicating injector sequence to be

turned off.

- INJOFF\_FMEM = Injectors which should not be fired due to a coil failure.

- INJ\_OFF\_LST = A byte containing the bit flags of the previous background

loop.

- INJ\_OFF\_NEXT = A byte containing bit flags indicating injectors to be

turned off upon the next round robin rotation.

- INJ\_ON = Number of injectors desired to be on, cylinders.

- INJ\_ON\_LST = Last background pass value of INJ\_ON, number of cylinders.

Bit flags:

- INJ\_NEXT\_FLG = Flag signalling to the foreground to rotate the cutout

pattern when the firing order is on INJ\_RR\_TRIG cylinder, 1 -> change

pattern when injector INJ\_RR\_TRIG is scheduled.

Calibration Constants:

- FN1329 = A one-row table that maps an injector's 'firing sequence number'

to its 'injector number'.

- INJ\_7ON = Value which indicates bit pattern for 7 injector on.

- INJ\_6ON = Value which indicates bit pattern for 6 injectors on.

- INJ\_5ON = Value which indicates bit pattern for 5 injectors on.

- INJ\_4ON = Value which indicates bit pattern for 4 injectors on.

- INJ\_3ON = Value which indicates bit pattern for 3 injectors on.

- INJ\_2ON = Value which indicates bit pattern for 2 injectors on.

- INJ\_1ON = Value which indicates bit pattern for 1 injectors on.

- INJ\_0ON = Value which indicates bit pattern for 0 injectors on.

- INJCUTOUT\_SW = Switch to select injector cutout method to use; 1 -> round

robin, 0 -> normal injector cutout, set bit pattern.

- INJ\_HOLD = Number of complete engine cycles to hold current bit pattern.

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FUEL STRATEGY, BACKGROUND INJECTOR CUTOUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- INJ\_RR\_TRIG = Firing order cylinder number in which round robin rotations

will occur at.

- NUMCYL = Number of cylinders.

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FUEL STRATEGY, BACKGROUND INJECTOR CUTOUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_INJ\_OFF\_BG\_COM3

BEGIN: determine\_bit\_pattern

INJ\_ON = NUMCYL --------------------| inj\_off = 0

(all injectors on) | ;no change to INJ\_CTR

| ;no change to INJ\_OFF\_NEXT

| ;no change to INJ\_NEXT\_FLG

|

| --- ELSE ---

|

INJ\_ON <> INJ\_ON\_LST ---------------| Do: set\_bit\_pattern

(injector count has changed) | INJ\_CTR = 0

| ;no change to INJ\_OFF\_NEXT

| ;no change to INJ\_NEXT\_FLG

|

| --- ELSE ---

|

INJ\_CTR >= | inj\_off = INJ\_OFF\_LST

INJ\_HOLD \* NUMCYL ------------| | Do: injector\_round\_robin(1)

|AND -| INJ\_OFF\_NEXT = inj\_off

INJCUTOUT\_SW = 1 -------------| | INJ\_NEXT\_FLG = 1

| inj\_off = INJ\_OFF\_LST

| INJ\_CTR = 0

|

| --- ELSE ---

|

| inj\_off = INJ\_OFF\_LST

| ;no change to INJ\_CTR

| ;no change to INJ\_OFF\_NEXT

| ;no change to INJ\_NEXT\_FLG

DISCUTOUT1 <> 0 --------------|

|OR --| Do: dis\_fmem\_bits

DISCUTOUT2 <> 0 --------------| |

| --- ELSE ---

|

| INJOFF\_FMEM = 0

;This logic combines the injector inj\_off bits and the DIS\_FMEM bits.

inj\_off(bit(n)) = 1 ----------|

|OR --| INJ\_OFF(bit(n)) = 1

INJOFF\_FMEM(bit(n)) = 1 ------| |

| --- ELSE ---

|

| INJ\_OFF(bit(n)) = 0

unconditionally --------------------| INJ\_OFF\_LST = INJ\_OFF

| INJOFF = INJ\_OFF

END: determine\_bit\_pattern

8-236

FUEL STRATEGY, BACKGROUND INJECTOR CUTOUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: foreground\_round\_robin

;Execute the following logic upon every PIP up edge:

unconditionally --------------------| INJ\_CTR = INJ\_CTR + 1

| (increment count of cylinder

| events for this bit pattern)

;Do the following logic before INJ\_OFF is checked in foreground:

INJ\_NEXT\_FLG = 1 -------------| | INJOFF = INJ\_OFF\_NEXT

|AND -| INJ\_NEXT\_FLG = 0

INJ\_BANK1 = INJ\_RR\_TRIG ------| |

| --- ELSE ---

|

| no change INJ\_OFF

| no change INJ\_NEXT\_FLG

END: foreground\_round\_robin

BEGIN: dis\_fmem\_bits

;Execute the following process only when called.

;Convert DISCUTOUT1,2 into a sequence number and build a bit pattern.

unconditionally --------------------| count = 0

;Execute the following routines 'numcyl' time(s).

FN1329(count) = DISCUTOUT1 ---|

|OR --| INJOFF\_FMEM(bit(count)) = 1

FN1329(count) = DISCUTOUT2 ---| |

| --- ELSE ---

|

| INJOFF\_FMEM(bit(count)) = 0

unconditonally ---------------------| count = count + 1

END: dis\_fmem\_bits

8-237

FUEL STRATEGY, BACKGROUND INJECTOR CUTOUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: set\_bit\_pattern

Set the master bit pattern each time INJ\_ON changes.

INJ\_ON = 7 -------------------------| inj\_off = INJ\_7ON

|

| --- ELSE ---

|

INJ\_ON = 6 -------------------------| inj\_off = INJ\_6ON

|

| --- ELSE ---

|

INJ\_ON = 5 -------------------------| inj\_off = INJ\_5ON

|

| --- ELSE ---

|

INJ\_ON = 4 -------------------------| inj\_off = INJ\_4ON

|

| --- ELSE ---

|

INJ\_ON = 3 -------------------------| inj\_off = INJ\_3ON

|

| --- ELSE ---

|

INJ\_ON = 2 -------------------------| inj\_off = INJ\_2ON

|

| --- ELSE ---

|

INJ\_ON = 1 -------------------------| inj\_off = INJ\_1ON

|

| --- ELSE ---

|

| inj\_off = INJ\_0ON

END: set\_bit\_pattern

BEGIN: injector\_round\_robin(shift)

Do the following routines 'shift' time(s).

unconditionally ------------------| inj\_off = inj\_off \* 2

(shifted left by one bit)

inj\_off >= 2 \*\* NUMCYL -----------| inj\_off = inj\_off + 1

(MS bit is wrapped to LS bit) |

| --- ELSE ---

|

| no change to inj\_off

END: injector\_round\_robin

8-238

FUEL STRATEGY, INJ\_ON LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.36 INJ\_ON DETERMINATION LOGIC (CDAN0)

OVERVIEW

This module is for non-Torque Control based strategies so that the INJ\_ON

parameter can be assigned and then used by the generic round robin logic.

DEFINITIONS

Registers:

- COOL\_PI\_INT = Fail safe cooling output, number of cylinders to turn off.

- INJ\_ON = Number of injectors to be turned (left) on.

- INJ\_ON\_LST = Previous background state of INJ\_ON.

- INJ\_TR = Torque ratio obtained from turning off a number of injectors.

Bit Flags:

- COOL\_FLG = Overtemp flag: 1 -> overtemp.

- DFSFLG = Indicates DECEL fuel shutoff, 1 -> active.

- DIS\_FMEM = Coil failure flag, associated cylinders will be disabled.

- HALF\_FUEL = Flag which indicates one-half of the injections are to be

cut-out; 1 -> HALF FUEL.

- NO\_FUEL = FLag which indicates that all injections are to be cut-out; 1

-> no fuel.

Calibration Constants:

- ENGCYL = Number of pip's per engine revolution, NUMCYL/2.

- NUMCYL = Number of cylinders in the engine.

8-239

FUEL STRATEGY, INJ\_ON LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_INJ\_ON\_COM1

BEGIN: injector\_ratio\_calc

;Execute the following process once per background loop.

unconditionally ------------------------| INJ\_ON\_LST = INJ\_ON

COOL\_FLG = 1 ---------------------------| INJON = NUMCYL - COOL\_PI\_INT

;fail safe cooling |

| --- ELSE ---

NO\_FUEL = 1 ----------------------| |

|OR --| INJ\_ON = 0

DFSFLG = 1 -----------------------| | ;no injectors on

|

| --- ELSE ---

|

HALF\_FUEL = 1 --------------------------| INJ\_ON = ENGCYL

| ;numcyl divided by 2

|

| --- ELSE ---

|

| INJ\_ON = NUMCYL

DIS\_FMEM = 1 ---------------------------| INJ\_TR = min( 2 / NUMCYL,

;cylinders being disabled | INJ\_ON / NUMCYL )

|

| --- ELSE ---

|

| INJ\_TR = INJ\_ON / NUMCYL

END: injector\_ratio\_calc

8-240

FUEL STRATEGY, PIP COUNTER FOR CRANKING FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.37 PIP COUNTER FOR CRANKING FUEL (CDAA0)

OVERVIEW

This module updates the pip counter used in crank mode, CRKPIP\_CTR\_W and its

background equivalent, CRKPIPCTR\_BW.

DEFINITIONS

INPUTS

Registers:

- ATMR1\_LST = Last calculated value of ATMR1.

- BP = Barometric absolute pressure.

- CRKPIP\_CTR\_W = Foreground word register to count PIPs for crank fuel.

- CRKPIPCTR\_BW = Background word register to count PIPs for crank fuel.

Bit Flags:

- CRKFLG = Crank flag; 1 -> engine in Crank mode.

- FLG\_STALL = Flag indicating a stall has occured; transition from

underspeed/run to crank

Calibration Constants:

- CRKCTR\_RESET = CRKPIP\_CTR reset switch; 1 -> reset CRKPIP\_CTR upon stall.

- CRKPIPCNT2\_W = CRKPIPCTR\_BW reset value for underspeed to crank

transitions, sec.

- CRKTM1 = Time in run or underspeed below which CRKPIP\_CTR\_W is reset to

CRKPIPCNT2\_W, sec.

- CRKTMR\_INC = Calibration switch which determines whether CRKPIP\_CTR\_W

runs when the engine state is out of crank.

OUTPUTS

Registers:

- CRKPIP\_CTR\_W = See above.

- CRKPIPCTR\_BW = See above.

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FUEL STRATEGY, PIP COUNTER FOR CRANKING FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_CRKPIPCTR\_COM1

CRKPIP\_CTR\_W - PIP COUNTER FOR CRANKING FUEL

CRKPIP\_CTR\_W is used as a crank fuel multiplier in order to do a lean-out or

fuel shut-off during sub-zero cold operation. Some calibrators are using the

logic to improve restarts following a stall during -20 deg F testing by

turning off the fuel during the first seconds of crank. This allows the

engine to restart on the residual fuel remaining in the manifold after the

stall.

CRKCTR\_RESET = 1 ------------|

|

FLG\_STALL = 1 ---------------|AND -| Reset counter part way

| | CRKPIP\_CTR\_W = CRKPIPCNT2\_W

ATMR1\_LST <= CRKTM1 ---------| | CRKPIPCTR\_BW = CRKPIPCNT2\_W

(in run or underspeed less |

than CRKTM1 seconds) |

| --- ELSE ---

CRKFLG = 1 ------------------| |

(in crank) |OR --| CRKPIP\_CTR\_W is incremented

| | every rising edge of PIP

CRKTMR\_INC > 0 --------------| | CRKPIPCTR\_BW = CRKPIP\_CTR\_W

|

| --- ELSE ---

|

| Freeze CRKPIP\_CTR\_W

| CRKPIP\_CTR\_W = CRKPIPCTR\_BW

In Foreground PIP\_DATA module

always ----------------------------| Increment CRKPIP\_CTR\_W every

| rising edge of PIP,

| Clip CRKPIP\_CTR\_W at 65535 as

| a maximum

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FUEL STRATEGY, CLOSED THROTTLE NEUTRAL TIMER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.38 CLOSED THROTTLE NEUTRAL TIMER (CDAA0)

OVERVIEW

This module updates the closed throttle mode neutral timer, CTNTMR.

DEFINITIONS

INPUTS

Registers:

- APT = Throttle mode flag; -1 -> closed throttle, 0 -> part throttle, 1 ->

wide open throttle.

- ECT = Engine coolant temperature, deg. F.

- N = Engine speed, RPM.

Bit Flags:

- CTNFLG = 1 -> closed throttle neutral idle.

- NDSFLG = Neutral/Drive flag; 1 -> Drive.

Calibration Constants:

- CTHIGH = Hot star minimum engine coolant temperature, Deg F.

- FN880(CTNTMR) = DSDRPM adder vs. time at Idle, sec.

- INLRPM = Maximum RPM to increment CTHTMR.

- INLRPH = Hysteresis for INLRPM.

- NIHYS = Neutral Idle Hysteresis, sec. Base value is 2, range is 0 to

100.

- NIOLD = Neutral Idle Open Loop Delay, sec. Base value is 255, range is 0

to 255.

OUTPUTS

Registers

- CTNTMR = Closed throttle mode neutral timer, sec.

Bit Flags:

- CTNFLG = 1 -> closed throttle neutral idle.

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FUEL STRATEGY, CLOSED THROTTLE NEUTRAL TIMER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_CTNTMR\_COM1

ECT > CTHIGH -----------------------|

|

APT = -1 ---------------------------|

(closed throttle) |

|AND -| Count up CTNTMR

NDSFLG = 0 -------------------------| | Clip to NIOLD + NIHYS

(neutral) | | CTNFLG = 1

| |

N < INLRPM + FN880 -----------|S Q -| |

| |

N > INLRPM + FN880 + INLRPH --|C |

| --- ELSE ---

|

| Count down CTNTMR

| CTNFLG = 0

| Clip CTNTMR to 0

8-244

FUEL STRATEGY, TIME AT IDLE WITH TRANSMISSION IN DRIVE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.39 TIME AT IDLE WITH TRANSMISSION IN DRIVE (CDAA0)

OVERVIEW

This module updates the timer, IDLTMR.

DEFINITIONS

INPUTS

Registers:

- APT = Throttle mode flag; -1 -> closed throttle, 0 -> part throttle, 1 ->

wide open throttle.

- N = Engine speed, RPM.

Bit Flags:

- DNDSUP = Drive/Neutral select.

- IDLFLG = Flag indicating transmission in drive and at idle.

Calibration Constants:

- IDLRPM = Maximum RPM for Closed Throttle Mode Idle, rpm. Range of 0 to

7000, accuracy of 25 RPM.

- IDRPMH = Hysteresis for IDLRPM. Range of 0 to 1000, accuracy of 25 RPM.

OUTPUTS

Bit Flags:

- IDLFLG = Flag indicating transmission in drive and at idle.

Registers

- IDLTMR = Time at idle with transmission in drive.

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FUEL STRATEGY, TIME AT IDLE WITH TRANSMISSION IN DRIVE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_IDLTMR\_COM1

DNDSUP = 1 ---------------------|

(drive) |

|AND -| Increment IDLTMR

APT = -1 -----------------------| | IDLFLG = 1

(CLOSED THROTTLE mode) | |

| |

N < IDLRPM ---------------|S Q -| |

| |

N > IDLRPM + IDRPMH ------|C |

| --- ELSE ---

|

| IDLTMR = 0

| IDLFLG = 0

8-246

FUEL STRATEGY, LOM LOAD TRANSITION TIMER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.40 LOM LOAD TRANSITION TIMER (CDAA0)

OVERVIEW

This module updates the timer LUGTMR.

DEFINITIONS

INPUTS

Registers:

- APT = Throttle mode flag; -1 -> closed throttle, 0 -> part throttle, 1 ->

wide open throttle.

- LOAD = Universal normalized load parameter.

Calibration Constants:

- FN125 = LOM Load function to activate LOM spark strategy. Input: RPM

and Output: load.

- LUGSW = LUGTMR logic switch.

- LUGTIM = Engine load transition time, sec.

OUTPUTS

Registers

- LUGTMR = LOM load transition timer, sec.

PROCESS

STRATEGY MODULE: FUEL\_LUGTMR\_COM1

LOAD > FN125 -------------------|

|OR --| Count up LUGTMR

APT = 1 ------------------------| | (clip at LUGTIM)

(Wide Open Throttle) |

| --- ELSE ---

LOAD <= FN125 ------------------| |

|AND -| LUGTMR = 0

LUGSW = 1 ----------------------| |

| --- ELSE ---

|

| Count down LUGTMR

| (Clip at 0)

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FUEL STRATEGY, TIME SINCE INCREMENTING LAMMUL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.41 TIME SINCE INCREMENTING LAMMUL (CDAA0)

OVERVIEW

This module shows the logic for updating the timer MULTMR.

DEFINITIONS

OUTPUTS

Registers:

- MULTMR = Time since incrementing LAMMUL, msec.

PROCESS

STRATEGY MODULE: FUEL\_MULTMR\_COM1

Always -------------------------------------| Count up MULTMR

(Note: MULTMR is periodically set to 0 within

the Open Loop Fuel Logic)

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FUEL STRATEGY, FUEL TIMER CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.42 TIMER SUMMARY (CDAI0)

TIMER DESCRIPTION

----- -----------

ATMR1 Time since start (time since exiting crank mode) (sec)

ATMR1\_HI\_RES Time since start (time since exiting crank mode)

with a higher resolution that ATMR1. (sec)

ATMR2 Time since engine coolant temperature became

greater than TEMPFB (sec)

ATMR3 Time since Entering RUN Mode (sec)

CTTMR Time at closed throttle timer (sec)

NDDTIM Time since neutral/drive switch state change (sec)

DEFINITIONS

INPUTS

Registers:

- APT = Throttle mode flag; -1 -> closed throttle, 0 -> part throttle, 1 ->

wide open throttle.

- ATMR1\_LST = Last calculated value of ATMR1.

- ECT = Engine coolant temperature, deg. F.

Bit Flags:

- CRKFLG = Crank flag; 1 -> engine in Crank mode.

- DNDSUP = Drive/Neutral select.

- UNDSP = Underspeed flag; 1 -> Underspeed mode or Crank.

Calibration Constants:

- TEMPFB = Minimum ECT required to start ATMR2 timer, deg F.

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FUEL STRATEGY, FUEL TIMER CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- ATMR1\_LST = Last calculated value of ATMR1.

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FUEL STRATEGY, FUEL TIMER CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_TIMERS\_COM1

FUEL TIMER CONTROL LOGIC

ATMR1 - TIME SINCE ENGINE START-UP

CRKFLG = 0 --------------------------| ATMR1\_LST = ATMR1

(RUN or UNDERSPEED mode) | (save last calculated value of ATMR1)

| Count up ATMR1

| Count up ATMR1\_HI\_RES

| (calculate new values)

|

| --- ELSE ---

|

| ATMR1\_LST = ATMR1

| (save last calculated value of ATMR1)

| ATMR1 = 0

| ATMR1\_HI\_RES = 0

ATMR2 - TIME SINCE ENGINE COOLANT TEMPERATURE BECAME GREATER THAN TEMPFB

ECT > TEMPFB ------------------|S Q -| COUNT UP ATMR2

| |

CRKFLG = 1 --------------------|C |

| --- ELSE ---

|

| ATMR2 = 0

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FUEL STRATEGY, FUEL TIMER CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ATMR3 - TIME SINCE ENTERING RUN MODE

UNDSP = 0 ---------------------------| Increment ATMR3

(Run Mode)

CTTMR - TIME AT CLOSED THROTTLE

APT = -1 ----------------------------| COUNT UP CTTMR

(closed throttle mode) |

| --- ELSE ---

|

| CTTMR = 0

NDDTIM - TIME SINCE NEUTRAL/DRIVE SWITCH STATE CHANGE

NEUTRAL/DRIVE SWITCH STATE CHANGE ---| NDDTIM = 0

|

| --- ELSE ---

|

| COUNT UP NDDTIM

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FUEL STRATEGY, CRANK PIP INJECTOR SELECTOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.43 CRK\_PIP\_INJ SELECTOR LOGIC (CDAL0)

OVERVIEW

This module switches between the default (initial) value and CRK\_PIP\_CAL for

parameter CRK\_PIP\_INJ (number of PIPs per injector firing) based on the

number of background loops where the instantaneous ECT (ECT\_INST) is LESS

THAN CRK\_PIP\_ECT. This logic uses the calibrated method of injector

servicing as a default until such time as the actual ECT level is believed to

be accurate. It is expected that the ECT will be verified in time to support

the 'trickle' fuel alternate calibration for extremely cold conditions, since

ECT accuracy is believed to be related to the number of background loops from

EEC power-up which, during cold engine conditions, will occur much sooner

than the first recognized PIP. The recommended method of start injector

servicing is 'big-bang', where all injectors are fired simultaneously, once

every NUMCYL pips. Trickle fueling is only recommended during extremely cold

starting conditions.

DEFINITIONS

Registers:

- CRK\_LOOP\_CTR = Crank BG loop counter for assigning CRK\_PIP\_INJ.

- CRK\_PIP\_INJ = Number of PIP periods per injector firing.

- ECT\_INST = Instantaneous ECT (no rolling average).

- TSLPIP = Time sine last PIP.

Bit Flags:

- CRK\_PIP\_INT = CRK\_PIP\_INJ initialization indicator, set in foreground

logic; 1 -> CRK\_PIP\_INJ is initialized.

Calibration Constants:

- CRK\_PIP\_ECT = ECT break point which selects between the default

CRK\_PIP\_INJ (1), and CRK\_PIP\_CAL.

- CRK\_PIP\_CAL = Number of PIP periods per injector firing for higher ECTs.

8-253

FUEL STRATEGY, CRANK PIP INJECTOR SELECTOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_CRK\_INJ\_COM1

CRK\_PIP\_INJ SELECTOR LOGIC

CRK\_PIP\_INT = 1 --------------|

|AND -| CRK\_PIP\_INT := 0

TSLPIP > 800 msec ------------| | CRK\_LOOP\_CTR := 0

;stall or aborted start

CRK\_PIP\_INT = 1 --------------------| (Exit module)

|

| --- ELSE ---

|

ECT\_INST <= CRK\_PIP\_ECT ------------| CRK\_LOOP\_CTR := CRK\_LOOP\_CTR + 1

;cold engine indicated

CRK\_LOOP\_CTR >= 3 ------------------| CRK\_PIP\_INJ := 1

;definitely a cold engine | CRK\_LOOP\_CTR := 3

| ;use trickle fuel injector method

|

| --- ELSE ---

|

| CRK\_PIP\_INJ := CRK\_PIP\_CAL

| ;use calibrated injector fueling

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FUEL STRATEGY, LAMBSE MODULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.44 LAMBSE MODULATION (CDAM0)

OVERVIEW

In order to discriminate between marginal HEGO sensors and bad HEGO sensors,

a closed loop fuel control limit cycle at a frequency higher than the natural

frequency of the system is required.

This module is designed to generate a signal to be superimposed over the

normal closed loop PI fuel control signal. This signal will be in the range

of 2.5HZ - 5 Hz and take any wave form as defined in FN339B. The signal will

be added to LAMBSEn when calculating required fuel flow.

The signal generator is implemented by the parameters FN339B, DSRD\_FREQ (in

Hertz), and AMP\_MULT as shown below. The output, multiplied by AMP\_MULT

takes values in units of normalized A/F and is stored in LAMBSE\_MODn.

|

1 + \*

| \* \*

| \* \*

| \* \*

F |

N | \* \*

3 |

3 |

9 | \* \*

B |

|

|\* \*

0 \*-------------------------------------------------\*----------->

0 1 FN\_INPUT

(normalized time)

in real time, the plot is:

|

AMP\_MULT + \*

| \* \*

| \* \*

LAMBSE\_MODn |

| \* \*

| 1/(DSRD\_FREQ)

LAM\_OFFSET \*------------------------\*------------------------\*---------->

| time

| \* \*

|

| \* \*

| \* \*

- AMP\_MULT + \*

|

8-255

FUEL STRATEGY, LAMBSE MODULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- FN\_GEN\_TMR = LAMBSE fuel modulation function generator timer.

Free-running up counter. Units are seconds.

Resolution = 0.001, Range 0 - 1, Initial value = 0.0.

- LAM\_CYCLES = Number of commanded LAMBSE\_MOD cycles that have occured

since starting the upstream EGO monitor.

Bit Flags:

- LAM\_MOD\_FLG = Flag used to initiate high frequency fuel modulation for

the upstream EGO monitor.

Resolution = 1, Range = 0 - 1, Base value = 0.

- SMPL\_EGO\_FLG = Flag used to enable the foreground EGO sampling process

used on the upstream EGO sensors.

Calibration Constants:

- DSRD\_FREQ = Desired frequency of LAMBSE fuel modulation, Hertz.

Resolution = 0.25, Range = 1 - 10, Base value = 2.5.

- AMP\_MULT = LAMBSE fuel modulation amplitude multiplier. Units are

normalized A/F.

Resolution = 0.001, Range = 0 - 0.5, Base value = 0.1.

- FN339B(x) = LAMBSE fuel modulation function generator. Output has units

of normalized A/F, input has units of normalized time (FN\_INPUT), ranging

from 0 - 20 (useful range 0 - 2).

Resolution = 0.001, Range = 0 - 1, 10 xy pairs.

Base calibration = (0.0, 0.0), (0.2, 0.588), (0.35, 0.891),

(0.45, 0.988), (0.5, 1.0), (0.55, 0.988), (0.65, 0.891),

(0.8, 0.588), (1.0, 0.0).

- LAM\_MOD\_MAX = Maximum value for LAMBSE MODn, NORM A/F.

- LAM\_MOD\_MIN = Minimum value for LAMBSE MODn, NORM A/F.

OUTPUTS

Registers:

- LAMBSE\_MODn = LAMBSE fuel modulation signal (n = 1, 2). This register is

added to LAMBSE when calculating fuel flow to give a high frequency EGO

switch. Units are normalized A/F.

Resolution = 0.00003, Range = -.5 to +.5, Initial value = 0.0.

- FN\_INPUT = LAMBSE fuel modulation function generator input. Units are

normalized time.

Resolution = 0.0005, Range = 0 - 20, Initial value = 0.0.

8-256

FUEL STRATEGY, LAMBSE MODULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_LAMBSE\_MOD\_COM1

LAM\_MOD\_FLG = 1 -----------------------| function\_input =

| 2 \* DSRD\_FREQ \* FN\_GEN\_TMR

|

| --- ELSE ---

|

| No action

LAM\_MOD\_FLG = 1 -----------------|

|AND -| FN\_INPUT = MOD(function\_input,2)

function\_input > 2 --------------| | FN\_GEN\_TMR = 0

| amplitude\_multiplier = AMP\_MULT

| LAM\_CYCLES = LAM\_CYCLES + 1

|

| --- ELSE ---

LAM\_MOD\_FLG = 1 -----------------| |

|AND -| FN\_INPUT = function\_input - 1

function\_input > 1 --------------| | amplitude\_multiplier = - AMP\_MULT

|

| --- ELSE ---

|

LAM\_MOD\_FLG = 1 -----------------------| FN\_INPUT = function\_input

| amplitude\_multiplier = AMP\_MULT

|

| --- ELSE ---

|

| FN\_INPUT = 0

| FN\_GEN\_TMR = 0

LAM\_MOD\_FLG = 1 -----------------------| lambse\_mod1 = (amplitude\_

| multiplier \*

| FN339B(FN\_INPUT))

| lambse\_mod2 = (-1) \* lambse\_mod1

|

| LAM\_OFFSET = FN1353A(N,LOAD)/2

|

| lambse\_mod1 = lambse\_mod1 +

| LAM\_OFFSET

| lambse\_mod1 = min(lambse\_mod1,

| LAM\_MOD\_MAX)

| LAMBSE\_MOD1 = max(lambse\_mod1,

| LAM\_MOD\_MIN)

| lambse\_mod2 = lambse\_mod2 +

| LAM\_OFFSET

| lambse\_mod2 = min(lambse\_mod2,

| LAM\_MOD\_MAX)

| LAMBSE\_MOD2 = max(lambse\_mod2,

| LAM\_MOD\_MIN)

|

| --- ELSE ---

|

| LAM\_OFFSET = 0

| LAMBSE\_MOD1 = 0

| LAMBSE\_MOD2 = 0

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FUEL STRATEGY, LAMBSE MODULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

LAM\_MOD\_FLG = 0 -----------------|

|OR --| LAM\_CYCLES = 0

SMPL\_EGO\_FLG = 0 ----------------|

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FUEL STRATEGY, LAMBSE MODULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.45 FEATURE: CLOSED LOOP FUEL CONTROL - V2.8C\_CLFUL\_NONFLEX\_96 (CDAN2)

8.45.1 CLOSED LOOP LAMBSE CONTROLLER (CDAN0)

OVERVIEW

NOTE: In the following OVERVIEW, the term BIAS is used to describe the bias

from stoichiometry. In the definitions and process, the term is actually

named BIAS\_Gx. BIAS\_Gx has more resolution than the previous BIAS register.

The following description applies to each side of an engine if operating in

stereo HEGO mode.

1. Independent closed loop ramp rates and jumpback (LAMBSE1 and LAMBSE2)

amounts are calculated.

2. Calibration values for peak-to-peak amplitude, bias, and transport delay

are common to both sides.

3. ANPIP1, ANPIP2, ENPIP1, ENPIP2, and LAMBSE calculations are unique to

each side.

4. The injector pulsewidths, FUELPW1 and FUELPW2, are calculated from

LAMBSE1 and LAMBSE2, respectively.

NOTE: If system uses only one HEGO sensor, the strategy uses LAMBSE1 and

FUELPW1 for the desired LAMBSE and fuel Pulsewidth. (NUMEGO = 1)

INTENT

The goals of the closed loop strategy are:

1. To add capability of introducing large amounts of Air/Fuel biasing

(expressed as ratio of bias to peak-to-peak amplitude).

2. To maximize the feedback limit cycle frequency for all bias values.

3. To maintain a simple calibration procedure to describe the closed loop

limit cycle.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

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APPROACH

The fuel flow is driven in a limit cycle manner about stoichiometry. Using

the HEGO (Heated Exhaust Gas Oxygen) sensor, the computer increases or

decreases the injector pulsewidths in a controlled manner. If the HEGO reads

rich, the pulsewidths will be decreased (made leaner) at a calculated rate.

If the HEGO reads lean, the pulsewidths will be increased (made richer) at a

calculated rate.

When an HEGO switch occurs, an instantaneous change (or "jumpback") is made

in the air/fuel ratio back towards stoichiometry. The jump is made relative

to the A/F ratio (lambda) value at the HEGO switch.

The limit cycle can be biased to operate on the average richer (or leaner) of

stoichiometry.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

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An example of the closed loop limit cycle is shown below:

LIMIT CYCLE DESCRIPTION

(lean bias example)

- - - - - - - - - \*

| \* \* \*

| \* \* \*

| \* \* LEAN \*

| \* \* \*

| \* \* \*

| \* \* \*

| \* | \* \*

| \*- - - --- - - -\* - - - - - - - - \* - - AVERAGE

| \* \* A/F RATIO

| \* \*

| --------------------------\*-------------------\*----- STOICHIOMETRY

| | \* \*

| | \* \*

| BIAS\_Gx \* \*

| TERM \* \*

| \* \*

| RICH \* \*

|--PEAK TO PEAK \* \*

| AMPLITUDE \* \*

| \* \*

- - - - - - - - - - - - - - - - - - - - - - - - \*

HEGO SENSOR STATUS

RICH \*\*\*\*\*\*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* \*

\* \*

\* \*

LEAN \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

INJECTOR PULSEWIDTH STATUS

ON \*\* \*\*\*\* \*\*\*\*\* \*\*\*\*\*\* \*\*\*\*\*\*\* \*\*\*\*\*\*\* \*\*\*\*\*

\* \* \* \* \* \* \* \* \* \* \* \* \*

\* \* \* \* \* \* \* \* \* \* \* \* \*

\* \* \* \* \* \* \* \* \* \* \* \* \*

OFF \*\*\*\*\*\*\*\* \*\*\*\*\*\*\* \*\*\*\*\*\* \*\*\*\*\* \*\*\*\* \*\*\*\*\*\* \*\*\*\*\*\*

| |

<--DECREASING --->|<---------INCREASING ------->|<---DECREASING --->

PULSEWIDTH | PULSEWIDTH | PULSEWIDTH

8-261

FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

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The bias term is used to make the limit cycle operate at an average A/F ratio

rich or lean of stoichiometry. For zero bias, the average A/F ratio is

stoichiometry.

Based on calibration information supplied by the user, the fuel pulsewidth

ramp rates and jumpback distances are calculated automatically to produce the

proper limit cycle.

The direction of the bias is controlled by the sign of the bias value. If

the bias term is negative, a rich bias is indicated. If the sign of the bias

term is positive, a lean bias is indicated.

Peak-to-Peak amplitude determines the labmda excursions allowed in Closed

Loop Fuel. Too large an excursion will be felt as a road load surge or rpm

variations at idle. Because of the RPM rolls at idle, the capability exists

in the strategy to use a specific idle peak-to-peak, ISC\_PTP.

System transport lag time; time delay from when a fuel change is made until

the HEGO sensor indicates this change; varies with engine speed, units are

REVs.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\* WARNING \*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

It is imperative that an accurate value for the system transport lag be

entered. An incorrect value will result in greatly reduced catalyst

efficiencies due to excessively fast or slow ramp rates, incorrect jumpback

amounts, etc.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\* WARNING \*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Two methods of achieving the desired bias are employed.

1. Variable jumpback distance on one side of the limit cycle with symmetric

pulsewidth ramp rates.

2. No jumpback on one side of the limit cycle with asymmetric pulsewidth

ramp rates.

The logic used to achieve biasing depends on the absolute value of

BIAS\_G/PTPAMPx (|BIAS\_G/PTPAMP|): where:

BIAS\_Gx = Amount of bias from stoichiometry.

PTPAMPx = Limit cycle peak-to-peak amplitude.

Any calculated value of |B/P| exceeding LC\_RATIO, results in PTPAMP to be

increased. This is done to avoid extremely long limit cycle periods.

FOR NO BIAS |BIAS\_G/PTPAMP| = 0

The limit cycle has full jumpback on both sides of stoichiometry and uses

symmetric pulsewidth ramp rates.

FOR SMALL BIAS 0 < |BIAS\_G/PTPAMP| <= 0.171573 (0.171573 = 3 - SQRT(8))

The limit cycle has a partial jumpback on one side of stoichiometry to

achieve biasing and uses symmetric pulsewidth ramp rates.

FOR LARGE BIAS 0.171573 < |BIAS\_G/PTPAMP| <= LC\_RATIO

The limit cycle has no jumpback on one side of stoichiometry and uses

asymmetric pulsewidth ramp rates to achieve biasing.

Examples of biasing are shown on the next page.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

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CLOSED LOOP LIMIT CYCLE EXAMPLES

(not drawn to scale)

NO BIAS | BIAS\_G/PTPAMPx | = 0

\* \* \* \* \*

\*\* \*\* \*\* \*\* \*\*

\* \* \* \* \* \* \* \* \* \* SYMMETRIC RAMP RATES

\* \* \* \* \* \* \* \* \* \* FULL JUMPBACK IN

-----\*---\*---\*---\*---\*---\*---\*---\*---\*--- BOTH DIRECTIONS

\* \* \* \* \* \* \* \* \*

\* \* \* \* \* \* \* \* \*

\*\* \*\* \*\* \*\* \*

\* \* \* \* \*

SMALL BIAS | BIAS\_G/PTPAMPx | < 0.171573

\* \* \* \*

\*\* \*\* \*\* \*\*

\* \* \* \* \* \* \* \* SYMMETRIC RAMP RATES

\* \* \* \* \* \* \* \* PARTIAL JUMPBACK

-----\*------\*---\*------\*---\*------\*---\*---- IN ONE DIRECTION

\* \* \* \* \* \* \*

\* \* \* \* \* \* \* \*

\* \* \* \* \* \* \* \*

\*\* \*\* \*\* \*\*

\* \* \* \*

MODERATE BIAS | BIAS\_G/PTPAMPx | = 0.171573

\* \* \* \*

\*\* \*\* \*\* \*\*

\* \* \* \* \* \* \* \* SYMMETRIC RAMP RATES

\* \* \* \* \* \* \* \* NO JUMPBACK

-----\*-------\*---\*-------\*---\*-------\*---\*-- IN ONE DIRECTION

\* \* \* \* \* \* \*

\* \* \* \* \* \* \*

\* \* \* \* \* \* \*

\* \* \* \* \* \* \*

\* \* \*

LARGE BIAS | BIAS\_G/PTPAMPx | > 0.171573

\* \*

\* \* \* \*

\* \* \* \* \* ASYMMETRIC RAMP RATES

\* \* \* \* NO JUMPBACK

-----\*------------\*-------\*------------\*----- IN ONE DIRECTION

\* \* \* \*

\* \* \* \*

\* \* \* \*

\* \* \* \*

\* \*

NOTE: Limit cycle frequency decreases with increasing bias.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

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After an HEGO switch, a finite amount of time (equal to the transport lag)

should pass before the HEGO can switch. Noise in the HEGO system could be

interpreted by the computer as HEGO switches. These phantom switches could

occur at a faster rate than dictated by the system transport lag time. Since

the jumpback is made from the lambda when the HEGO switches, phantom switches

could make the jumpback go beyond the average Air/Fuel ratio. A high rate of

phantom switches would create a high rate of jumps. A special feature of the

closed loop strategy prevents this problem.

A full jumpback is done only if the proper transport lag time has elapsed.

If not, the jumpback distance is reduced to match the reduction in transport

lag time. The actual strategy uses PIP signal counts to control this

feature.

The jumpback distance is multiplied by the ratio piprat.

piprat = Ratio of the actual number of PIP signals since the last HEGO switch

to the expected number of PIP signals between HEGO switches; clipped to a

maximum of 1.0. piprat is a temporary register.

piprat = ANPIPn/ENPIPn

ANPIPn = Actual number of PIP signals since the last HEGO switch; clipped to

a maximum of 255; reset to one when not in closed loop; reset to zero after

the HEGO switches and the jumpback distance is calculated; n = bank.

ENPIPn = Expected number of PIP signals between HEGO switches; reset to 1

when not in closed loop; n = bank.

The transport delay is entered as REVS. The strategy uses units of both

seconds and PIPS. The transport delay in PIPS is:

tdpip = tdrevs \* ENGCYL

Transport delay in seconds is:

tdsec = tdrevs \* 60/N

tdpip and tdsec are temporary registers.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

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NOTE: In the following logic diagrams, an HEGO switch is defined as either:

1. The HEGO sensor reads rich during the current background loop and it

reads lean during the previous background loop.

2. The HEGO sensor reads lean during the current background loop and it

reads rich during the previous background loop.

The strategy copes with failed sensors in a way that attempts to minimize the

emmisions and driveability impacts. When a single sensor failure in a dual

bank system occurs, control will be switched to the opposite, functioning

bank. However the EGOSTATE will be calculated 180 degrees out of phase so as

to drive LAMBSE in opposite directions in an attempt to cancel out the torque

fluculations that can result when both banks are are in phase. In addition,

the downstream EGO sensor will continue to be used in the faulty bank to trim

the lambse that is being generated from the functional bank. In this way

emmisions are kept in check during FMEM.

This strategy also has LAMBSE reset logic that will modify the ramp rate at

the open loop to closed loop transition. This will allow coming under

control quicker and reduce the emmisions created during the [potentially]

long ramp towards stoich. The normal ramp calculation is of the form:

LAMBSE = LAMBSE + (ramp\_rate \* delta\_time)

This is being modified to:

LAMBSE = LAMBSE + (RR\_MULTn \* (ramp\_rate \* delta\_time))

Where the RR\_MULTn is calculated a function of the difference between the

current LAMBSE and the LAMBSE of one. Once the value of one is attained or

an EGO switch occurs, the RR\_MULTn is held at a value of one and has no

effect. The calculation of RR\_MULTn is as follows:

RR\_MULTn = abs(1 - LAMBSE) \* RR\_MULT\_GAIN + 1

A suggested value for RR\_MULT\_GAIN of 32 will give fast reset times and

little or no overshoot of the stoich point, depending of stack-up of system

errors.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

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The following calling structure applies to the processes found in this file:

PROCESS LOCATION

----------------------------- ----------------------

pid\_definitions CLFUL\_CONTROLLER\_COM

closed\_loop\_fuel\_control CLFUL\_CONTROLLER\_COM

egostate\_calc CLFUL\_CONTROLLER\_COM

bias\_lookup CLFUL\_BIAS\_COM

ptpamp\_lookup CLFUL\_PTPAMP\_COM

transport\_delay\_lookup CLFUL\_TRANS\_DELAY\_COM

fmem\_calculations CLFUL\_CONTROLLER\_COM

fuel\_state\_control CLFUL\_CONTROLLER\_COM

jump\_calc() CLFUL\_CONTROLLER\_COM

ramp\_calc() CLFUL\_CONTROLLER\_COM

anpip\_control CLFUL\_CONTROLLER\_COM

closed\_loop\_fuel\_init CLFUL\_CONTROLLER\_COM

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

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DEFINITIONS

Registers:

- ANPIPn = Actual number of PIP signals since the last HEGO switch; clipped

to a maximum of 255; reset to one when not in closed loop; reset to zero

after the HEGO switches and the jumpback distance is calculated; n =

bank.

- BIAS\_Gx = Closed Loop biasing term = FN1353E(N,LOAD).

- ENPIPn = Expected number of PIP signals between HEGO switches; reset to 1

when not in closed loop; n = bank.

- EGOSTATE1 = State of the EGO sensor 11.

- EGOSTATE2 = State of the EGO sensor 21.

- FAILED\_BANK = Register indicating which bank is in lack of EGO switching.

- FUELPW1 = HEGO11 injector pulsewidths, clock ticks.

- FUELPW2 = HEGO21 injector pulsewidths, clock ticks.

- KAM\_ERROR = Indicates Keep Alive RAM invalid.

- LAMBSE1 = Desired open loop (or closed loop) equivalence ratio for Bank1

injectors. LAMBSE1 appears in the fuel pulsewidth equation for HEGO11.

- LAMBSE2 = Desired open loop (or closed loop) equivalence ratio for Bank2

injectors. LAMBSE2 appears in the fuel pulsewidth equation for HEGO21.

- LOAD = Universal normalized load parameter.

- MINPWT = MINPW converted to clock ticks.

- N = Engine RPM.

- OV\_TMR\_11 = EGO11 onervoltage timer.

- OV\_TMR\_21 = EGO21 overvoltage timer.

- PM = Normalized value of percentage of methanol, unitless.

- PTPAMP1 = Limit cycle peak\_to\_peak amplitude for bank 1.

- PTPAMP2 = Limit cycle peak\_to\_peak amplitude for bank 2.

- R\_BIAS1 = Rear BIAS trim for bank 1.

- R\_BIAS2 = Rear BIAS trim for bank 2.

- RR\_MULT1 = Bank 1 Closed Loop Ramp Rate Multiplier - serviced within

LAMBSE reset logic.

- RR\_MULT2 = Bank 2 Closed Loop Ramp Rate Multiplier - serviced within

LAMBSE reset logic.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TSLAMU1 = Time at which last LAMBSE1 update occurred, clock ticks.

- TSLAMU2 = Time at which last LAMBSE2 update occurred, clock ticks.

Bit Flags:

- EGOFL11 = Bank1 upstream HEGO flag.

- EGOFL21 = Bank2 upstream HEGO flag.

- FFG\_CSD11 = Fault flag for CSD on sensor 11.

- FFG\_CSD21 = Fault flag for CSD on sensor 21.

- LEGOFG11 = Lack of HEGO11 switching flag; 1 -> HEGO11 not switching.

- LEGOFG21 = Lack of HEGO21 switching flag; 1 -> HEGO21 not switching.

- LAM\_MOD\_FLG = Flag used to initiate high frequency fuel modulation for

the upstream EGO monitor.

- OLFLG = Open loop fuel flag; 1 -> open loop fuel, 0 -> closed loop fuel.

- RESET\_LEAN1 = Flag to indicate wheter LAMBSE1 was lean or rich upon last

transition; 1 -> lean, 0 -> rich.

- RESET\_LEAN2 = Flag to indicate wheter LAMBSE2 was lean or rich upon last

OL\_CL transition; 1 -> lean, 0 -> rich.

- RESET\_REQ1 = Flag passed from LAMBSE reset to closed loop logic to enable

use of ramp rate multiplier for Bank 1.

- RESET\_REQ2 = Flag passed from LAMBSE reset to closed loop logic to enable

use of ramp rate multiplier for Bank 2.

- SWTFL11 = Bank1 upstream HEGO11 switch flag; 0 -> no HEGO11 switch, 1 ->

HEGO11 switch.

- SWTFL21 = Bank2 upstream HEGO21 switch flag; 0 -> no HEGO21 switch, 1 ->

HEGO21 switch.

Calibration Constants:

- ENGCYL = Number of PIPS per engine revolution; or Number of cylinders/2.

- FN339 = Closed Loop ramp rate Multiplier versus absolute value of

BIAS\_G/PTPAMP.

Input = |BIAS\_G/PTPAMP|.

Output = Ramp rate multiplier.

- FN342 = Closed Loop Jumpback distance Multiplier versus |BIAS\_G/PTPAMP|

(Toward BIAS\_G).

Input = |BIAS\_G/PTPAMP|.

Output = Jumpback distance Multiplier.

- FN344 = Closed Loop Jumpback Distance Multiplier versus |BIAS\_G/PTPAMP|

(Opposite BIAS\_G).

Input = |BIAS\_G/PTPAMP|.

Output = Jumpback distance multiplier.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FN346 = Expected number of PIPs multiplier.

Input = |BIAS\_G/PTPAMP|.

Output = Multiplier.

- LAMMAX = Max Lambse clip when closed loop.

- LAMMIN = Min Lambse clip when closed loop.

- NUMEGO = Number of HEGO sensors present; mono or stereo only.

- RR\_MULT\_GAIN = roportional gain for the control of closed loop ramp rate

multipliers serviced in LAMBSE reset.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

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PROCESS

STRATEGY MODULE: CLFUL\_CONTROLLER\_COM1

BEGIN: pid\_definitions

unconditionally ---------------------| short\_trim\_1 := 128 / LAMBSE1

unconditionally ---------------------| short\_trim\_2 := 128 / LAMBSE2

pid\_def(j1979\_01\_06, short\_trim\_1 )

pid\_def(j1979\_01\_08, short\_trim\_2 )

END: pid\_definitions

BEGIN: closed\_loop\_fuel\_control

;Execute the following once per background pass.

KAM\_ERROR = 1 --------------| FAILED\_BANK := 0

unconditionally ------------| failed\_bank := FAILED\_BANK

OLFLG = 0 ------------|

|

LEGOFG21 = 1 ---| |AND -| FAILED\_BANK := 2

| | | ;mono HEGO or stereo

FFG\_CSD21 = 1 --|OR --| | ;HEGO with lack of

| | ;HEGO21 switching;

NUMEGO = 1 -----| | ;use HEGO11 sensor

| | ;only for closed loop

OV\_TMR\_21 > 0 --| | ;control of LAMBSE1 and

| ;LAMBSE2.

| Do: egostate\_calc

| Do: bias\_lookup

| Do: ptpamp\_lookup

| Do: transport\_delay\_lookup

| Do: fmem\_calculations

| Do: fuel\_state\_control

|

| --- ELSE ---

(continued on next page)

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

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(continued from previous page)

OLFLG = 0 ------------| |

|AND -| FAILED\_BANK := 1

LEGOFG11 = 1 ---| | | ;stereo HEGO with lack

|OR --| | ;of HEGO11 switching.

FFG\_CSD11 = 1 --| | ;use HEGO21 sensor

| | ;only for closed loop

OV\_TMR\_11 > 0 --| | ;control of LAMBSE2 and

| ;LAMBSE1.

| Do: egostate\_calc

| Do: bias\_lookup

| Do: ptpamp\_lookup

| Do: transport\_delay\_lookup

| Do: fmem\_calculations

| Do: fuel\_state\_control

|

| --- ELSE ---

|

OLFLG = 0 ------------------| FAILED\_BANK := 0

| ;normal stereo HEGO.

| ;use HEGO11 sensor

| ;for closed loop

| ;control of LAMBSE1

| ; and

| ;use HEGO21 sensor

| ;for closed loop

| ;control of LAMBSE2.

| Do: egostate\_calc

| Do: bias\_lookup

| Do: ptpamp\_lookup

| Do: transport\_delay\_lookup

| Do: fmem\_calculations

| Do: fuel\_state\_control

END: closed\_loop\_fuel\_control

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

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BEGIN: fuel\_state\_control

FAILED\_BANK <> 0 -----------|

|AND -| LAMBSE(FAILED\_BANK) := 1

failed\_bank <> FAILED\_BANK -| | ANPIP(FAILED\_BANK) := 0

| ;reset LAMBSE to 1 if a fault

| ;is detected.

For bank = 1 and 2 perform the following logic:

swtfl(bank) = 1 ------------------| Do: jump\_calc(bank)

|

| -- ELSE --

|

| Do: ramp\_calc(bank)

unconditionally -----------------| lambse := min(lambse,LAMMAX)

| LAMBSE(bank) :=

| max(lambse,LAMMIN)

|

| TSLAMU(bank) := clock

;end for loop.

END: fuel\_state\_control

BEGIN: egostate\_calc

EGOFL11 = 1 ----------------| EGOSTATE1 := 1

|

| -- ELSE --

|

| EGOSTATE1 := -1

EGOFL21 = 1 ----------------| EGOSTATE2 := 1

|

| -- ELSE --

|

| EGOSTATE2 := -1

END: egostate\_calc

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

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BEGIN: fmem\_calculations

;The following process, called from the closed\_loop\_fuel\_control

;process is used to substitute fmem values when single bank failures

;are present.

FAILED\_BANK = 1 ------|

|

NUMEGO = 2 -----------|AND -| egostate1 := (-1) \* EGOSTATE2

| | egostate2 := EGOSTATE2

HEGO\_CONFIG <> 0 -----| | swtfl1 := SWTFL21

;a rear ego exists | swtfl2 := SWTFL21

| fmem\_offset1 := R\_BIAS1

| fmem\_offset2 := 0

|

| --- ELSE ---

|

FAILED\_BANK = 2 ------| |

|AND -| egostate2 := (-1) \* EGOSTATE1

HEGO\_CONFIG <> 0 -----| | egostate1 := EGOSTATE1

;a rear ego exists | swtfl2 := SWTFL11

| swtfl1 := SWTFL11

| fmem\_offset2 := R\_BIAS2

| fmem\_offset1 := 0

|

| --- ELSE ---

FAILED\_BANK = 1 ------| |

|AND -| egostate2 := EGOSTATE2

NUMEGO = 2 -----------| | egostate1 := EGOSTATE2

;no rear ego exists | swtfl2 := SWTFL21

| swtfl1 := SWTFL21

| fmem\_offset2 := 0

| fmem\_offset1 := 0

|

| --- ELSE ---

|

FAILED\_BANK = 2 ------------| egostate2 := EGOSTATE1

;no rear ego exists | egostate1 := EGOSTATE1

| swtfl2 := SWTFL11

| swtfl1 := SWTFL11

| fmem\_offset2 := 0

| fmem\_offset1 := 0

|

| --- ELSE ---

|

| egostate2 := EGOSTATE2

| egostate1 := EGOSTATE1

| swtfl2 := SWTFL21

| swtfl1 := SWTFL11

| fmem\_offset2 := 0

| fmem\_offset1 := 0

END: fmem\_calculations

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: jump\_calc(bank)

;Jumpback and ENPIP calculations based on bias and HEGO state:

FAILED\_BANK = bank ------------| lambse := 1 + fmem\_offset(bank)

| ENPIP(bank) := 1

| RR\_MULT(bank) := 1

| RESET\_REQ(bank) := 0

| Exit this process

|

| --- ELSE ---

|

| piprat(bank) := min((ANPIP(bank)

| / ENPIP(bank)), 1)

| ;otherwise restrict the jumpback to

| :one half of PTPAMP

unconditionally ---------------| ANPIP(bank) := 0

| b\_over\_p := abs(BIAS\_G(bank))/PTPAMP(bank)

| RR\_MULT(bank) := 1

| RESET\_REQ(bank) := 0

| ;switch occured, stop

| ;reset, if in progress

| ;and reset actual PIP counter.

BIAS\_G(bank) >= 0 --|

|AND -|

egostate(bank) = 1 -| |

|OR --| lambse := LAMBSE(bank) +

BIAS\_G(bank) < 0 ---| | | (egostate(bank) \* (PTPAMP(bank)

|AND -| | + abs(BIAS\_G(bank)))

egostate(bank) = -1-| | \* FN344(b\_over\_p)

| \* piprat(bank))

|

| ENPIP(bank) := tdpip(bank)

|

| --- ELSE ---

|

| lambse := LAMBSE(bank) +

| (egostate(bank) \* PTPAMP(bank)

| \* FN342(b\_over\_p)

| \* piprat(bank))

|

| ENPIP(bank) := tdpip(bank)

| \* FN346(b\_over\_p)

END: jump\_calc

8-275

FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ramp\_calc(bank)

;Ramp-rate calculations based on bias and HEGO state:

;(executed when the HEGO(bank)1 sensor has not switched)

RESET\_LEAN(bank) = 0 -|

;coming from rich |

;LAMBSE |AND -|

| |

LAMBSE(bank) < 1.0 ---| |

;still rich |OR --|

| |

RESET\_LEAN(bank) = 1 -| | |

;coming from lean | | |

;LAMBSE |AND -| |AND -| RR\_MULT(bank) :=

| | | (abs(1-LAMBSE(bank)) \*

LAMBSE(bank) > 1.0 ---| | | RR\_MULT\_GAIN) + 1

;still lean | | ;calculate the ramp rate mult.

| | ;based on the distance between

RESET\_REQ(bank) = 1 --------------| | ;LAMBSE and 1 and the calibrated

| ;gain.

| ;This feature allows a fast ramp

| ;back to stoich when entering

| ;closed loop from open loop and

| ;eliminates the need for an

| ;uncontrolled jump to 1.0

|

| --- ELSE ---

|

| RR\_MULT(bank) := 1

| RESET\_REQ(bank) := 0

| ;stop the lambse reset,

| ;LAMBSE >=1 or a switch

| ;occured.

unconditionally ------------------| b\_over\_p := abs(BIAS\_G(bank))

| /PTPAMP(bank)

|

| p\_minus\_b := PTPAMP(bank)

| - abs(BIAS\_G(bank))

| p\_minus\_b := max(0, p\_minus\_b)

| ;clip this difference to 0 to ensure

| ;limit cycle stability for all

| ;combinations of bias and PTPAMP.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BIAS\_G(bank) >= 0 -----|

|AND -|

egostate(bank) = -1 ---| |

|OR --| lambse := LAMBSE(bank) +

BIAS\_G(bank) < 0 ------| | | (egostate(bank)

| | | \* p\_minus\_b

egostate(bank) = 1 ----|AND -| | \* (1 - FN339(b\_over\_p)

| | \* (clock - TSLAMU(bank))

FUELPW(bank) > MINPWT -| | \* RR\_MULT(bank)

| / tdsec(bank))

|

| --- ELSE ---

|

FUELPW(bank) > MINPWT -------------| lambse := LAMBSE(bank) +

| (egostate(bank)

| \* p\_minus\_b

| \* FN339(b\_over\_p)

| \* (clock - TSLAMU(bank))

| \* RR\_MULT(bank)

| / tdsec(bank))

|

| --- ELSE ---

|

| lambse := LAMBSE(bank)

RESET\_REQ(bank) = 1 ----------|

|

lambse > 1 -------| |AND -| RESET\_REQ(bank) := 0

|AND -| | | RR\_MULT(bank) := 1

LAMBSE(bank) < 1 -| | | | lambse := 1

|OR --| | ;lambse has crossed one

lambse < 1 -------| | | ;while a reset was in progress.

|AND -| | ;Stop the accelerated

LAMBSE(bank) > 1 -| | ;ramp and set lambse to one.

END: ramp\_calc

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FUEL STRATEGY, CLOSED LOOP LAMBSE CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: anpip\_control

;Execute the following on the rising edge of PIP.

unconditionally -------------------| ANPIP1 := min((ANPIP1 + 1),255)

| ANPIP2 := min((ANPIP2 + 1),255)

END: anpip\_control

BEGIN: closed\_loop\_fuel\_init

;Perform the following during RAM initialization

unconditionally -------------------| ANPIP1 := 1

| ANPIP2 := 1

| ENPIP1 := 1

| ENPIP2 := 1

| LAMBSE1 := 1

| LAMBSE2 := 1

| TSLAMU1 := 0

| TSLAMU2 := 0

| EGOSTATE1 := 0

| EGOSTATE2 := 0

END: closed\_loop\_fuel\_init

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FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.45.2 CLOSED LOOP LAMBSE CALCULATION (CDAN2)

OVERVIEW

This module is part of the closed loop fuel control. It is used to look up

the closed loop fuel bias from a table that is a function of engine speed and

engine load. A full description of how the bias affects the closed loop fuel

signal is given in the closed loop fuel control module.

This module supports the following features:

1. Normal Bias: FN1353E(N,LOAD), ,FN1353EB2(N,LOAD), FN315(VSBAR)

2. EGO Monitor Bias: 0.

| 3. Provides for a calibratable idle speed bias clip ISC\_BIAS\_MAX and

| ISC\_BIAS\_MIN.

This module will calculate bias for fore aft oxygen sensor control, full

OBD-II vehicles with the FTP catalyst monitor.

Block Diagram of Bias Look-up Module

+--------------+

LAM\_MOD\_FLG --->| |

| |

R\_BIAS1/2 ----->| +---> BIAS\_G1

| |

N ------------->| Bias Look-up |

| |

LOAD ---------->| +---> BIAS\_G2

| |

VSBAR --------->| |

| | |

| ISCFLG -------->| |

| | |

| ISC\_PTP\_SW ---->| |

+--------------+

DEFINITIONS

Registers:

- BIAS\_G1 = Closed Loop biasing term for bank 1.

- BIAS\_G2 = Closed Loop biasing term for bank 2.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| - ISCFLG = ISC mode flag 1 -> RPM control mode.

- LOAD = Universal load as ratio of aircharge over standard.

- N = Engine RPM.

- R\_BIAS1 = Rear bias trim for bank 1.

- R\_BIAS2 = Rear bias trim for bank 2.

- VSBAR = Filtered vehicle speed.

Bit Flags:

- LAM\_MOD\_FLG = Flag used to initiate high frequency fuel modulation for

the upstream EGO monitor.

Calibration Constants:

- BIAS\_MAX = Maximum total bias allowed.

- BIAS\_MIN = Minimum total bias allowed.

- FN021 = Load normalizing function; Input = Load, Output = Normalized

Load.

- FN039E = Speed normalizing function for BIAS table.

- FN315 = A/F bias multiplier in part throttle mode as a function of VSBAR.

- FN1353E = Amount of Bias from stoichiometry for bank 1.

X = FN039E(N)

Y = FN021(LOAD)

Output = Bias from stoichiometry. (Store in register).

- FN1353EB2 = Amount of Bias from stoichiometry for bank 2.

X = FN039E(N)

Y = FN021(LOAD)

Output = Bias from stoichiometry. (Store in register).

| - ISC\_BIAS\_MAX = Idle speed bias maximum clip.

| - ISC\_BIAS\_MIN = Idle speed bias minimum clip.

| - ISC\_PTP\_SW = Flag for idle speed peak-to-peak value to be used;

| 1 -> use ISC\_PTP.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CLFUL\_BIAS\_COM4

BEGIN: bias\_lookup

LAM\_MOD\_FLG = 1 ------------------------| BIAS\_G1 := 0

;HEGO monitor in progress | BIAS\_G2 := 0

|

| --- ELSE ---

|

| bias1 := FN1353E(N,LOAD) \*

| FN315(VSBAR)

| bias1 := bias1 + R\_BIAS1

| bias1 := min(bias1, BIAS\_MAX)

| BIAS\_G1 := max(bias1, BIAS\_MIN)

|

| bias2 := FN1353EB2(N,LOAD) \*

| FN315(VSBAR)

| bias2 := bias2 + R\_BIAS2

| bias2 := min(bias2, BIAS\_MAX)

| BIAS\_G2 := max(bias2, BIAS\_MIN)

| ISC\_PTP\_SW = 1 --------------|

| ;Idle speed PTP value |

| ;desired |

| | AND -----| BIAS\_G1 :=

| | | min(BIAS\_G1, ISC\_BIAS\_MAX)

| | | BIAS\_G1 :=

| | | max(BIAS\_G1, ISC\_BIAS\_MIN)

| ISCFLG > 0 ------------------| |

| | BIAS\_G2 :=

| | min(BIAS\_G2, ISC\_BIAS\_MAX)

| | BIAS\_G2 :=

| | max(BIAS\_G2, ISC\_BIAS\_MIN)

END: bias\_lookup

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FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.45.3 CLOSED LOOP LAMBSE CALCULATION (CDAI0)

OVERVIEW

This module is part of the closed loop fuel control. It is used to look up

the closed loop fuel peak to peak amplitude from a table that is a function

of engine speed and engine load. A full description of how the peak to peak

amplitude affects the closed loop fuel signal is given in the closed loop

fuel control module.

This module supports the following features:

1. Normal PTPAMP: FN1352(N,LOAD)

2. Idle PTPAMP: ISC\_PTP

This module will calculate bias for fore aft oxygen sensor control, full

OBD-II vehicles, FTP Catalyst monitor.

Block Diagram of PTPAMP Look-up Module

+--------------+

BIAS\_G1 ------->| |

| |

BIAS\_G2 ------->| |

| |

ISCFLG -------->| +---> PTPAMP1

| |

N ------------->| PTPAMP |

| Look up |

LOAD ---------->| +---> PTPAMP2

| |

ISC\_PTP\_SW ---->| |

| |

LC\_RATIO ------>| |

+--------------+

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FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- ISCFLG = ISC MODE Flag; 1 -> RPM CONTROL mode.

- LOAD = Universal normalized load parameter.

- N = Engine RPM.

Calibration Constants:

- FN021 = Load normalizing function; Input = Load, Output = Normalized

Load.

- FN039 = Engine speed (N) normalizing function.

- FN1352 = Closed Loop Peak-to-Peak amplitude, units are lambdas.

X = FN039(N)

Y = FN021(LOAD)

Output = Peak-to-Peak amplitude, PTPAMP.

- LC\_RATIO = Maximum BIAS\_G/PTPAMP ratio allowed before PTPAMP is

increased.

- ISC\_PTP = Idle speed peak-to-peak value.

- ISC\_PTP\_SW = Idle speed peak-to-peak value to be used at idle flag; 1 ->

use ISC\_PTP.

- PTPAMP\_MAX = Maximum value of PTPAMP allowed.

OUTPUTS

Registers:

- BIAS\_G1 = Closed loop fuel bias Bank 1.

- BIAS\_G2 = Closed loop fuel bias Bank 2.

- PTPAMP1 = Limit cycle peak\_to\_peak amplitude,bank 1.

- PTPAMP2 = Limit cycle peak\_to\_peak amplitude, bank 2.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CLFUL\_PTPAMP\_COM4

Calculation of PTPAMP

BEGIN: ptpamp\_lookup

ISCFLG > 0 -----------------------|

;idle speed RPM |

;control |AND -| ptpamp\_temp := ISC\_PTP

| |

ISC\_PTP\_SW = 1 -------------------| |

;idle speed PTP value desired |

| --- ELSE ---

|

| ptpamp\_temp := FN1352(N,LOAD)

|BIAS\_G1/ptpamp\_temp| > LC\_RATIO -------| ptpamp\_temp1 = |BIAS\_G1/LC\_RATIO|

| PTPAMP1 = min(ptpamp\_temp1,

| PTPAMP\_MAX)

|

| --- ELSE ---

|

| PTPAMP1 = ptpamp\_temp

|BIAS\_G2/ptpamp\_temp| > LC\_RATIO -------| ptpamp\_temp2 = |BIAS\_G2/LC\_RATIO|

| PTPAMP2 = min(ptpamp\_temp2,

| PTPAMP\_MAX)

|

| --- ELSE ---

|

| PTPAMP2 = ptpamp\_temp

END: ptpamp\_lookup

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FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.45.4 TRANSPORT DELAY LOOKUP (CDAI0)

OVERVIEW

This module is part of the closed loop fuel control. It is used to look up

the closed loop fuel transport delay from a table that is a function of

engine speed and engine load. A full description of how the transport delay

affects the closed loop fuel signal is given in the closed loop fuel control

module.

This module supports the following features:

1. Normal Transport Delay: FN1351(N,LOAD), TDMULT, FN346A(ECT)

2. EGO Monitor Transport Delay: FN1351E(N,LOAD)

This module will calculate transport delay for flexible fuel, fore aft oxygen

sensor control, full OBD-II vehicles with different delays from bank to bank,

FTP Catalyst monitor.

Block Diagram of Transport Delay Look-up Module

+--------------+

LAM\_MOD\_FLG --->| |

| +---> tdpip1

ECT ----------->| +---> tdsec1

| Transport |

N ------------->| Delay |

| Look-up +---> tdpip2

LOAD ---------->| +---> tdsec2

| |

+--------------+

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FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- ECT = Engine Coolant Temperature, deg F.

- LOAD = Universal normalized load parameter.

- N = Engine RPM.

Bit Flags:

- CAT\_TST\_PRG = Flag indicating start of catalyst test; 1 -> test in

progress, 0 -> no catalyst test.

- LAM\_MOD\_FLG = Flag used to initiate high frequency fuel modulation for

the upstream EGO monitor.

Calibration Constants:

- ENGCYL = Number of PIPs per engine revolution; or Number of cylinders/2.

- FN021 = Load normalizing function; Input = Load, Output = Normalized

Load.

- FN039 = Engine speed (N) normalizing function.

- FN346A(ECT) = Cold engine multiplier.

- FN1351 = System transport lag time; time delay from when a fuel change is

made until the HEGO sensor indicates this change, units are REVs.

X = FN039(N)

Y = FN021(LOAD)

Output = Transport delay, REVs.

- TDMULT = Transport time delay multiplier for bank 2; tdrevs2 = FN1351 \*

TDMULT.

OUTPUTS

Registers:

- tdpip1 = transport delay in pips for bank1.

- tdpip2 = transport delay in pips for bank2.

- tdsec1 = transport delay in seconds for bank 1.

- tdsec2 = transport delay in seconds for bank 2.

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FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CLFUL\_TRANS\_DELAY\_COM2

Calculation of tdpip and tdsec

BEGIN: transport\_delay\_lookup

LAM\_MOD\_FLG = 1 ------------------------| tdpip1 := FN1351E(N, LOAD) \* ENGCYL

;HEGO monitor in progress | tdsec1 := FN1351E(N, LOAD) \* 60/N

| tdpip2 := tdpip1

| tdsec2 := tdsec1

|

| --- ELSE ---

|

| tdpip1 := FN1351(N,LOAD) \* ENGCYL \*

| FN346A(ECT)

| tdsec1 := FN1351(N,LOAD) \* 60/N \*

| FN346A(ECT)

| tdpip2 := tdpip1 \* TDMULT

| tdsec2 := tdsec1 \* TDMULT

END: transport\_delay\_lookup

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.45.5 REAR EGO TRIM (CDAN2)

8.45.5.1 PROCEDURE Faosc\_init

| BEGIN: faosc\_init

| FUNCTIONAL REQUIREMENTS

This module calculates the BIAS trim on the front HEGOs, when Fore-Aft Oxygen

Sensor Control is enabled. The output of this module is R\_BIAS1/R\_BIAS2,

which are used in the closed loop fuel calculation.

| This module takes the downstream HEGO voltage and calculates a R\_BIAS using

| Proportional and Integral control. The R\_BIAS value will keep the closed

| loop fuel control operating in the catalyst window and therefore allow the

| control system to compensate for aged front HEGOs.

How FAOSC is implemented in a vehicle:

| +---------+

\_/| |\\_

| | /| |\ |

| /| ENGINE |\ |<----------+

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V V |

+-------+ |

| \_\_\_|\_\_\_\_\_\_\_|\_\_\_ |

| | | |

| EEC |----->-----+

| | R\_BIAS1/R\_BIAS2

| |

+---------------+

The control of the FAOSC module can be modeled with a simple P/I controller:

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| +-----------+

+------>| Ki/s |--------+

desired + | +-----------+ | R\_BIAS +---------+

VEGO ------>[ ]------| |-------->| ENGINE |---+

- A | +-----------+ | +---------+ |

VEGO | +------>| Kp |--------+ |

| +-----------+ |

| +-----------+ |

+----------------------| REAR HEGO |<------------------------+

+-----------+

This diagram shows the integral and proportional values are determined from

the error in the downstream ego voltage. The implementation of this module,

| however, allows for the calibration of the integral and proportional

| controllers on the basis of measured downstream VEGO only. This is done

| through functions FNFOASCI for the intergral control and FNFAOSCP for the

proportional control.

| The following is an example of integral control (FNFAOSCI) centered around

0.45v with no dead band and a constant gain.

FIGURE 1: FNFAOSCI (bias/min)

^

| |

0.001\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

| |

| |

| |

| |

< -----------------------+---------------------------------->

| 0 VEGO\_BAR\_Ix2 - FNVEGOSP(N,LOAD)

| |

| |

| |

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*|-0.001

v

FNFAOSCI with a small dead band around the setpoint.

FIGURE 2: FNFAOSCI (bias/min)

^

| |

0.001 \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

| | \*

| | \*

| | \*

| \*

< ------------------\*\*\*\*\*\*\*\*\*\*\*----------------------------->

| \* 0 VEGO\_BAR\_x2 - FNVEGOSP(N,LOAD)

| \* |

| \* |

| \* |

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* |-0.001

v

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The proportional control can work in conjunction with the integral control

to provide a better overall system. The proportional control is generated

from FNFAOSCP.

| The following is an example of a proportional control that would

correspond with the integral control of FIGURE 2:

| FIGURE 3: FNFAOSCP (bias)

^

| |

0.001\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

| |

| |

| |

| |

< -----------------------+---------------------------------->

0 VEGOx2\_BAR - FNVEGOSP(N,LOAD)

| |

| |

| |

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*|-0.001

v

| When the proportional and integral controls are working in parallel with an

| integral dead ban (FIGURES 2 & 3), the proportional will keep VEGO centered

| around 0.45v when VEGO is in the dead band and the integral will push the

voltage back into the dead band if the signal drifts out of the window.

The module also features a running average of the integral control. This

| allows the system to compensate for the aged HEGO drift even though the

system is not in the learning window of operation. This average is also used

as the starting point of the integral control when the conditions are right

for continued learning.

| In summary, the integral control provides the necessay R\_BIAS to keep the

front fuel control loop operating in the catalyst window, the proportional

| fine tunes the R\_BIAS to center or oscillate around a point within this

| window, and the average of the integral control allows the system to

adjust to an aged or drifted HEGO over a period of time.

;Perform during raminit.

| LOGICAL REQUIREMENTS

| Logic Diagram

| This structure diagram shows calling relations between

| logic charts in this process.

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

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| LEVEL ENTITY CALLED

| 1 Chart faosc\_init\_0

| EXTERNAL INTERFACE

| Inputs:

| - R\_BIAS\_AVG1

| - R\_BIAS\_AVG2

| Outputs:

| - FAOS\_DT1

| - FAOS\_DT2

| - R\_BIAS\_INT1

| - R\_BIAS\_INT2

| PARAMETER DECLARATIONS

| Registers:

| - FAOS\_DT1 = ELAPSED TIME SINCE THE UPDATE OF THE AVERAGE.

| Resolution: 0.000977 Units: seconds Init. Value: 0.050000

| Min. Value: 0.000000 Max. Value: 63.999001 Reg. Type: RAM

| - FAOS\_DT2 = ELAPSED TIME SINCE THE UPDATE OF THE AVERAGE.

| Resolution: 0.000977 Units: seconds Init. Value: 0.050000

| Min. Value: 0.000000 Max. Value: 63.990002 Reg. Type: RAM

| - R\_BIAS\_AVG1 = THE AVERAGE VALUE OF THE INTEGRAL VALUE OF R\_BIAS1

| Resolution: 0.000122 Units: UNITLESS Init. Value: 0.000000

| Min. Value: -3.990000 Max. Value: 3.990000 Reg. Type: KAM

| - R\_BIAS\_AVG2 = THE AVERAGE VALUE OF THE INTEGRAL VALUE OF R\_BIAS2

| Resolution: 0.000122 Units: UNITLESS Init. Value: 0.000000

| Min. Value: -3.990000 Max. Value: 3.990000 Reg. Type: KAM

| - R\_BIAS\_INT1 = THE INTEGRAL VALUE OF R\_BIAS1

| Resolution: 0.000122 Units: UNITLESS Init. Value: 0.000000

| Min. Value: -3.990000 Max. Value: 3.990000 Reg. Type: RAM

| - R\_BIAS\_INT2 = THE INTEGRAL VALUE OF R\_BIAS2

| Resolution: 0.000122 Units: UNITLESS Init. Value: 0.000000

| Min. Value: -3.990000 Max. Value: 3.990000 Reg. Type: RAM

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

8-291

FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| Logic Chart faosc\_init\_0

| Unconditionally -----------| FAOS\_DT1 := .05

| |

| | FAOS\_DT2 := .05

| | ;50 milliseconds is used as a representative

| | ;background loop time.

| |

| | R\_BIAS\_INT1 := R\_BIAS\_AVG1

| |

| | R\_BIAS\_INT2 := R\_BIAS\_AVG2

| |

END: faosc\_init

8.45.5.2 PROCEDURE Faosc2\_main

BEGIN: faosc2\_main

| FUNCTIONAL REQUIREMENTS

;Execute routines that must be run every loop, regardless:

| LOGICAL REQUIREMENTS

| Logic Diagram

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart faosc2\_main\_0

| 2 Procedure closed\_loop\_timer

| 2 Procedure faosc\_scp\_report

| 2 Procedure fault\_lockout

| 2 Procedure vego\_filter

| 2 Procedure vego\_ratchet

| 2 Function faosc\_avg

| 2 Function faosc\_p\_control

| 2 Function learn\_timer

| 2 Function output\_routing

| 2 Function rego\_ok\_logic

| EXTERNAL INTERFACE

| Inputs:

| No parameters are applicable.

| Outputs:

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| No parameters are applicable.

| PARAMETER DECLARATIONS

| No parameters applicable.

| Logic Chart faosc2\_main\_0

| Unconditionally -----------------------| DO: vego\_filter

| |

| | DO: vego\_ratchet

| |

| | DO: fault\_lockout

| |

| | DO: rego\_ok\_logic(1)

| |

| | DO: rego\_ok\_logic(2)

| |

| | DO: closed\_loop\_timer

| |

| | DO: faosc\_p\_control(1)

| |

| | DO: faosc\_p\_control(2)

| |

| | DO: learn\_timer(1)

| |

| | DO: learn\_timer(2)

| |

| | DO: faosc\_avg(1)

| |

| | DO: faosc\_avg(2)

| |

| | DO: faosc\_scp\_report

| |

| | DO: output\_routing(1)

| |

| | DO: output\_routing(2)

| |

END: faosc2\_main

8.45.5.3 PROCEDURE Vego\_filter

BEGIN: vego\_filter

| FUNCTIONAL REQUIREMENTS

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;Filter HEGO sensors for use in the fore/aft control:

| LOGICAL REQUIREMENTS

| Logic Diagram

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart vego\_filter\_0

| 2 Function rolav

| EXTERNAL INTERFACE

| Inputs:

| - BG\_TMR

| - VEGO12

| - VEGO22

| Outputs:

| No parameters are applicable.

| PARAMETER DECLARATIONS

| Registers:

| - VEGO12 = Bank1 downstream HEGO voltage

| Resolution: 0.001000 Units: VOLT Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 5.000000 Reg. Type: RAM

| - VEGO12\_BAR = FILTERED BANK1 DOWNSTREAM HEGO VOLTAGE.

| Resolution: 0.001000 Units: VOLT Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 5.000000 Reg. Type: RAM

| - VEGO22 = Bank2 downstream HEGO voltage

| Resolution: 0.001000 Units: VOLT Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 5.000000 Reg. Type: RAM

| - VEGO22\_BAR = FILTERED BANK2 DOWNSTREAM HEGO VOLTAGE.

| Resolution: 0.001000 Units: VOLT Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 5.000000 Reg. Type: RAM

| - VEGO\_BAR\_I12 = FILTERED BANK1 DOWNSTREAM HEGO VOLTAGE USED FOR INTEGRAL

| CONTROL.

| Resolution: 0.001000 Units: VOLT Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 5.000000 Reg. Type: RAM

| - VEGO\_BAR\_I22 = FILTERED BANK2 DOWNSTREAM HEGO VOLTAGE USED FOR INTEGRAL

| CONTROL.

| Resolution: 0.001000 Units: VOLT Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 5.000000 Reg. Type: RAM

| Calibration Constants:

| - TC\_VEGO\_FA = TIME CONSANT FOR REAR HEGO FILTER TO BE USED IN FORE/AF

| T CONTROL.

| Resolution: 0.001000 Base Value: 0.000000 Units: seconds

| Min. Value: 0.000000 Max. Value: 63.990002 Cal. Level: RCON/VECTR

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| - TC\_VEGO\_FA\_I = TIME CONSANT FOR REAR HEGO FILTER TO BE USED IN FORE/ AFT

| INTEGRALCONTROL.

| Resolution: 0.001000 Base Value: 0.000000 Units: seconds

| Min. Value: 0.000000 Max. Value: 63.990002 Cal. Level: RCON/VECTR

| Timers:

| - BG\_TMR = BACKGROUND LOOP TIMER

| Resolution: 0.000977 Units: seconds Init. Value: 0.000000

| Clip Min.: 0.000000 Clip Max.: 63.999001

| Timer Type: FREE RUN Direction: UP

| Logic Chart vego\_filter\_0

| Unconditionally -----------| VEGO12\_BAR := rolav(VEGO12, TC\_VEGO\_FA)

| |

| | VEGO22\_BAR := rolav(VEGO22, TC\_VEGO\_FA)

| |

| | VEGO\_BAR\_I12 := rolav(VEGO12, TC\_VEGO\_FA\_I)

| |

| | VEGO\_BAR\_I22 := rolav(VEGO22, TC\_VEGO\_FA\_I)

| |

END: vego\_filter

8.45.5.4 PROCEDURE Vego\_ratchet

BEGIN: vego\_ratchet

| FUNCTIONAL REQUIREMENTS

;Capture peak rich and lean values of the HEGO voltage to determine ;if the

sensor is warmed up and ready to use.

| LOGICAL REQUIREMENTS

| Logic Diagram

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart vego\_ratchet\_0

| 1 Chart vego\_ratchet\_1

| 1 Chart vego\_ratchet\_2

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| EXTERNAL INTERFACE

| Inputs:

| - ATMR1

| - VEGO12\_BAR

| - VEGO22\_BAR

| Outputs:

| - VEGO\_OK\_L1

| - VEGO\_OK\_L2

| - VEGO\_OK\_R1

| - VEGO\_OK\_R2

| PARAMETER DECLARATIONS

| Registers:

| - VEGO12\_BAR = FILTERED BANK1 DOWNSTREAM HEGO VOLTAGE.

| Resolution: 0.001000 Units: VOLT Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 5.000000 Reg. Type: RAM

| - VEGO22\_BAR = FILTERED BANK2 DOWNSTREAM HEGO VOLTAGE.

| Resolution: 0.001000 Units: VOLT Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 5.000000 Reg. Type: RAM

| - VEGO\_OK\_R2 = Bank 2 rear EGO OK on the rich side for FAOSC use.

| Resolution: 1.000000 Units: FLAG Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 1.000000 Reg. Type: RAM

| Bit Flags:

| - VEGO\_OK\_L1 = Bank 1 rear EGO OK on the lean side for FAOSC use.

| Initial Value: 0

| - VEGO\_OK\_L2 = Bank 2 rear EGO OK on the lean side for FAOSC use.

| Initial Value: 0

| - VEGO\_OK\_R1 = Bank 1 rear EGO OK on the rich side for FAOSC use.

| Initial Value: 0

| Calibration Constants:

| - REGO\_TM = Time delay into run mode before allowing FAOSC voltage

| monitoring of the downstream sensors.

| Resolution: 1.000000 Base Value: 0.000000 Units: seconds

| Min. Value: 0.000000 Max. Value: 255.000000 Cal. Level: RCON/VECTR

| - VEGO\_FAOS\_MN = Minimum voltage required to allow FAOSC.

| Resolution: 0.001000 Base Value: 5.000000 Units: VOLTS

| Min. Value: 0.000000 Max. Value: 5.000000 Cal. Level: RCON/VECTR

| - VEGO\_FAOS\_MX = Maximum voltage required to allow FAOSC.

| Resolution: 0.001000 Base Value: 0.000000 Units: VOLTS

| Min. Value: 0.000000 Max. Value: 5.000000 Cal. Level: RCON/VECTR

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| Timers:

| - ATMR1 = TIME SINCE ENGINE START

| Resolution: 1.000000 Units: seconds Init. Value: 0.000000

| Clip Min.: 0.000000 Clip Max.: 255.000000

| Timer Type: ACTUATED Direction: UP

| Logic Chart vego\_ratchet\_0

| ATMR1 < REGO\_TM -----------------| Exit this process.

| | ;do not look for peaks until the engine

| | ;has run for a little while

| |

| Logic Chart vego\_ratchet\_1

| VEGO12\_BAR >= VEGO\_FAOS\_MX ------------------| VEGO\_OK\_R1 := 1

| |

| | --- ELSE ---

| |

| VEGO12\_BAR <= VEGO\_FAOS\_MN ------------------| VEGO\_OK\_L1 := 1

| |

| Logic Chart vego\_ratchet\_2

| VEGO22\_BAR >= VEGO\_FAOS\_MX ------------------| VEGO\_OK\_R2 := 1

| |

| | --- ELSE ---

| |

| VEGO22\_BAR <= VEGO\_FAOS\_MN ------------------| VEGO\_OK\_L2 := 1

| |

END: vego\_ratchet

8.45.5.5 PROCEDURE Fault\_lockout

BEGIN: fault\_lockout

| FUNCTIONAL REQUIREMENTS

;Disable FAOSC when faults on EGR, secondary air and misfire are detected.

| LOGICAL REQUIREMENTS

| Logic Diagram

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart fault\_lockout\_0

| EXTERNAL INTERFACE

| Inputs:

| - FFG\_EGR

| - FFG\_MISFIRE

| - FFG\_SAIR

| Outputs:

| - FAOSC\_FMEM

| PARAMETER DECLARATIONS

| Bit Flags:

| - FAOSC\_FMEM = Flag for FAOSC fault lockout

| Initial Value: 0

| - FFG\_EGR = OBDII system FMEM flag for the EGR system - 1 -> EGR s ystem

| not currently operationg reliably.

| Initial Value: 0

| - FFG\_MISFIRE = OBDII system FMEM flag for engine misfire - 1 -> c urrently

| misfiring.

| Initial Value: 0

| - FFG\_SAIR = OBDII system FMEM flag for the sair system - 1 -> sair s ytem

| is not currently under control reliably

| Initial Value: 0

| Calibration Constants:

| - FAOSC\_ENA\_SW = Calibration switch for FAOSC fault lockout logic

| Resolution: 1.000000 Base Value: 0.000000 Units: SWITCH

| Min. Value: 0.000000 Max. Value: 1.000000 Cal. Level: RCON/VECTR

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| Logic Chart fault\_lockout\_0

| FAOSC\_ENA\_SW = 1 ----------------------| | FAOSC\_FMEM := 1

| | |

| FFG\_MISFIRE = 1 -----------------| |AND -|

| | | |

| FFG\_SAIR = 1 --------------------|OR --| |

| | |

| FFG\_EGR = 1 ---------------------| |

| |

| | --- ELSE ---

| |

| | FAOSC\_FMEM := 0

| |

END: fault\_lockout

8.45.5.6 FUNCTION Rego\_ok\_logic

| BEGIN: rego\_ok\_logic

| FUNCTIONAL REQUIREMENTS

| ;Determine if rear EGO is ready to be used for trimming:

| LOGICAL REQUIREMENTS

| Logic Diagram

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart rego\_ok\_logic\_0

| 2 Function rego\_ok

| 2 Function VEGO\_OK\_L

| 2 Function VEGO\_OK\_R

| EXTERNAL INTERFACE

| Inputs:

| - bank - Argument

| - EGO\_DS\_MON

| - FAOSC\_FMEM

| Outputs:

| There are no returns from this function.

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

8-299

FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| PARAMETER DECLARATIONS

| Bit Flags:

| - EGO\_DS\_MON = Flag used to signal when the downstream EGO monitor has

| run to completion.

| Initial Value: 0

| - FAOSC\_FMEM = Flag for FAOSC fault lockout

| Initial Value: 0

| Calibration Constants:

| - HEGO\_CONFIG = HEGO CONFIGURATION REGISTER

| Resolution: 1.000000 Base Value: 1.000000 Units: UNITLESS

| Min. Value: 0.000000 Max. Value: 3.000000 Cal. Level: RCON/VECTR

| Logic Chart rego\_ok\_logic\_0

| bank = 2 ------------------------| | rego\_ok(bank) := 1

| |AND -| |

| HEGO\_CONFIG = 2 -----------------| | |

| |OR --| |

| bank = 1 ------------------------| | | |

| |AND -| | |

| HEGO\_CONFIG <> 0 ----------------| | |

| | |

| FFG\_EGO(bank) 2 = 0 -------------------------| |

| | |

| EGO\_DS\_MON = 1 ------------------------| |AND -|

| ;downstream sensor is monitored | | |

| |OR --| |

| VEGO\_OK\_R(bank) = 1 -------------| | | |

| |AND -| | |

| VEGO\_OK\_L(bank) = 1 -------------| | |

| | |

| FAOSC\_FMEM = 0 ------------------------------| |

| |

| | --- ELSE ---

| |

| | rego\_ok(bank) := 0

| |

| END: rego\_ok\_logic

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

8-300

FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.45.5.7 PROCEDURE Closed\_loop\_timer

| BEGIN: closed\_loop\_timer

| FUNCTIONAL REQUIREMENTS

| ;Calculate closed loop time:

| LOGICAL REQUIREMENTS

| Logic Diagram

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart closed\_loop\_timer\_0

| EXTERNAL INTERFACE

| Inputs:

| - OLFLG

| Outputs:

| - RBIAS\_CL\_TMR

| PARAMETER DECLARATIONS

| Bit Flags:

| - OLFLG = OPEN LOOP FLAG; 1->Open Loop, 0->Closed Loop.

| Initial Value: 0

| Timers:

| - RBIAS\_CL\_TMR = TIME SINCE ENTRY INTO CLOSED LOOP.

| Resolution: 1.000000 Units: seconds Init. Value: 0.000000

| Clip Min.: 0.000000 Clip Max.: 255.000000

| Timer Type: FREE RUN Direction: UP

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

8-301

FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| Logic Chart closed\_loop\_timer\_0

| OLFLG = 0 -----------------------| No action

| | ;allow free running upcounting

| | ;RBIAS\_CL\_TMR to increment

| |

| | --- ELSE ---

| |

| | No action

| | ;reset closed loop timer

| |

| | RBIAS\_CL\_TMR := 0

| |

| END: closed\_loop\_timer

8.45.5.8 FUNCTION Faosc\_p\_control

| BEGIN: faosc\_p\_control

| FUNCTIONAL REQUIREMENTS

;Look up the value for the proportional R\_BIAS control.

| LOGICAL REQUIREMENTS

| Logic Diagram

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart faosc\_p\_control\_0

| 2 Function fox

| 2 Function rego\_ok

| 2 Function R\_BIAS\_PROP

| 2 Function table

| EXTERNAL INTERFACE

| Inputs:

| - bank - Argument

| - error

| - EXT\_REG

| - LOAD

| - N

| Outputs:

| There are no returns from this function.

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

8-302

FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| PARAMETER DECLARATIONS

| Registers:

| - EXT\_REG = Signed inferred exhaust wall temperature at the rear HEGO

| location.

| Resolution: 0.125000 Units: degrees Init. Value: 0.000000

| Min. Value: -4095.000000Max. Value: 4096.000000 Reg. Type: KAM

| - LOAD = UNIVERSAL LOAD AS RATIO OF AIR CHARGE OVER STANDARD

| Resolution: 0.000031 Units: UNITLESS Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 1.999969 Reg. Type: RAM

| - N = Engine speed (RPM)

| Resolution: 0.250000 Units: REV/MIN Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 16383.750000Reg. Type: RAM

| Calibration Constants:

| - FAOP\_EGO\_TMP = MINIMUM REGO TEMPERATURE REQUIRED TO USE PROPORTIONAL BIAS

| Resolution: 0.125000 Base Value: 0.000000 Units: degrees

| Min. Value: -4096.000000Max. Value: 4095.875000 Cal. Level: RCON/VECTR

| - FNFAOSCP = Proportional feedback bias from FAOSC.

| Resolution: 0.000122 Base Value: NIL Units: NORM A/F

| Min. Value: -0.015000 Max. Value: 0.015000 Cal. Level: RCON/VECTR

| XY Pairs: 7 X Input: SIGNED ERROR X Input Units: VOLTS

| - FNVEGOSP = VEGO SETPOINT FOR FAOSC.

| Resolution: 0.003900 Units: VOLTS Table Size: 10X8

| X Input: NIL X Normalizing Fcn: FN021

| Min. Value: 0.000000 Max. Value: 0.990000

| Y Input: N Normalizing Fcn: FN039E

| - PROP\_LD\_MAX = MAXIMUM LOAD ALLOWED TO USE PROPORTIONAL BIAS

| Resolution: 0.000031 Base Value: 0.000000 Units: UNITLESS

| Min. Value: 0.000000 Max. Value: 1.990000 Cal. Level: RCON/VECTR

| - PROP\_LD\_MIN = MINIMUM LOAD REQUIRED TO USE PROPORTIONAL BIAS

| Resolution: 0.000031 Base Value: 1.990000 Units: UNITLESS

| Min. Value: 0.000000 Max. Value: 1.990000 Cal. Level: RCON/VECTR

| - PROP\_N\_MAX = MAXIMUM RPM ALLOWED TO USE PROPORTIONAL BIAS

| Resolution: 0.250000 Base Value: 0.000000 Units: RPM

| Min. Value: 0.000000 Max. Value: 16383.000000Cal. Level: RCON/VECTR

| - PROP\_N\_MIN = MINIMUM RPM REQUIRED TO USE PROPORTIONAL BIAS

| Resolution: 0.250000 Base Value: 16383.000000Units: RPM

| Min. Value: 0.000000 Max. Value: 16383.000000Cal. Level: RCON/VECTR

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

8-303

FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| Logic Chart faosc\_p\_control\_0

| N > PROP\_N\_MIN ------------------| | setpoint := FNVEGOSP(N, LOAD)

| | | ;the table lookup above should

| N < PROP\_N\_MAX ------------------| | ;return a word interpolated value.

| | |

| LOAD > PROP\_LD\_MIN --------------| | error := VEGO(bank) 2 \_BAR -

| |AND -| setpoint

| LOAD < PROP\_LD\_MAX --------------| |

| | | R\_BIAS\_PROP(bank) := FNFAOSCP(error)

| EXT\_REG > FAOP\_EGO\_TMP ----------| |

| | |

| rego\_ok(bank) = 1 ---------------| |

| |

| | --- ELSE ---

| |

| | R\_BIAS\_PROP(bank) := 0

| |

| END: faosc\_p\_control

8.45.5.9 FUNCTION Learn\_timer

| BEGIN: learn\_timer

| FUNCTIONAL REQUIREMENTS

;Determine if drive conditions are acceptable for learning:

| LOGICAL REQUIREMENTS

| Logic Diagram

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart learn\_timer\_0

| 2 Function abs

| 2 Function FAO\_MON\_FLG

| 2 Function LAMAVE

| 2 Function LAMBSE

| 2 Function learn\_timer\_running

| 2 Function RBIAS\_LNTMR

| EXTERNAL INTERFACE

| Inputs:

| - bank - Argument

| - ECT

| - LAM\_MOD\_FLG

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| - LOAD

| - MFMFLG

| - N

| - VSBAR

| Outputs:

| There are no returns from this function.

| PARAMETER DECLARATIONS

| Registers:

| - ECT = COOLANT TEMP

| Resolution: 2.000000 Units: degrees Init. Value: 60.000000

| Min. Value: -256.000000 Max. Value: 254.000000 Reg. Type: RAM

| - LOAD = UNIVERSAL LOAD AS RATIO OF AIR CHARGE OVER STANDARD

| Resolution: 0.000031 Units: UNITLESS Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 1.999969 Reg. Type: RAM

| - N = Engine speed (RPM)

| Resolution: 0.250000 Units: REV/MIN Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 16383.750000Reg. Type: RAM

| - VSBAR = FILTERED VEHICLE SPEED

| Resolution: 0.500000 Units: RPM Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 127.500000 Reg. Type: RAM

| Bit Flags:

| - LAM\_MOD\_FLG = Flag used to initiate high frequency fuel modulation

| for the upstream EGO monitor.

| Initial Value: 0

| - MFMFLG = MAP/MAF FMEM FLAG

| Initial Value: 0

| Calibration Constants:

| - LAM\_DIFF\_FAO = MAXIMUM ALLOWABLE DIFFERENCE IN LAMBSE FROM LAMAVE

| Resolution: 0.000031 Base Value: 0.000000 Units: UNITLESS

| Min. Value: 0.000000 Max. Value: 1.999969 Cal. Level: RCON/VECTR

| - RBIAS\_ECT\_MN = MINIMUM ECT REQUIRED TO USE REAR EGO FOR FRONT EGO

| TRIMMING.

| Resolution: 2.000000 Base Value: -20.000000 Units: degrees

| Min. Value: -40.000000 Max. Value: 254.000000 Cal. Level: RCON/VECTR

| - RBIAS\_ECT\_MX = MAXIMUM ECT ALLOWED TO USE REAR EGO FOR FRONT EGO

| TRIMMING.

| Resolution: 2.000000 Base Value: 254.000000 Units: degrees

| Min. Value: -40.000000 Max. Value: 254.000000 Cal. Level: RCON/VECTR

| - RBIAS\_LAM\_MN = Minimum allowable average A/F ratio for FAOSC in tegral

| learning.

| Resolution: 0.000030 Base Value: 1.000000 Units: --

| Min. Value: 0.000000 Max. Value: 1.990000 Cal. Level: RCON/VECTR

| - RBIAS\_LAM\_MX = Maximum allowable average A/F ratio for FAOSC in tegral

| learning.

| Resolution: 0.000030 Base Value: 1.000000 Units: --

| Min. Value: 0.000000 Max. Value: 1.990000 Cal. Level: RCON/VECTR

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

8-305

FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| - RBIAS\_LD\_MAX = MAXIMUM LOAD ALLOWED TO USE REAR EGO TO LEARN BIAS.

| Resolution: 0.000031 Base Value: 0.900000 Units: UNITLESS

| Min. Value: 0.000000 Max. Value: 1.990000 Cal. Level: RCON/VECTR

| - RBIAS\_LD\_MIN = MINIMUM LOAD REQUIRED TO USE REAR EGO TO LEARN BIAS.

| Resolution: 0.000031 Base Value: 0.100000 Units: UNITLESS

| Min. Value: 0.000000 Max. Value: 1.990000 Cal. Level: RCON/VECTR

| - RBIAS\_N\_MAX = MAXIMUM RPM ALLOWED TO USE REAR EGO TO LEARN BIAS.

| Resolution: 0.250000 Base Value: 5000.000000 Units: RPM

| Min. Value: 0.000000 Max. Value: 16383.000000Cal. Level: RCON/VECTR

| - RBIAS\_N\_MIN = MINIMUM RPM REQUIRED TO USE REAR EGO TO LEARN BIAS.

| Resolution: 0.250000 Base Value: 1000.000000 Units: RPM

| Min. Value: 0.000000 Max. Value: 16383.000000Cal. Level: RCON/VECTR

| - RBIAS\_VS\_MIN = MINIMUM VEHICLE SPEED REQUIRED BEFORE BIAS TRIMMING IS

| ALLOWED.

| Resolution: 0.500000 Base Value: 35.000000 Units: MPH

| Min. Value: 0.000000 Max. Value: 127.500000 Cal. Level: RCON/VECTR

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| Logic Chart learn\_timer\_0

| VSBAR >= RBIAS\_VS\_MIN -----------------| | No action

| ;cruise condition. | | ;allow free running

| | | ;upcounting RBIAS\_LNTMR(bank

| N > RBIAS\_N\_MIN -----------------------| | ;) to increment

| | |

| N < RBIAS\_N\_MAX -----------------------| | learn\_timer\_running(bank) := 1

| ;rpm is within learning range. | |

| | |

| LOAD > RBIAS\_LD\_MIN -------------------| |

| | |

| LOAD < RBIAS\_LD\_MAX -------------------| |

| ;LOAD is within learning range. | |

| | |

| ECT > RBIAS\_ECT\_MN --------------------| |

| |AND -|

ECT < RBIAS\_ECT\_MX --------------------| |

;ECT is within learning range. | |

| |

LAM\_MOD\_FLG = 0 -----------------------| |

;not doing EGO response rate test. | |

| |

MFMFLG = 0 ----------------------------| |

;air meter functional. | |

| |

abs(LAMBSE(bank) - LAMAVE(bank)) < | |

| LAM\_DIFF\_FAO -------------------------| |

| |

LAMAVE(bank) <= RBIAS\_LAM\_MX ----------| |

| |

LAMAVE(bank) >= RBIAS\_LAM\_MN ----------| |

| |

| | --- ELSE ---

| |

| | No action

| | ;reset learn timer

| |

| RBIAS\_LNTMR(bank) := 0

|

| | learn\_timer\_running(bank) := 0

| |

| |

| FAO\_MON\_FLG(bank) := 0

| |

END: learn\_timer

8.45.5.10 FUNCTION Faosc\_avg

| BEGIN: faosc\_avg

| FUNCTIONAL REQUIREMENTS

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

8-307

FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;Calculate the average of the integral bias trim. ;This algorithm

essentially implements a rolav() function, but will ;allow very large time

constants. The rolav() function will not perform ;adequately for very long

time constants because when the time constant ;is big, the amount the

filtered value must change in one background pass ;is very small. If the

change is less than the resoulution of the filtered ;parameter, the rolav()

function will add (or subtract) one bit from the ;filtered value. This

results in a ramp, not an exponential response. ;This routine will not add

| (or subtract) one bit if the filtered value should ;change by less than the

| resolution of the filtered value. Instead the ;delta time between execution

of the filter equation will be accumulated. ;The accumulated delta time will

then be used next execution cycle to compute ;a new filter constant. This

accumulation of delta times will continue until ;at least on full resolution

of the filtered value should be added (or ;subtracted) during this execution

cycle. In this way the exponential ;behaviour can be obtained for very long

| time constants. ;The software must carry enough resolution in the

| calculation of the ;'new\_average' intermediate value to decide if the

difference between it ;and the current filtered value is less than one bit

resolution.

| LOGICAL REQUIREMENTS

| Logic Diagram

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart faosc\_avg\_0

| 2 Function FAOS\_DT

| 2 Function R\_BIAS\_AVG

| 2 Function R\_BIAS\_INT

| 1 Chart faosc\_avg\_1

| 2 Function FAOS\_DT

| 2 Function new\_average

| 2 Function R\_BIAS\_AVG

| 2 Function R\_BIAS\_INT

| EXTERNAL INTERFACE

| Inputs:

| - bank - Argument

| - BG\_TMR

| Outputs:

| There are no returns from this function.

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

8-308

FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| PARAMETER DECLARATIONS

| Calibration Constants:

| - TCRBIAS = TIME CONSTANT FOR THE AVERAGE RBIAS

| Resolution: 0.007812 Base Value: 150.000000 Units: seconds

| Min. Value: 0.000000 Max. Value: 511.992187 Cal. Level: RCON/VECTR

| Timers:

| - BG\_TMR = BACKGROUND LOOP TIMER

| Resolution: 0.000977 Units: seconds Init. Value: 0.000000

| Clip Min.: 0.000000 Clip Max.: 63.999001

| Timer Type: FREE RUN Direction: UP

| Logic Chart faosc\_avg\_0

| R\_BIAS\_AVG(bank) = R\_BIAS\_INT(bank) ---| FAOS\_DT(bank) := BG\_TMR

| | ;stop averaging

| |

| | EXIT this process.

| |

| Logic Chart faosc\_avg\_1

| Unconditionally -----------| f := 1 / (1 + (TCRBIAS / FAOS\_DT(bank)))

| | ;calculate fiter constant for long term first

| | ;order filter.

| |

| | new\_average(bank) := f \* R\_BIAS\_INT(bank) + (1 -

| | f) \* R\_BIAS\_AVG(bank)

| |

| abs(new\_average(bank) - R\_BIAS\_AVG(bank)) < (BIAS\_G\_RES / 2)

-----------------| FAOS\_DT(bank) := BG\_TMR | + FAOS\_DT(bank) | ;the step to

| be taken cannot | ;be contained in the | ;resolution of the | ;R\_BIAS\_AVG

| term. | ;Instead of taking the step, | ;increase the delta time input | ;to

the filter and recompute | ;next background pass. | | --- ELSE --- | |

R\_BIAS\_AVG(bank) := | new\_average(bank) | FAOS\_DT(bank) := BG\_TMR

END: faosc\_avg

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

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8.45.5.11 PROCEDURE Faosc\_scp\_report

BEGIN: faosc\_scp\_report

| FUNCTIONAL REQUIREMENTS

;Store the average values into separate KAM parameters so they can be

;assigned to FFFFh when hardware is not present. They are required by ;SCP

Mode06 reporting.

| LOGICAL REQUIREMENTS

| Logic Diagram

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart faosc\_scp\_report\_0

| EXTERNAL INTERFACE

| Inputs:

| - FFFFh

| - R\_BIAS\_AVG1

| - R\_BIAS\_AVG2

| Outputs:

| - FAO\_SCP\_AVG1

| - FAO\_SCP\_AVG2

| PARAMETER DECLARATIONS

| Registers:

| - FAO\_SCP\_AVG1 = Copy of R\_BIAS\_AVG1, assigned to FFFFh when HEGO is n

| ot present.

| Resolution: 0.000122 Units: UNITLESS Init. Value: 0.000000

| Min. Value: -3.990000 Max. Value: 3.990000 Reg. Type: KAM

| - FAO\_SCP\_AVG2 = Copy of R\_BIAS\_AVG2, assigned to FFFFh when HEGO is n ot

| present.

| Resolution: 0.000122 Units: UNITLESS Init. Value: 0.000000

| Min. Value: -3.990000 Max. Value: 3.990000 Reg. Type: KAM

| - R\_BIAS\_AVG1 = THE AVERAGE VALUE OF THE INTEGRAL VALUE OF R\_BIAS1

| Resolution: 0.000122 Units: UNITLESS Init. Value: 0.000000

| Min. Value: -3.990000 Max. Value: 3.990000 Reg. Type: KAM

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| - R\_BIAS\_AVG2 = THE AVERAGE VALUE OF THE INTEGRAL VALUE OF R\_BIAS2

| Resolution: 0.000122 Units: UNITLESS Init. Value: 0.000000

| Min. Value: -3.990000 Max. Value: 3.990000 Reg. Type: KAM

| Calibration Constants:

| - HEGO\_CONFIG = HEGO CONFIGURATION REGISTER

| Resolution: 1.000000 Base Value: 1.000000 Units: UNITLESS

| Min. Value: 0.000000 Max. Value: 3.000000 Cal. Level: RCON/VECTR

| - NUMEGO = Number of HEGO sensors used.

| Resolution: 1.000000 Base Value: 2.000000 Units: ENUMERATED

| Min. Value: 1.000000 Max. Value: 2.000000 Cal. Level: RCON/VECTR

| Logic Chart faosc\_scp\_report\_0

| HEGO\_CONFIG = 0 -----------------------| FAO\_SCP\_AVG1 := FFFFh

| ;no rear EGO exists. |

| | FAO\_SCP\_AVG2 := FFFFh

| |

| | --- ELSE ---

| |

| NUMEGO = 1 ----------------------| | FAO\_SCP\_AVG1 := R\_BIAS\_AVG1

| ;single bank |OR --|

| | | FAO\_SCP\_AVG2 := FFFFh

| HEGO\_CONFIG = 3 -----------------| |

| ;y - pipe configuration |

| |

| | --- ELSE ---

| |

| | FAO\_SCP\_AVG1 := R\_BIAS\_AVG1

| |

| | FAO\_SCP\_AVG2 := R\_BIAS\_AVG2

| |

END: faosc\_scp\_report

8.45.5.12 FUNCTION Output\_routing

| BEGIN: output\_routing

| FUNCTIONAL REQUIREMENTS

;Determine if Fore-Aft Oxygen Sensor Control has been requested:

| LOGICAL REQUIREMENTS

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| Logic Diagram

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart output\_routing\_0

| 2 Function faosc\_i\_control

| 2 Function final\_calc

| 2 Function learn\_timer\_running

| 2 Function max

| 2 Function min

| 2 Function R\_BIAS

| 2 Function R\_BIAS\_AVG

| 2 Function R\_BIAS\_INT

| 2 Function R\_BIAS\_PROP

| 1 Chart output\_routing\_1

| EXTERNAL INTERFACE

| Inputs:

| - bank - Argument

| - FAILED\_BANK

| - KAM\_ERROR

| Outputs:

| There are no returns from this function.

| PARAMETER DECLARATIONS

| Registers:

| - FAILED\_BANK = Register indicating which bank is in lack of EGO switching.

| Resolution: 1.000000 Units: UNITLESS Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 10.000000 Reg. Type: KAM

| Bit Flags:

| - FALD\_BNK\_OLD = Last pass value of FAILED\_BANK

| Initial Value: 0.000000

| - KAM\_ERROR = INDICATES KEEP ALIVE RAM INVALID

| Initial Value: 0

| Calibration Constants:

| - HEGO\_CONFIG = HEGO CONFIGURATION REGISTER

| Resolution: 1.000000 Base Value: 1.000000 Units: UNITLESS

| Min. Value: 0.000000 Max. Value: 3.000000 Cal. Level: RCON/VECTR

| - RBIAS\_AVG\_MN = Minimum allowable value of R\_BIAS\_AVG

| Resolution: 0.000122 Base Value: -0.015000 Units: UNITLESS

| Min. Value: -3.990000 Max. Value: 3.990000 Cal. Level: RCON/VECTR

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| - RBIAS\_AVG\_MX = Maximum allowable value of R\_BIAS\_AVG

| Resolution: 0.000122 Base Value: 0.015000 Units: UNITLESS

| Min. Value: -3.990000 Max. Value: 3.990000 Cal. Level: RCON/VECTR

| - RBIAS\_MAX = MAXIMUM ALLOWABLE VALUE OF R\_BIAS

| Resolution: 0.000122 Base Value: 0.015000 Units: UNITLESS

| Min. Value: -3.990000 Max. Value: 3.990000 Cal. Level: RCON/VECTR

| - RBIAS\_MIN = MINIMUM ALLOWABLE VALUE OF R\_BIAS

| Resolution: 0.000122 Base Value: -0.015000 Units: UNITLESS

| Min. Value: -3.990000 Max. Value: 3.990000 Cal. Level: RCON/VECTR

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| Logic Chart output\_routing\_0

| FAILED\_BANK <> bank -| | R\_BIAS(bank) := 0

| |AND -| |

| FALD\_BNK\_OLD = bank -| | | R\_BIAS\_AVG(bank) := 0

| | |

| HEGO\_CONFIG = 0 -----------| | R\_BIAS\_INT(bank) := 0

| | |

| KAM\_ERROR = 1 -------------|OR --| R\_BIAS\_PROP(bank) := 0

| | |

| R\_BIAS\_AVG(bank) < | |

| RBIAS\_AVG\_MN -------------| |

| | |

| R\_BIAS\_AVG(bank) > | |

| RBIAS\_AVG\_MX -------------| |

| |

| | --- ELSE ---

| |

| learn\_timer\_running(bank) = 1 ---| DO: faosc\_i\_control(bank)

| |

| | DO: final\_calc(bank)

| |

| | rbias := R\_BIAS\_INT(bank) + R\_BIAS\_PROP(

| | bank)

| |

| | rbias := min(rbias, RBIAS\_MAX)

| |

| | R\_BIAS(bank) := max(rbias, RBIAS\_MIN)

| |

| | --- ELSE ---

| |

| | rbias := R\_BIAS\_AVG(bank) + R\_BIAS\_PROP(

| | bank)

| |

| | rbias := min(rbias, RBIAS\_MAX)

| |

| | R\_BIAS(bank) := max(rbias, RBIAS\_MIN)

| |

| | R\_BIAS\_INT(bank) := R\_BIAS\_AVG(bank)

| |

| Logic Chart output\_routing\_1

| Unconditionally -----------------| FALD\_BNK\_OLD := FAILED\_BANK

| |

END: output\_routing

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

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8.45.5.13 FUNCTION Faosc\_i\_control

| BEGIN: faosc\_i\_control

| FUNCTIONAL REQUIREMENTS

;Calculate BIAS\_SUM(bank):

| LOGICAL REQUIREMENTS

| Logic Diagram

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart faosc\_i\_control\_0

| 2 Function BIAS\_SUM

| 2 Function FAO\_MON\_FLG

| 2 Function fox

| 2 Function RBIAS\_LNTMR

| 2 Function rego\_ok

| 2 Function table

| EXTERNAL INTERFACE

| Inputs:

| - bank - Argument

| - BG\_TMR

| - error

| - LOAD

| - N

| - RBIAS\_CL\_TMR

| Outputs:

| There are no returns from this function.

| PARAMETER DECLARATIONS

| Registers:

| - LOAD = UNIVERSAL LOAD AS RATIO OF AIR CHARGE OVER STANDARD

| Resolution: 0.000031 Units: UNITLESS Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 1.999969 Reg. Type: RAM

| - N = Engine speed (RPM)

| Resolution: 0.250000 Units: REV/MIN Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 16383.750000Reg. Type: RAM

| Calibration Constants:

| - FNFAOSCI = Integral feedback

| Resolution: 0.000008 Base Value: NIL Units: LAMBDA/MIN

| Min. Value: -0.025000 Max. Value: 0.249000 Cal. Level: RCON/VECTR

| XY Pairs: 7 X Input: SIGNED ERROR X Input Units: VOLTS

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| - FNVEGOSP = VEGO SETPOINT FOR FAOSC.

| Resolution: 0.003900 Units: VOLTS Table Size: 10X8

| X Input: NIL X Normalizing Fcn: FN021

| Min. Value: 0.000000 Max. Value: 0.990000

| Y Input: N Normalizing Fcn: FN039E

| - RBIAS\_CL\_TM = TIME REQUIRED IN CLOSED LOOP BEFORE BIAS TRIMMING IS

| ALLOWED.

| Resolution: 1.000000 Base Value: 10.000000 Units: seconds

| Min. Value: 0.000000 Max. Value: 255.000000 Cal. Level: RCON/VECTR

| - RBIAS\_LN\_TM = TIME REQUIRED AT SPEED/LOAD CONDITION TO START LEARNING.

| Resolution: 1.000000 Base Value: 10.000000 Units: seconds

| Min. Value: 0.000000 Max. Value: 255.000000 Cal. Level: RCON/VECTR

| Timers:

| - BG\_TMR = BACKGROUND LOOP TIMER

| Resolution: 0.000977 Units: seconds Init. Value: 0.000000

| Clip Min.: 0.000000 Clip Max.: 63.999001

| Timer Type: FREE RUN Direction: UP

| - RBIAS\_CL\_TMR = TIME SINCE ENTRY INTO CLOSED LOOP.

| Resolution: 1.000000 Units: seconds Init. Value: 0.000000

| Clip Min.: 0.000000 Clip Max.: 255.000000

| Timer Type: FREE RUN Direction: UP

| Logic Chart faosc\_i\_control\_0

| rego\_ok(bank) = 1 ---------| | setpoint := FNVEGOSP(N, LOAD)

| ;rear EGO bank O. K. | | ;the table lookup above should return a

| | | ;word interpolated value.

| RBIAS\_LNTMR(bank) > | |

| RBIAS\_LN\_TM --------------|AND -| error := VEGO\_BAR\_I(bank) 2 - setpoint

| ;learning conditions | |

| ;stabilized. | | BIAS\_SUM(bank) := ((FNFAOSCI(error) / 60)

| | | \* BG\_TMR) + BIAS\_SUM(bank)

| RBIAS\_CL\_TMR > | |

| RBIAS\_CL\_TM --------------| | FAO\_MON\_FLG(bank) := 1

| ;have been closed loop | ;This flag actuates the timer

| ;long enough for catalyst |

| ;to stabilize. | : FAO\_MON\_TMR(bank) to increment.

| |

| | --- ELSE ---

| |

| | BIAS\_SUM(bank) := 0

| |

| | FAO\_MON\_FLG(bank) := 0

| | ;The timer FAO\_MON\_TMR(bank) holds its

| | ;current value.

| |

| END: faosc\_i\_control

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

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8.45.5.14 FUNCTION Final\_calc

| BEGIN: final\_calc

| FUNCTIONAL REQUIREMENTS

| LOGICAL REQUIREMENTS

| Logic Diagram

| This structure diagram shows calling relations between logic charts in this

| process.

| LEVEL ENTITY CALLED

| 1 Chart final\_calc\_0

| 1 Chart final\_calc\_1

| 2 Function RBIAS\_EGOSW

| 1 Chart final\_calc\_2

| 2 Function abs

| 2 Function BIAS\_SUM

| 2 Function max

| 2 Function min

| 2 Function RBIAS\_EGOSW

| 2 Function R\_BIAS\_INT

| 1 Chart final\_calc\_3

| EXTERNAL INTERFACE

| Inputs:

| - bank - Argument

| - FAILED\_BANK

| - R\_BIAS\_INT1

| - swtfl

| Outputs:

| There are no returns from this function.

| PARAMETER DECLARATIONS

| Registers:

| - FAILED\_BANK = Register indicating which bank is in lack of EGO switching.

| Resolution: 1.000000 Units: UNITLESS Init. Value: 0.000000

| Min. Value: 0.000000 Max. Value: 10.000000 Reg. Type: KAM

| - R\_BIAS\_INT1 = THE INTEGRAL VALUE OF R\_BIAS1

| Resolution: 0.000122 Units: UNITLESS Init. Value: 0.000000

| Min. Value: -3.990000 Max. Value: 3.990000 Reg. Type: RAM

| - R\_BIAS\_INT2 = THE INTEGRAL VALUE OF R\_BIAS2

| Resolution: 0.000122 Units: UNITLESS Init. Value: 0.000000

| Min. Value: -3.990000 Max. Value: 3.990000 Reg. Type: RAM

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| Calibration Constants:

| - BIAS\_G\_RES = RESOLUTION OF BIAS\_G

| Resolution: 0.000000 Base Value: 0.000244 Units: UNITLESS

| Min. Value: 0.000000 Max. Value: 0.000488 Cal. Level:

| Not\_Modifiable

| - HEGO\_CONFIG = HEGO CONFIGURATION REGISTER

| Resolution: 1.000000 Base Value: 1.000000 Units: UNITLESS

| Min. Value: 0.000000 Max. Value: 3.000000 Cal. Level: RCON/VECTR

| - RBIAS\_INT\_MN = Minimum allowable FAOSC integral term.

| Resolution: 0.000122 Base Value: -0.015000 Units: --

| Min. Value: -3.990000 Max. Value: 3.990000 Cal. Level: RCON/VECTR

| - RBIAS\_INT\_MX = Maximum allowable FAOSC integral term.

| Resolution: 0.000122 Base Value: 0.015000 Units: --

| Min. Value: -3.990000 Max. Value: 3.990000 Cal. Level: RCON/VECTR

| Logic Chart final\_calc\_0

| FAILED\_BANK = bank --------| other\_bank := 3 - bank

| |

| | swtfl := SWTFL(other\_bank) 1

| | ;if the current bank has a failed upstream EGO

| | ;, the switch flag from the other bank should

| | ;be used to pace the learning.

| |

| | --- ELSE ---

| |

| | swtfl := SWTFL(bank) 1

| |

| Logic Chart final\_calc\_1

| swtfl = 1 -----------------| RBIAS\_EGOSW(bank) := RBIAS\_EGOSW(bank) + 1

| |

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, REAR EGO TRIM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| Logic Chart final\_calc\_2

| abs(BIAS\_SUM(bank)) >= | rbias\_int := R\_BIAS\_INT(bank) + BIAS\_SUM(

| BIAS\_G\_RES ---------------| | bank)

| ;sum is greater that | |

| ;resolution of BIAS\_G. |AND -| rbias\_int := min(rbias\_int, RBIAS\_INT\_MX)

| | |

| RBIAS\_EGOSW(bank) >= 1 ----| | R\_BIAS\_INT(bank) := max(rbias\_int,

| ;at least one EGO switch | RBIAS\_INT\_MN)

| ;has occurred since last |

| ;RBIAS update. | BIAS\_SUM(bank) := 0

| |

| | RBIAS\_EGOSW(bank) := 0

| |

| Logic Chart final\_calc\_3

| HEGO\_CONFIG = 3 -----------------| R\_BIAS\_INT2 := R\_BIAS\_INT1

| |

END: final\_calc

| STRATEGY FILE: CLFUL\_FAOSC\_COM1/GEN=25A2

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FUEL STRATEGY, COOLING FAIL-SAFE LOGIC - CDAN2

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8.46 COOLING FAIL-SAFE LOGIC (CDAN0)

OVERVIEW

The module provides the null assignment to COOL\_FLG for all those strategies

that do not have the cylinder head temperature protection logic (fail safe

cooling).

DEFINITIONS

Bit Flags:

- COOL\_FLG = Flag indicating overtemperature conditions; 1 ->

overtemperature occured.

PROCESS

STRATEGY MODULE: FUEL\_COOL\_FAIL\_COM2

Execute the following process once per background pass.

unconditionally ------------------------| COOL\_FLG = 0

| ; Ensure flag remains clear

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FUEL STRATEGY, BACKGROUND F/A RATIO MULTIPLIER LOGIC - CDAN2

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8.47 FAR\_MUL BACKGROUND LOGIC (CDAK0)

OVERVIEW

This logic provides an Offboard Diagnostic Unit (ODU) the capability to

control the delivered LBMF\_INJn independently from the main strategy control

in order to allow CARB verification of the OBDII Adaptive Fuel Monitor.

The process by which an ODU manipulates the EEC-V delivered fuel mass is as

follows:

1) The ODU queries the EEC-V for two two-byte Parameter IDs (PIDs) which

provide the recommended rich and lean fuel mass multiplier limits for use

during the OBDII Adaptive Fuel Monitor demonstration, the EEC's copy of the

desired multiplier, and a response code indicating the status of the test.

The data will be reported over the SCP link. The first message contains the

recommended rich FAR\_MUL limit (FAR\_RICH\_LIM) and the recommended lean

FAR\_MUL limit (FAR\_LEAN\_LIM). The second message contains the EEC copy of

the multiplier (FAR\_MUL\_SCP) and the response code (FAR\_MUL\_RSP).

2) The ODU will next download two bytes of contiguous data, starting at the

199th byte of the 200 byte ODU user RAM array as described in the SCP

chapter. The starting address of this 200 byte array can be obtained via the

scp\_odu\_ram PID. The first data byte will represent the appropriate Fuel

Mass Multiplier data value (FAR\_MUL\_SCP). The second data byte will

represent the one's compliment of FAR\_MUL\_SCP (FAR\_MUL\_CHK). The one's

complement (Exclusive OR) is used here in order to provide strategy

robustness.

3) The two RAM bytes will be used within the EEC-V, per the following logic,

to either deliver a fuel mass multiplier to the foreground fuel logic, or to

disable the use of the multiplier in the final LBMF\_INJn calculation. If a

multiplier is used, it will be ramped from a value of 1.0 to the desired

magnitude by the EEC to produce a smooth transition and avoid potential

engine start-up problems. The time period over which the ramp is executed

(FAR\_MUL\_RAMP) is calibrateable.

If the ODU should go offline or otherwise stop transmitting the

TESTER\_PRESENT message, then the EEC-V will revert back to its normal fuel

scheduling logic and the FAR\_MUL multiplier will be set to 1.0 after

ODU\_TIMEOUT seconds have passed.

NOTE: The PID described above (and the substitution process it allows) will

not be available to any offboard SCP tool other than those specifically

designated by the Powertrain Control Systems and Diagnostic Systems

Departments. This process is NOT intended for any other use besides

demonstrating the ability of the EEC-V system to detect and respond to large

errors in the engine fuel and/or air mass calculations, per the applicable

OBDII specifications.

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FUEL STRATEGY, BACKGROUND F/A RATIO MULTIPLIER LOGIC - CDAN2

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DEFINITIONS

INPUTS

Registers:

- DLOAD\_EXEC\_KEY = Command KEY byte to enable execution of a downloaded

program (via SCP) - S/W parm is: DLOAD\_EXEC\_KEY, EDTS parm is

DLOAD\_EXEC\_K.

- FAR\_MUL\_CHK = Check byte of FAR\_MUL\_SCP. Must be One's compliment for

demonstration of OBDII Adaptive Fuel Monitor for CARB.

- FAR\_MUL\_SCP = Byte downloaded (via SCP) to load into FAR\_MUL for

demonstration of OBDII Adaptive Fuel Monitor. Used to impose a fuel

error in strategy.

- N = Engine speed, rpm.

- SCP\_DWNLD\_ST = Current level of SCP Download & Execute State Machine.

Bit Flags:

- DEMAND\_MODE = Flag set when and On-Demand self test mode is active.

- FAR\_MUL\_RDY = Flag indicating readiness of Adaptive Fuel Monitor

demonstration test; 0 -> test not ready, 1 -> test ready to run.

- FAR\_MUL\_RUN = Flag indicating state of Adaptive Fuel Monitor

demonstration test; 0 -> test not running, 1 -> test running.

- UNDSP = Engine underspeed/run mode flag; 1 -> in crank or underspeed

mode, 0 -> in run mode.

Calibration Constants:

- FAR\_LEAN\_LIM = Lean limit of fuel mass (or fuel-air ratio) multiplier,

unitless.

- FAR\_MUL\_RAMP = Desired duration of fuel multiplier ramp, sec.

- FAR\_MUL\_SW = Switch to enable use of fuel mass multiplier for development

purposes ONLY, unitless. (Value must be set to 1 with RCON to enable

use. This parameter will not be calibratable at VECTOR level.)

- FAR\_RICH\_LIM = Rich limit of fuel mass (or fuel-air ratio) multiplier,

unitless.

8-322

FUEL STRATEGY, BACKGROUND F/A RATIO MULTIPLIER LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- FAR\_MUL = Percentage of fueling error to impose into EEC-V system in

order to demonstrate the OBDII Adaptive Fuel Monitor for CARB. Assigned

via SCP.

- FAR\_MUL\_CHK = See above.

- FAR\_MUL\_SCP = See above.

- FAR\_MUL\_RSP = Response code indicating the status of the test for SCP

communications;

00h -> affirmative response

22h -> conditions not correct

44h -> ready for download

- FAR\_MUL\_SLP = Desired change in multiplier per unit time, 1/sec.

- FAR\_MUL\_TMR = Free-running timer used to ramp fuel multiplier to desired

value, sec.

Bit Flags:

- FAR\_MUL\_FLG = Foreground flag which enables FAR\_MUL to be used in

injector fuel pulsewidth calculations in order to demonstrate the OBDII

Adaptive Fuel Monitor for CARB.

- FAR\_MUL\_RDY = See above.

- FAR\_MUL\_RUN = See above.

OTHER

- far\_mul\_1 = A two byte parameter used for SCP control of the Fuel Mass

Multiplier. The first byte contains the value for FAR\_RICH\_LIM. The

second byte contains the value for FAR\_LEAN\_LIM.

- far\_mul\_2 = A two byte parameter used for SCP control of the Fuel Mass

Multiplier. The first byte contains the EEC's copy of the downloaded

multiplier, FAR\_MUL\_SCP. The second byte contains a response code

indicating the status of the test, FAR\_MUL\_RSP.

- far\_mul\_scp = Clipped value of dowloaded multiplier, unitless.

- far\_mul\_tmr = Clipped value of timer used for ramp, sec.

- spc\_odu\_ram = This parameter is a PID of single word length which

provides the beginning address of the ODU user RAM area. This PID will

allow SBDS to download diagnostic routines to the user RAM area without

having to consult the DOC files of the corresponding strategy. This

parameter is not displayable.

8-323

FUEL STRATEGY, BACKGROUND F/A RATIO MULTIPLIER LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_FAR\_MUL\_COM1

BEGIN: fuel\_mass\_multiplier

;This process is executed once per background loop.

SCP\_DWNLD\_ST = 3 -----------------|

;SCP is in proper |

;DLXQT state |

|

DLOAD\_EXEC\_KEY <> 8002h ----------|AND -| ;Allow LBMF\_INJn

;Currently not executing | | ;Substitution in FG.

;any other routine | |

| | Do: continue\_test

DEMAND\_MODE = 0 ------------------| |

;No other On Demand test | FAR\_MUL\_RSP = 00h

;test is active | ;General response code for

| ;affirmative response

|

| --- ELSE ---

|

FAR\_MUL\_SW = 1 -------------------------| ;Allow substitution for

;Enable multiplier for | ;calibration development only.

;development work | ;Switch must be poked with RCON

|

| Do: continue\_test

|

| FAR\_MUL\_RSP = 44h

| ;General response code for

| ;ready for download

|

| --- ELSE ---

|

| ;Disable LBMF\_INJn

| ;substitution.

|

| FAR\_MUL = 1.0

| FAR\_MUL\_FLG = 0

| FAR\_MUL\_SCP = 0

| FAR\_MUL\_CHK = 0

| FAR\_MUL\_RDY = 0

| FAR\_MUL\_RUN = 0

|

| FAR\_MUL\_RSP = 22h

| ;General response code for

| ;conditions not correct

END: fuel\_mass\_multiplier

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FUEL STRATEGY, BACKGROUND F/A RATIO MULTIPLIER LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: continue\_test

;This process is executed only when explicitly called.

unconditionally ------------------------| FAR\_MUL\_SCP = (Contents of memory

| location at address

| (scp\_odu\_ram+C6h))

| ;Desired fuel mass multiplier as

| ;downloaded to 199th byte of ODU

| ;user RAM

|

| FAR\_MUL\_CHK = (Contents of memory

| location at address

| (scp\_odu\_ram+C7h))

| ;One's complement of desired

| ;multiplier as downloaded to 200th

| ;byte of ODU user RAM.

|

| :See definitions for description

| ;of scp\_odu\_ram.

N = 0 ----------------------------|

;Engine is not running |

|AND -| ;Engine must be stopped to begin

FAR\_MUL\_CHK = (1's compliment | | ;test.

of FAR\_MUL\_SCP) ---| |

;Robustness check of data | FAR\_MUL\_RDY = 1

| ;Test is ready to run.

|

| --- ELSE ---

UNDSP = 0 ------------------------| |

;Engine is running |AND -| ;Ramp in multiplier as soon as the

| | ;engine is running.

FAR\_MUL\_RDY = 1 ------------------| |

;Multiplier downloaded | Do: initialize\_ramp

;and verified |

| far\_mul\_tmr = min(FAR\_MUL\_TMR,

| FAR\_MUL\_RAMP)

| ;Clip to stop ramping at desired

| ;multiplier value. This clip is

| ;necessary because the timer is

| ;free-running.

|

| FAR\_MUL = clip((FAR\_MUL\_SLP\*

| far\_mul\_tmr) + 1,

| FAR\_LEAN\_LIM,

| FAR\_RICH\_LIM)

| ;Clip to ensure improper values

| ;are not passed to foreground

|

| FAR\_MUL\_FLG = 1

| ;Multiplier is active

END: continue\_test

8-325

FUEL STRATEGY, BACKGROUND F/A RATIO MULTIPLIER LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: initialize\_ramp

;This process is executed only when explicitly called.

FAR\_MUL\_RUN = 0 ------------------------| far\_mul\_scp = clip(FAR\_MUL\_SCP,

| FAR\_LEAN\_LIM,

| FAR\_RICH\_LIM)

| ;Clip to ensure that slope

| ;calculated below is accurate.

|

| FAR\_MUL\_SLP = (far\_mul\_scp - 1) /

| FAR\_MUL\_RAMP

| FAR\_MUL\_RUN = 1

| ;Lock out further resets while

| ;running.

| FAR\_MUL\_TMR = 0

| ;Reset ramp timer.

END: initialize\_ramp

BEGIN: pid\_definitions

The following logic defines PID messages for the fuel mass multiplier used

for demonstration of the adaptive fuel monitor. RAM and ROM parameters are

sent in separate messages to facilitate software coding.

pid\_def(far\_mul\_1, FAR\_RICH\_LIM, FAR\_LEAN\_LIM)

; | |

;rich limit -----------+ |

;lean limit -------------------------+

pid\_def(far\_mul\_2, FAR\_MUL\_SCP, FAR\_MUL\_RSP)

; | |

;EEC copy of desired | |

;multiplier -----------+ |

;response code ---------------------+

END: pid\_definitions

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FUEL STRATEGY, SPEED LIMITER SELFTEST CODE SETTING - OBDII - \*\*S\*\*

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8.48 SPEED LIMITER CONTINUOUS SELFTEST CODE SETTING - OBDII (CDAN0)

OVERVIEW

To assist service diagnosis of reported misfire a continuous self test code

is set when the fuel cut off speed limiter is invoked.

DEFINITIONS

INPUTS

Bit Flags:

- CCM\_TST\_ENA = Continuous self test enabled.

- FUEL\_CUT = Fuel cutout active. Set in foreground for continuous self

test.

OUTPUTS

Bit Flags:

- FUEL\_CUT = See above.

OTHERS

- store\_code (Pxxx) = Stores the fault code specified by Pxxx.

- P1270 = Faultcode, RPM or VSS limit reached.

PROCESS

STRATEGY MODULE: FUEL\_RPM\_LIM\_OBDII\_COM1

CCM\_TST\_ENA = 1 ------------------|

|AND -| store\_code(P1270)

FUEL\_CUT = 1 ---------------------| | (store fault code P1270 in memory)

|

| FUEL\_CUT = 0

|

| --- ELSE ---

|

| no action

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FUEL STRATEGY, SPEED LIMITER SELFTEST CODE SETTING - OBDII - \*\*S\*\*

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

8-328

CHAPTER 9

IGNITION TIMING STRATEGY

9-1

IGNITION TIMING STRATEGY, OVERVIEW - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.1 OVERVIEW (CDAI1)

OVERVIEW

The relationships of the calculations are shown below via variable usage.

The entries in the boxes are headings of sections in the strategy.

+------------+ +----------------+

| BORDERLINE | | BASE EMISSIONS | +---------------+

| SPARK |<-SPK\_LAMBSE--| AND |--SPK\_LAMBSE->| MAXIMUM BRAKE |

| DETONATION | | DRIVE SPARK | | TORQUE SPARK |

+------------+ +----------------+ +---------------+

| | | |

SPK\_BDL SPK\_BASE SPK\_M\_B\_T |

| | | |

+--------------+ +---------+ | |

| | | |

| | +----------------------+ | |

| | | SPARK FOR LOW LOAD | SPK\_MBT\_LAST |

| | | OPERATING CONDITIONS | | |

| | +----------------------+ | |

| | | | |

| | | V |

| | | +-------------------+ |

| | SPK\_LOW\_LOAD | TORQUE TRUNCATION | |

| | | | VIA SPARK RETARD | |

| | | +-------------------+ |

+-------------+ | | | | | |

| OSCILLATION | | | | +-----------+ | |

| MODULATION | | | | | | |

+-------------+ | | | SPK\_TRUNC | |

| | | | | | | |

| SPK\_OSC\_OFF V V V V | |

| | +---------------------------+ | |

| +----->| SELECT LOWEST SPARK VALUE | LAST\_LD\_MBT |

| +---------------------------+ | |

| | | |

| SPK\_ABS\_LIM | |

| SPK\_FLEX\_LIM V |

| | +-----------------------+ |

| +------------------>| TORQUE BASED FEEDBACK | |

| | | SPARK AT IDLE | |

SPK\_OSCMOD | +-----------------------+ |

| | | |

| | SPK\_IDLE\_FB |

| | SPK\_STATE |

| V | |

| +-------------------------+<------------+ |

+------------>| FINAL SPARK CALCULATION | |

+-------------------------+ |

| |

SAF |

| |

V |

+----------------+ |

| spark delivery | TR\_SPK\_DELTA

+----------------+ |

| |

9-2

IGNITION TIMING STRATEGY, OVERVIEW - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

spout transition V

9-3

IGNITION TIMING STRATEGY, FINAL SPARK CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.2 FINAL SPARK CALCULATION (CDAN0)

OVERVIEW

Spark advance final (SAF) is the value of the spark advance angle calculated

by the background strategy modules. It is further modified by the foreground

modules and converted into a coded pulsewidth which is sent to the EDIS.

background foreground foreground

spark angle spark angle pulsewidth

------------------------------------------

SAF ---> SAFTOT ---> SAPW

SPK\_SOURCE values if using the torque control chapter:

0 Crank or underspeed

1 Base

2 Borderline

3 Torque control - see TQ\_SOURCE for further

clarification of torque truncation source

6 Stabilized low load

7 Cold engine low load

8 Idle feedback at minimum clip

9 Idle feedback

10 Spark set by on-demand self-test

11 Oscillation modulation modifying base

12 Oscillation modulation modifying borderline

13 Oscillation modulation modifying torque control

SPK\_SOURCE values if not using the torque control chapter:

0 Crank or underspeed

1 Base

2 Borderline

3 Tip-in torque truncation

4 Transmission gear torque truncation

5 Vehicle speed limiter torque truncation

6 Stabilized low load

7 Cold engine low load

8 Idle feedback at minimum clip

9 Idle feedback

10 Spark set by on-demand self-test

11 Oscillation modulation modifying base

12 Oscillation modulation modifying borderline

13 Oscillation modulation modifying torque control

DEFINITIONS

Registers:

- ER\_SPARK = Value of SAF during on demand self test, deg.

- SAF = Spark Advance Final, deg.

- SPK\_ABS\_LIM = Spark is never allowed to go above this value because of

detonation, torque limitation or base spark requirements.

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IGNITION TIMING STRATEGY, FINAL SPARK CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SPK\_FLEX\_LIM = This is a desirable spark limit which may be exceeded

briefly when torque is required by a strategy such as feedback spark.

- SPK\_IDLE\_FB = Spark by Feedback Spark logic.

- SPK\_OSCMOD = OSCMOD correction to other spark calculations.

- SPK\_SOURCE = Identifies the source calculation for the final spark value.

- SPK\_STATE = Defines the use of feedback spark, 0 -> feedback spark is not

being used, 1 -> transitioning into feedback spark, 2 -> using the

feedback spark calculation, 3 -> transitioning out of feedback spark.

Bit Flags:

- ER\_SPK\_REQ = Indicates that the on demand self test requires SAF to be

equal to ER\_SPARK; 1 -> SAF = ER\_SPARK.

- UNDSP = Underspeed Flag; 1 -> Underspeed or Crank Mode, 0 -> Run mode.

Calibration Constants:

- SPK\_ADD = Calibration adder to over-all spark equation. Used to

explicitly specify spark advance when SPK\_MUL is calibrated to zero, deg.

- SPK\_MUL = Calibration multiplier to over-all spark equation. Typically,

SPK\_MUL is set to zero and then SPK\_ADD explicitly determines spark

advance, deg.

- SPLCLP = Lower limit spark clip for rotor registry.

- SPUCLP = Upper limit spark clip for rotor registry.

- SUBST\_REQ17 = Substitution required flag for channel 17.

9-5

IGNITION TIMING STRATEGY, FINAL SPARK CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SPARK\_FINAL\_CALC\_COM2

BEGIN: spark\_final\_calc\_main

; This module executes every background loop. Note that it reads top down.

; Determine if feedback spark calculation is being used. Select

; either feedback spark or the flexible limit as the first limiting

; spark value.

SPK\_STATE = 0 ---------------| saf := SPK\_FLEX\_LIM + SPK\_OSCMOD

(Not in Feed | spk\_source\_saf := spk\_source\_flex

Back Spark) |

| --- ELSE ---

|

| saf = SPK\_IDLE\_FB + SPK\_OSCMOD

| spk\_source\_saf := spk\_source\_fb

; Clip the value of the final spark advance so that it does not exceed

; SPK\_ABS\_LIM (although it may do so after being modified by the spark

; adder and multiplier, SPK\_ADD and SPK\_MUL).

SPK\_ABS\_LIM <= saf ----------| saf\_fin := SPK\_ABS\_LIM \* SPK\_MUL + SPK\_ADD

| spk\_source\_fin := spk\_source\_abs

|

| --- ELSE ---

|

| saf\_fin := saf \* SPK\_MUL + SPK\_ADD

| spk\_source\_fin := spk\_source\_saf

; Set final spark advance and note the source of the value.

ER\_SPK\_REQ = 1 --------------| t\_saf := ER\_SPARK

| SPK\_SOURCE := 10

| ; Spark for on-demand self-test

|

| --- ELSE ---

|

UNDSP = 0 -------------------| t\_saf := saf\_fin

| SPK\_SOURCE := spk\_source\_fin

| ; Normal spark

|

| --- ELSE ---

|

| t\_saf := 10

| SPK\_SOURCE := 0

| ; Spark for crank/underspeed

9-6

IGNITION TIMING STRATEGY, FINAL SPARK CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUE: spark\_final\_calc\_main

; The final background value of spark advance in the temporary register,

; t\_saf, is limited to the range:

;

; SPLCLP <= t\_saf <= SPUCLP

unconditionally ----------| t\_saf := MAX(t\_saf,SPLCLP)

| t\_saf := MIN(t\_saf,SPUCLP)

| SAF := t\_saf

; Output state control over-ride of final spark advance. This routine will

; over-ride the SAF value if the engine-running self-test is not being

; performed and the engine is not underspeed. This value over-rides all

; background spark calculations elsewhere in this module.

ER\_SPK\_REQ <> 1 -------|

|AND -| DO: substitute(17,saf\_tmp)

UNDSP = 0 -------------| | SAF := saf\_tmp

|

| --- ELSE ---

|

SUBST\_REQ17 = 1 -------------| DO: osc\_response(17,22h)

| ; OSC requested but operating conditions will

| ; not allow substitute to occur

END: spark\_final\_calc\_main

9-7

IGNITION TIMING STRATEGY, SELECT LOWEST SPARK VALUE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.3 SELECT LOWEST SPARK VALUE (CDAL0)

OVERVIEW

Select the most retarded value of spark from the base spark, borderline

detonation limit, torque truncation and cold start spark calculations.

DEFINITIONS

Registers:

- SPK\_ABS\_LIM = Spark is never allowed to go above this value because of

detonation, torque limitation or base spark requirements.

- SPK\_BASE = Desired spark advance for optimal emissions and driveability,

deg.

- SPK\_BDL = Borderline detonation spark limit, deg.

- SPK\_FLEX\_LIM = This is a desirable spark limit which may be exceeded

briefly when torque is required by a strategy such as feedback spark or

oscmod.

- SPK\_LOW\_LOAD = Idle emissions spark ceiling. Lowest of Cold Start Spark

and Inspection Maintenance requirements.

- SPK\_OSC\_OFF = The amount by which the base spark calculation is reduced

to make room for an increase as calculated by the OSCMOD strategy.

- SPK\_TRUNC = Spark ceiling when engine torque needs to be limited.

9-8

IGNITION TIMING STRATEGY, SELECT LOWEST SPARK VALUE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SPARK\_LOWEST\_COM1

BEGIN: spark\_lowest\_main

; This process executes once each background loop. It must be executed

; before the SPARK\_FINAL\_CALC\_COMn module. Note that it reads top-down.

unconditionally ----------| DO: spark\_flexible\_limit

| DO: spark\_absolute\_limit

END: spark\_lowest\_main

BEGIN: spark\_flexible\_limit

; This process executes when called from spark\_lowest\_main. Note that it

; reads top-down.

; Calculate the flexible spark limit, SPK\_FLEX\_LIM, by determining the more

; retarded of the sum of SPK\_ABS\_LIM plus the OSCMOD offset and

; SPK\_LOW\_LOAD. This value of spark may be exceeded by the oscillation

; modulation and feedback spark calculations.

abs\_plus\_off > SPK\_LOW\_LOAD ------------| SPK\_FLEX\_LIM := SPK\_LOW\_LOAD

| spk\_source\_flex := spk\_source\_low

|

| --- ELSE ---

|

| SPK\_FLEX\_LIM := abs\_plus\_off

| spk\_source\_flex := 10

| + spk\_source\_abs

unconditionally ------------------------| abs\_plus\_off := SPK\_ABS\_LIM +

SPK\_OSC\_OFF

END: spark\_flexible\_limit

BEGIN: spark\_absolute\_limit

; This process executes when called from spark\_lowest\_main. Note that it

; reads top-down.

; Calculate the absolute spark limit, SPK\_ABS\_LIM by determining the

; most retarded of base, borderline and torque truncation spark values.

intermed\_lim > SPK\_BASE ----------------| SPK\_ABS\_LIM := SPK\_BASE

| spk\_source\_abs := 1

|

| --- ELSE ---

|

| SPK\_ABS\_LIM := intermed\_lim

| spk\_source\_abs := spk\_source\_int

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IGNITION TIMING STRATEGY, SELECT LOWEST SPARK VALUE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUE: spark\_absolute\_limit

; Calculate the intermediate spark limit which is needed by the

; absolute spark limit calculation, by determining the most retarded

; of the borderline and torque truncation values.

SPK\_BDL > SPK\_TRUNC --------------------| intermed\_lim := SPK\_TRUNC

| spk\_source\_int := spk\_source\_trunc

|

| --- ELSE ---

|

| intermed\_lim := SPK\_BDL

| spk\_source\_int := 2

END: spark\_absolute\_limit

9-10

IGNITION TIMING STRATEGY, BASE EMISSIONS AND DRIVE SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.4 BASE EMISSIONS AND DRIVE SPARK (CDAL0)

OVERVIEW

The base spark strategy is essentially MBT spark modified to achieve

functional requirements for emissions and drive quality.

DEFINITIONS

INPUTS

Registers:

- BP = Barometric Pressure, " Hg.

- DASPOT = Dashpot contribution to idle air flow, ppm. See Idle Speed

Control chapter for calculation. Used here as input to Dashpot Spark

multiplier, FN839.

- ECT = Engine coolant temperature, deg F.

- EGRACT = Actual EGR percent = 100 \* EM / AMPEM.

- ISCFLG = ISC mode indicator; -1 -> Dashpot Mode; 0 -> Dashpot Preposition

Mode; 1 -> Closed Loop RPM Control Mode; 2 -> Closed Loop RPM Control

(Lock-out entry to RPM control.)

- LOAD = Universal load variable. Normalized CYLARC\_BG divided by SARCHG,

unitless.

- N = Engine RPM.

- SPKBASE\_IMRC = Base spark adder when using intake manifold runner

control, set to zero otherwise. Degrees, positive for advance.

- SPKBASE\_VCT = Base spark adder when using variable cam timing, set to

zero otherwise. Degrees, negative for retard, positive for advance.

- SPK\_CMB\_ADJ = Spark modifier for engine combustion noise, degrees.

- SPK\_LAMBSE = Value of LAMBSE to be used in spark calculations, unitless.

- TP\_REL = RELATIVE TP ( TP - RATCH ).

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration. 1 -> use

anti-plug fouling strategy, 0 -> use standard strategy.

Calibration Constants:

- FN012(LOAD) = Normalized LOAD for full-sized spark tables.

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IGNITION TIMING STRATEGY, BASE EMISSIONS AND DRIVE SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FN013(LOAD) = Normalized LOAD for half-sized spark tables.

- FN014(ECT) = Normalized ECT for spark calculation.

- FN014\_ALT(ECT) = Normalized ECT for spark calculation during anti-plug

fouling mode.

- FN015(SPK\_LAMBSE) = Normalized LAMBSE for spark calculation.

- FN016(N) = Normalized rpm for full-sized spark tables.

- FN017(N) = Normalized rpm for half-sized spark tables.

- FN700(TP\_REL) = Throttle position multiplier for engine combustion noise

spark modifier.

- FN702(ECT) = Engine coolant temperature multiplier for engine combustion

noise spark modifier.

- FN711(LOAD) = The increase in spark for each percent of EGR, deg / \_%

EGR.

- FN712(BP) = Proportions the contribution from the base sea level and base

altitude spark tables as a function of altitude, unitless.

- FN839(DASPOT) = Decel spark multiplier as a function of dashpot air flow.

- FN2100(N,LOAD) = Base spark table at sea level. The values in this table

should be used at all altitudes unless there are specific altitude

related emissions reasons, deg.

X = FN016(N)

Y = FN012(LOAD)

- FN2110(N,LOAD) = Base spark table at altitude. These values should be

the same as the base sea level table unless there are specific altitude

emissions related reasons to justify a change, deg.

X = FN016(N)

Y = FN012(LOAD)

- FN2115(N,LOAD) = Engine combustion noise spark modifier, degrees.

X = FN016(N)

Y = FN012(LOAD)

- FN2120(ECT,LOAD) = The change in desired spark as a function of engine

coolant temperature, deg.

X = FN014(ECT) be visible.

Y = FN013(LOAD)

- FN2120\_ALT(ECT,LOAD) = The change in desired spark as a function of

engine coolant temperature and load during anti-plug fouling mode, deg.

X = FN014\_ALT(ECT)

Y = FN013(LOAD)

- FN2140(N,SPK\_LAMBSE) = This table is intended to adjust spark for

whatever calibration adjustments which may be necessary. Examples of

such adjustments are retarding spark when lean for improved NOX,

adjusting spark when rich due to wide open throttle and over-advancing

spark to reduce catalyst temperatures.

X = FN017(N)

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IGNITION TIMING STRATEGY, BASE EMISSIONS AND DRIVE SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Y = FN015(SPK\_LAMBSE)

OUTPUTS

Registers:

- SPK\_BASE = Desired spark advance for optimal emissions and driveability.

Degrees BTDC.

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IGNITION TIMING STRATEGY, BASE EMISSIONS AND DRIVE SPARK - CDAN2

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PROCESS

STRATEGY MODULE: SPARK\_BASE\_COM10

BEGIN: spark\_base\_main

; This module executes each background loop. Note that it reads top down.

; Alternate calibration for anti-plug fouling strategy.

ALT\_CAL\_FLG = 1 ---------| fn2120 := FN2120\_ALT(ECT,LOAD)

|

| --- ELSE ---

|

| fn2120 := FN2120(ECT,LOAD)

; Calculate modifier for engine combustion noise reduction. This

; should be calibrated such that little or no spark retard is used

; when the driver is asking for power (via throttle position TP\_REL).

; Also, it may be calibrated for little or no spark retard at low

; or high temperatures.

unconditionally ---------| SPK\_CMB\_ADJ := FN2115(N,LOAD)

| \* FN700(TP\_REL)

| \* FN702(ECT)

; Main base spark calculation.

unconditionally ----------| spk\_base\_temp := FN2100(N,LOAD) \* FN712(BP)

| + FN2110(N,LOAD) \* (1 - FN712(BP))

| + fn2120

| + FN711(LOAD) \* EGRACT

| + FN2140(N,SPK\_LAMBSE)

| + SPK\_CMB\_ADJ

| + SPKBASE\_IMRC

| + SPKBASE\_VCT

; If in dashpot mode of idle speed control, use a dashpot multiplier

; on the base spark calculation.

ISCFLG = -1 --------------| SPK\_BASE := spk\_base\_temp \* FN839(DASPOT)

|

| --- ELSE ---

|

| SPK\_BASE := spk\_base\_temp

END: spark\_base\_main

9-14

IGNITION TIMING STRATEGY, BORDERLINE DETONATION SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.5 BORDERLINE DETONATION SPARK (CDAN0)

OVERVIEW

This logic calculates the spark advance at which borderline level detonation

takes place.

One part of BORDERLINE\_SPK is the Transient Spark strategy (also called

lugging mode strategy) which attempts to reflect the ability of the engine to

tolerate higher spark without detonation during transient conditions as

opposed to steady state conditions. One possible explanation is that during

a tip-in cylinder temperature increases from one stabilized temperature to

another higher temperature and that this change is not reflected adequately

in ECT. The result is that the engine can tolerate a greater spark advance

for a few seconds until the cylinder temperature stabilizes at its new level.

It is also thought that the amount of swirl of the air charge may have an

effect. This strategy provides a means to supply an increase in spark during

transitions.

DEFINITIONS

Registers:

- ACT = Air Charge Temperature, deg F.

- BP = Barometric Pressure, " Hg.

- CYL\_AIR\_CHG = Current cylinder air charge.

- DASPOT = Dashpot contribution to idle air flow, ppm. See Idle Speed

Control chapter for calculation. Used here as input to Dashpot Spark

multiplier, FN839.

- ECT = Engine coolant temperature, deg F.

- EGRACT = Actual EGR percent = 100 \* EM / AMPEM.

- ISCFLG = ISC mode indicator; -1 -> Dashpot Mode; 0 -> Dashpot Preposition

Mode; 1 -> Closed Loop RPM Control Mode; 2 -> Closed Loop RPM Control

(Lock-out entry to RPM control.)

- LOAD = Universal load variable.

- LUGTMR = The time since the engine transitioned into higher load

operating conditions.

- N = Engine RPM.

- OCTADJ = Field Octane Adjust input, unitless; 1 -> Retard for octane

adjustment is desired, 0 -> No retard is desired.

- SPK\_BDL = Borderline detonation spark limit. Degrees BTDC.

9-15

IGNITION TIMING STRATEGY, BORDERLINE DETONATION SPARK - CDAN2

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- SPK\_BDL\_FFS = Borderline spark adder when using flexible fuel, set to

zero otherwise. Degrees, negative for retard, positive for advance.

- SPK\_BDL\_VCT = Borderline spark adder when using variable cam timing, set

to zero otherwise. Degrees, negative for retard, positive for advance.

- SPK\_LAMBSE = Value of LAMBSE to be used in spark calculations, unitless.

- SPK\_TIP\_IMRC = Difference between IMRC open and IMRC closed slopes for

the foreground borderline update.

Bit Flags:

- SPK\_BDL\_UPDT = Flag to inform the background manager that the borderline

spark module must be executed on a priority basis.

Calibration Constants:

- FN012(LOAD) = Normalized LOAD for full-sized spark tables.

- FN013(LOAD) = Normalized LOAD for half-sized spark tables.

- FN015(SPK\_LAMBSE) = Normalized LAMBSE for spark calculation.

- FN016(N) = Normalized RPM for full-sized spark tables.

- FN017(N) = Normalized RPM for half-sized spark tables.

- FN721(LOAD) = Increase in the detonation limit as a function of percent

EGR, deg / % EGR.

- FN722(BP) = The octane level of fuel sold at high altitude is typically

lower than equivalent fuel grades sold as sea level. This function gives

the calibrator the option of compensating the spark calculation for fuel

quality as a function of altitude.

- FN723(LUGTMR) = Transient increase in the detonation limit following an

increase in load, degrees.

- FN724A(ECT) = Multiplier which corrects for the non-linear effect of

coolant

- FN725A(ACT) = Multiplier which corrects for the non-linear effect of

ambient air temperature on borderline detonation, unitless.

- FN726(N) = Change to the borderline calculation when the octane adjust

pin is grounded, deg.

- FN839(DASPOT) = Decel spark multiplier as a function of dashpot air flow.

- FN2200(N,LOAD) = Base borderline detonation table, degrees.

X = FN016(N)

Y = FN012(LOAD)

- FN2220(N,LOAD) = Borderline detonation adjustment for coolant

temperature, degrees spark/degree F.

X = FN017(N)

Y = FN013(LOAD)

9-16

IGNITION TIMING STRATEGY, BORDERLINE DETONATION SPARK - CDAN2

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- FN2230(N,LOAD) = Borderline detonation adjustment for air charge

temperature, degrees spark/degree F.

X = FN017(N)

Y = FN013(LOAD)

- FN2240(N,SPK\_LAMBSE) = Borderline detonation adjustment for a change in

Air/Fuel ratio.

X = FN017(N)

Y = FN015(SPK\_LAMBSE)

- FN2250(N,LOAD) = Increase in spark values that the engine can tolerate

without detonation after a load increase but before the engine begins to

knock.

X = FN017(N)

Y = FN013(LOAD)

- OCTADJHP = Octane adjust input hardware present switch; 0 -> no OCTADJ

input exists, 1 -> an OCTADJ input is present.

- SARCHG = Air charge mass of cylinder vol. at standard BP.

9-17

IGNITION TIMING STRATEGY, BORDERLINE DETONATION SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SPARK\_BORDERLINE\_COM7

BEGIN: spark\_borderline\_main

; This module executes each background loop. Note that it reads top down.

; Calculate borderline spark adder for the octane adjust service switch.

OCTADJ = 1 ------------------------|

; octane adjust input is high |AND -| bl\_octane\_adjust\_add := FN726(N)

| |

OCTADJHP = 1 ----------------------| |

; octane adjust feature enabled |

| --- ELSE ---

|

| bl\_octane\_adjust\_add := 0

; If this calculation of SPK\_BDL is for the pre-emptive tip-in retard

; logic, the value of LOAD must be updated to reflect the current value

; of cylinder air charge.

SPK\_BDL\_UPDT = 1 ------------------------| LOAD := CYL\_AIR\_CHG / SARCHG

; Calculate borderline detonation spark angle.

always --------------| spk\_bdl\_temp := FN2200(N,LOAD)

| + FN2220(N,LOAD) \* FN724A(ECT)

| + FN2230(N,LOAD) \* FN725A(ACT)

| + FN2240(N,SPK\_LAMBSE)

| + FN2250(N,LOAD) \* FN723(LUGTMR)

| + FN721(LOAD) \* EGRACT

| + FN722(BP)

| + bl\_octane\_adjust\_add

| + SPK\_BDL\_FFS

| + SPK\_BDL\_IMRC

| + SPK\_BDL\_VCT

; Add dashpot spark multiplier if in dashpot idle speed control mode.

ISCFLG = -1 ---------| SPK\_BDL := spk\_bdl\_temp \* FN839(DASPOT)

|

| --- ELSE ---

|

| SPK\_BDL := spk\_bdl\_temp

9-18

IGNITION TIMING STRATEGY, BORDERLINE DETONATION SPARK - CDAN2

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CONTINUE: spark\_borderline\_main

; Clear the pre-emptive calculation flag used for the foreground tip-in

; retard logic.

unconditionally -----| SPK\_BDL\_UPDT := 0

END: spark\_borderline\_main

9-19

IGNITION TIMING STRATEGY, SPARK FOR LOW LOAD OPERATING CONDITIONS - CDAN2

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9.6 SPARK FOR LOW LOAD OPERATING CONDITIONS (CDAA0)

OVERVIEW

Spark retard is used to increase catalyst temperatures by forcing increased

air mass flow. This approach is used in the Cold Start Low Load Spark and

Stabilized Low Load Spark strategies. A second application is to limit

piston slap (cold knock) at colder engine temperatures.

The Cold Idle Spark logic provides an upper clip for spark during cold

starts. The clip serves to retard the spark below MBT which causes the idle

speed control to deliver a higher air mass flow through the engine in order

to maintain the desired rpm. The higher air mass flow serves to heat the

catalyst so that it can begin to function sooner.

During extended idles the air mass flow is low enough that the catalyst cools

and becomes less efficient. The Stabilized Low Load strategy retards spark

under stabilized idle conditions to maintain catalyst temperature.

DEFINITIONS

INPUTS

Registers:

- AM = Air mass flow, lb/min.

- APT = At Part Throttle; -1 -> Closed throttle, 0 -> Part throttle, 1 ->

Wide Open throttle.

- ATMR3 = Time since entering run mode, sec.

- ECT = Engine coolant temperature, deg F.

- ISCFLG = ISC mode indicator flag; -1 -> Dashpot Mode, 0 -> Dashpot

Preposition Mode, 1 -> closed Loop RPM Control Mode, 2 -> Closed Loop RPM

Control (Lockout entry to RPM control).

- LOAD = Universal load variable. Normalized CYLARC\_BG divided by SARCHG,

unitless.

- N = Engine RPM.

- STB\_LOLD\_TMR = Timer to control spark clip for Stable Low Load

conditions, sec.

Calibration Constants:

- CLLS\_AT\_PT = Enables and disables the cold low load spark clip at part

throttle, unitless.

- FN012(LOAD) = Normalized LOAD for full-sized spark tables.

9-20

IGNITION TIMING STRATEGY, SPARK FOR LOW LOAD OPERATING CONDITIONS - CDAN2

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- FN013(LOAD) = Normalized LOAD for half-sized spark tables.

- FN016(N) = Normalized RPM for full-sized spark tables.

- FN017(N) = Normalized RPM for half-sized spark tables.

- FN018B(ATMR3) = ATMR3 normalizing function.

- FN020C(ECT) = Temperature normalizing function for ECT.

- FN741(STB\_LOLD\_TMR) = Ceiling for spark limiting for Stable Low Load

conditions.

- FN2000 = Maximum spark allowed during a cold start. This spark depends

on the coolant temperature which is essentially the temperature at the

start for the relatively short time during which this table is used.

X = FN020C(ECT)

Y = FN018B(ATMR3)

- FN2001 = Adds spark to the cold idle clip when the speed load point

results in an air mass flow which is high enough so that retarding spark

is not necessary to achieve catalyst light off. It also allows disabling

the clip when the load is high enough to indicate that the customer is

demanding performance.

X = FN017(N)

Y = FN013(LOAD)

- SPUCLP = Rotor registry upper clip, degrees BTDC.

- STAB\_LOLD\_AM = Value of AM below which spark may be clipped for Stable

Low Load conditions.

Bit Flags:

- DNDSUP = Delayed Neutral/Drive flag; 0 -> neutral, 1 -> drive.

OUTPUTS

Registers:

- SPK\_LOW\_LOAD = Emissions spark value at idle. It is the lower of the

Cold Low Load and Stable Low Load calculations.

- STB\_LOLD\_TMR = Timer to control spark clip for Stable Low Load

conditions, sec.

Bit Flags:

- SLL\_DWN\_FLG = Controls STB\_LOLD\_TMR; 1 -> decrement STB\_LOLD\_TMR, 0 -> no

change to STB\_LOLD\_TMR.

- SLL\_UP\_FLG = Controls STB\_LOLD\_TMR; 1 -> increment STB\_LOLD\_TMR, 0 -> no

change to STB\_LOLD\_TMR.

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IGNITION TIMING STRATEGY, SPARK FOR LOW LOAD OPERATING CONDITIONS - CDAN2

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PROCESS

STRATEGY MODULE: SPARK\_LOW\_LOAD\_COM1

Set SPK\_LOW\_LOAD to the more retarded of Cold Low Load and Stable Low Load

spark:

spk\_lo\_ld\_cold > spk\_lo\_ld\_stab ------| SPK\_LOW\_LOAD = spk\_lo\_ld\_stab

| spk\_source\_low = 6

|

| --- ELSE ---

|

| SPK\_LOW\_LOAD = spk\_lo\_ld\_cold

| spk\_source\_low = 7

Cold Idle Spark:

CLLS\_AT\_PT = 1 -----------------|

|OR --| spk\_lo\_ld\_cold = FN2000(ECT,ATMR3)

APT = -1 -----------------------| | + FN2001(N,LOAD)

(closed throttle) |

| --- ELSE ---

|

| spk\_lo\_ld\_cold = SPUCLP

Stabilized Low Load strategy:

DNDSUP = 0 ---------------------------| spk\_lo\_ld\_stab = FN741(STB\_LOLD\_TMR)

(in neutral) |

| --- ELSE ---

|

| spk\_lo\_ld\_stab = SPUCLP

ISCFLG > 0 ---------------------|

(RPM control or lockout) |

|AND -| Increment STB\_LOLD\_TMR

AM <= STAB\_LOLD\_AM -------------| | SLL\_UP\_FLG = 1

(Low exhaust flow) | SLL\_DWN\_FLG = 0

|

| --- ELSE ---

ISCFLG > 0 ---------------------| |

(RPM control or lockout) | |

|AND -| Decrement STB\_LOLD\_TMR

AM > STAB\_LOLD\_AM --------------| | SLL\_UP\_FLG = 0

(High exhaust flow) | SLL\_DWN\_FLG = 1

|

| --- ELSE ---

|

| STB\_LOLD\_TMR = 0

| SLL\_UP\_FLG = 0

| SLL\_DWN\_FLG = 0

9-22

IGNITION TIMING STRATEGY, TORQUE TRUNCATION VIA SPARK RETARD - CDAN2

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9.7 TORQUE TRUNCATION VIA SPARK RETARD (CDAE0)

OVERVIEW

Torque truncation is the reduction of spark in order to reduce the torque

delivered by the engine. This approach is used here for three different

problems:

1. Limit vehicle speed because of tire manufacturers speed

restrictions.

2. Limit engine torque in because under certain conditions some

automatic transmissions are unable to handle maximum engine torque.

3. Limit the rate of rise of engine torque during tip-ins to reduce

powertrain windup and impact caused by drive train lash.

DEFINITIONS

INPUTS

Registers:

- BG\_TMR = Background loop time, secs.

- DNDT\_SPK = Rate of change of engine RPM for use in tip in retard,

RPM/S\*S. This parameter is calculated at the start of the spark routine,

which means a recent value of DNDT is used.

- DNDT\_LST = Last pass value for DNDT\_SPK, RPM/S\*S.

- ECT = Engine coolant temperature, deg F.

- LOAD = Universal load variable. Normalized CYLARC\_BG divided by SARCHG,

unitless.

- N = Engine RPM.

- NOVS = Ratio of engine speed to vehicle speed used to infer transmission

gear, rpm/mph.

- SAF = Spark Advance Final, deg.

- SPK\_M\_B\_T = Spark advance required to achieve Maximum Brake Torque.

- SPK\_MBT\_LAST = Last pass value of SPK\_M\_B\_T, degrees.

- TIP\_ALLOW\_LD = Allowed load limit with spark assumed to be at MBT, for

tip in spark retard, unitless.

- TIP\_LAST\_LOAD = Last background loop load value, unitless.

9-23

IGNITION TIMING STRATEGY, TORQUE TRUNCATION VIA SPARK RETARD - CDAN2

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- TR\_TQ\_LIMIT = Torque ratio required to achieve TQ\_LIMIT.

- VSBAR = Filtered vehicle speed.

Bit Flags:

- FLG\_TQ\_TRUN = Torque truncation flag; 1 -> torque truncation required.

- HSPFLG = High speed mode flag; 1 -> high speed alternate fuel/spark.

Calibration Constants:

- SPK\_DNDT\_C = DNDT hysterysis to restore tip-in retard, RPM/S\*S.

- SPK\_TIP\_ECT = ECT below which tip-in retard is disabled, deg F

- SPK\_TIP\_NOVS = NOVS below which tip-in retard is disabled, RPM/MPH.

- SPK\_LDRATE = Allowable rate of increase in LOAD to determine tip-in

retard spark advance, LOAD/SEC.

- FN013(LOAD) = Normalized LOAD for half-sized spark tables.

- FN017(N) = Normalized RPM for half-sized spark tables.

- FN179(NOBAR) = Offset from SPK\_M\_B\_T which determines maximum allowable

spark when it is desired to limit vehicle speed through spark. This

function contains negative numbers indicating retard from SPK\_M\_B\_T.

- FN766 = Transfer function which calculates the torque ratio at which an

engine is operating from the spark delta from MBT.

- FN799(TIP\_TR or TR\_TQ\_LIMIT) = Transfer function which returns a spark

retard from MBT as a function of desired torque ratio, degrees.

- SPUCLP = Rotor registry upper clip, degrees BTDC.

- TIP\_MIN\_SPK = Spark calculated using the tip in spark retard strategy is

not allowed below this calibration parameter, degrees.

- TIP\_TR\_TRIG = Torque ratio above which tip in spark retard is disabled.

This is a fraction just less than 1, unitless.

9-24

IGNITION TIMING STRATEGY, TORQUE TRUNCATION VIA SPARK RETARD - CDAN2

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OUTPUTS

Registers:

- LAST\_LD\_MBT = Load from the last pass corrected to the value load would

have to have if spark was at MBT in order for the engine to generate the

same torque output.

- SPK\_TRUNC = Highest allowed value of spark for torque truncation reasons.

- TIP\_ALLOW\_LD = Allowed load limit with spark assumed to be at MBT, for

tip in spark retard, unitless.

- TIP\_DELTA = Incremental increase load (corrected to MBT) allowed for

current background loop, unitless.

- DNDT\_LST = Last pass value of DNDT\_SPK, RPM/S\*S.

- TIP\_LAST\_LD = Last background loop load value, unitless.

- TIP\_TR = Calculated torque ratio allowed for current background loop,

unitless.

9-25

IGNITION TIMING STRATEGY, TORQUE TRUNCATION VIA SPARK RETARD - CDAN2

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PROCESS

STRATEGY MODULE: SPARK\_TRQ\_TRNC\_COM1

Calculate the torque truncation spark, SPK\_TRUNC, as the lowest value of the

sources of torque truncation: 1) vehicle speed limiting, 2) low gear torque

limiting and 3) tip in torque retard:

spk\_trunc\_low > spk\_trunc\_tipret ------| SPK\_TRUNC = spk\_trunc\_tipret

| spk\_source\_trunc = 3

|

| --- ELSE ---

|

| SPK\_TRUNC = spk\_trunc\_low

| spk\_source\_trunc = spk\_source\_tlow

spk\_trunc\_vss > spk\_trunc\_gear --------| spk\_trunc\_low = spk\_trunc\_gear

| spk\_source\_tlow = 4

|

| --- ELSE ---

|

| spk\_trunc\_low = spk\_trunc\_vss

| spk\_source\_tlow = 5

Vehicle speed limiter. The spark speed limiter strategy must be coordinated

with the fuel speed limiter strategy.

HSPFLG = 1 ----------------------------| spk\_trunc\_vss = SPK\_M\_B\_T +

(vehicle speed too high) | FN179(NOBAR)

| --- ELSE ---

|

| spk\_trunc\_vss = SPUCLP

Torque truncation for transmission.

FLG\_TQ\_TRUN = 1 -----------------------| spk\_trunc\_gear =

| SPK\_M\_B\_T + FN799(TR\_TQ\_LIMIT)

|

| --- ELSE ---

|

| spk\_trunc\_gear = SPUCLP

9-26

IGNITION TIMING STRATEGY, TORQUE TRUNCATION VIA SPARK RETARD - CDAN2

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TIP-IN RETARD

Tip-in retard limits the rise in engine torque by comparing the ratio of the

desired torque to the actual torque if at MBT. Once this ratio is

calculated, the spark is retarded to reach the desired torque. Load is used

in this strategy instead of torque because it is roughly proportional to the

indicated torque and readily available and widely understood.

Calculate LAST\_LD\_MBT which is defined as the load from the last pass,

corrected to the value load would have to have if spark was at MBT in order

for the engine to generate the same torque output. The calculation uses the

last pass values of TIP\_LAST\_LD and SAF.

LAST\_LD\_MBT = TIP\_LAST\_LD \* FN766(SPK\_MBT\_LAST - SAF)

Calculate the allowable increase in torque expressed as load. If DNDT is

decreasing rapidly allow spark back to the maximum value (indicates engine

has moved through the lash region). Tip-in retard can be disabled in high

gears by NOVS. It can also be disabled at cold ECT if the spark retard

creates poor combustion issues at the low temperatures.

DNDT\_SPK < DNDT\_LST - SPK\_DNDT\_C -|

|

NOVS < SPK\_TIP\_NOVS --------------|OR --| TIP\_DELTA = 1

| |

ECT < SPK\_TIP\_ECT ----------------| |

| --- ELSE ---

|

| TIP\_DELTA = SPK\_LDRATE \* BG\_TMR

Calculate the allowed MBT load from the allowed load calculated last pass

using the last pass value of TIP\_ALLOW\_LD and the actual delivered MBT load,

LAST\_LD\_MBT.

TIP\_ALLOW\_LD < LAST\_LD\_MBT ------------| TIP\_ALLOW\_LD = TIP\_ALLOW\_LD +

| TIP\_DELTA

|

| --- ELSE ---

|

| TIP\_ALLOW\_LD = LAST\_LD\_MBT +

| TIP\_DELTA

9-27

IGNITION TIMING STRATEGY, TORQUE TRUNCATION VIA SPARK RETARD - CDAN2

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Prepare the uncompensated load, TIP\_LAST\_LD, and the current DNDT\_SPK for the

next pass:

TIP\_LAST\_LD = LOAD

DNDT\_LST = DNDT\_SPK

Using new values calculate the allowed torque ratio:

TIP\_TR = TIP\_ALLOW\_LD / LOAD

Make sure this value of spark is calculated only when tip in retard is

desired.

TIP\_TR < TIP\_TR\_TRIG ------------------| spk\_tip = SPK\_M\_B\_T +

| FN799(TIP\_TR)

|

| --- ELSE ---

|

| spk\_tip = SPUCLP

Do not allow a spark value below a calibratable minimum, TIP\_MIN\_SPK:

spk\_tip < TIP\_MIN\_SPK -----------------| spk\_trunc\_tipret = TIP\_MIN\_SPK

|

| --- ELSE ---

|

| spk\_trunc\_tipret = spk\_tip

9-28

IGNITION TIMING STRATEGY, MAXIMUM BRAKE TORQUE SPARK - CDAN2

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9.8 MAXIMUM BRAKE TORQUE SPARK (CDAL0)

OVERVIEW

The MBT spark calculation is used for real time torque calculations. The

calibration is provided by engine mapping. The use of a different

calibration will affect the torque accuracy. For this reason, the

calibration provided by engine mapping should not be modified.

DEFINITIONS

Registers:

- ECT = Coolant temperature degrees farenheit.

- EGRACT = Actual EGR rate.

- LOAD = Universal LOAD as ratio of air charge over standard.

- N = Engine speed RPM.

- SPK\_LAMBSE = The lambse value used in spark calculations. It is set

equal to 1 when fuel is in closed loop otherwise it is LAMBSE.

- SPK\_M\_B\_T = Spark advance required to achieve Maximum Brake Torque.

Degrees BTDC.

- SPK\_MBT\_IMRC = Maximum brake torque adder when using intake manifold

runner control, set to zero otherwise. Degrees, positive for advance.

- SPK\_MBT\_LAST = Last pass value of SPK\_M\_B\_T. Degrees BTDC.

- SPK\_MBT\_VCT = Maximum brake torque spark adder when using variable cam

timing, set to zero otherwise. Degrees, negative for retard, positive

for advance.

Calibration Constants:

- FN013(LOAD) = Normalized LOAD for half sized spark tables, unitless.

- FN014(ECT) = Normalized ECT for spark calculation, unitless.

- FN034A(LOAD) = Load normalizing function for torque calculation,

unitless.

- FN070C(N) = RPM normalizing function for torque calculation, unitless.

- FN730(SPK\_LAMBSE) = MBT spark adder for rich and lean A/F.

- FN731(LOAD) = Function of load which multiplies percent EGR for the

purpose of adjusting MBT spark.

- FN2300(N,LOAD) = MBT spark at 14.6 A/F and 0% EGR.

X = FN070C(N)

Y = FN034A(LOAD)

9-29

IGNITION TIMING STRATEGY, MAXIMUM BRAKE TORQUE SPARK - CDAN2

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- FN2320(ECT,LOAD) = Compensates MBT for engine coolant temperature.

X = FN014(ECT)

Y = FN013(LOAD)

9-30

IGNITION TIMING STRATEGY, MAXIMUM BRAKE TORQUE SPARK - CDAN2

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PROCESS

STRATEGY MODULE: SPARK\_MBT\_COM1

BEGIN: SPARK\_MBT

; This module executes each background loop. Note that it reads top down.

; Store MBT value calculated last background loop.

unconditionally ----------| SPK\_MBT\_LAST := SPK\_M\_B\_T

; Calculate maximum brake torque spark.

unconditionally ----------| SPK\_M\_B\_T := FN2300(N,LOAD)

| + FN2320(ECT,LOAD)

| + FN731(LOAD) \* EGRACT

| + FN730(SPK\_LAMBSE)

| + SPK\_MBT\_IMRC

| + SPK\_MBT\_VCT

END: SPARK\_MBT

9-31

IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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9.9 TORQUE-BASED FEEDBACK SPARK AT IDLE (CDAC0)

STRATEGY MODULE: SPARK\_IDLE\_FB\_COM5

OVERVIEW

The feedback spark strategy is a closed loop control algorithm which operates

at idle and attempts to maintain a desired engine rpm by increasing and

decreasing engine torque through spark advance adjustmnts. The controller

reacts to the rpm error from the desired rpm with a proportional correction

of spark. RPM control is accomplished in conjunction with the Idle Speed

Control and Fuel strategies. The reason that spark is used for this problem

is that spark advance is the quickest responding EEC output which directly

affects engine output torque. This spark strategy supplies engine torque

quickly and the correction disappears as the fundamental response of

increased air flow supplied by the ISC strategy phases in.

The approach to control rpm through spark advance adjustments is intuitively

understandable but the task of accomplishing it is complicated by two

nonlinearities. First, the relationship between spark advance and torque is

non-linear, and second, the relationship between an rpm error and torque is

non-linear. This strategy takes advantage of a torque ratio formulation

which results in three benefits:

1. The strategy linearizes the relationship between spark advance and

torque. In other words the requested torque is accurately delivered.

2. The desired torque compensation is correct regardless of engine operating

conditions such as rpm and load.

3. The control algorithm is calibratable with one parameter (SPK\_LOAD\_RES)

which effectively defines the amount of torque the strategy will supply

on demand. The operating spark which supplies this reserve of torque is

calculated in the strategy without additional calibration.

The strategy is based on mapping data supplied by the Calibration Optimzation

and Analysis section in PEDD. The data is entered into FN766 as shown below:

FN766

=====

1.0 |\*\*\*\*\*\*\*\*\*

Engine Torque | \*\*\*\*\*\*\*

------------- | \*\*\*\*

Torque @ MBT | \*\*\*

0.7 |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

0 30

Spark Retard from MBT (deg)

The input is the amount (a positive number) spark is retarded from MBT spark

advance in degrees. The output is the ratio of delivered engine torque at a

particular spark advance to the engine torque delivered when the engine is

operating at MBT. In other words, when the engine is operating at MBT the

torque ratio is 1, and when the operating point is retarded from MBT the

torque ratio will be a fractional dimensionless value such as .9 or .8.

9-32

IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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The strategy also requires the mirror image of this function. It is

calibrated in FN799:

FN799

=====

30 |\*\*\*\*\*\*\*\*\*\*

Spark Retard | \*\*\*\*\*\*\*

from MBT (deg) | \*\*\*\*\*

| \*\*\*

0 |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

0.7 1.0

Engine Torque

-------------

Torque @ MBT

The strategy is an implementation of the following calculation:

TORQUE RATIO ENGINE = TORQUE RATIO AVAILABLE

- TORQUE RATIO RESERVE

+ TORQUE RATIO CORRECTION

The components are defined as follows:

TORQUE RATIO ENGINE = Torque ratio to be supplied by the engine.

This value is called tr\_eng in the strategy and will be converted

to a spark advance by evaluating: SPK\_M\_B\_T + FN799(tr\_eng)

TORQUE RATIO AVAILABLE = This is the ratio of torque available for use.

It is the torque ratio supplied if the engine were to operate at

the absolute spark limit. It is typically calculated from the

equation: TR\_ABS = FN766(SPK\_M\_B\_T - SPK\_ABS\_LIM)

TORQUE RATIO RESERVE = This is a reserve of torque expressed as a torque

ratio which is created by retarding spark below MBT. This torque is

available to the controller to compensate for torque disturbances.

This reserve is essentially the only calibratable part of the

strategy. The desired torque to be held in reserve by operating

retarded from MBT is calibrated through the parameter SPK\_LOAD\_RES.

TORQUE RATIO CORRECTION = This is the amount of torque expressed as a

torque ratio which reflects a torque disturbance as measured by an

rpm error. This torque called TR\_COR in the strategy, compensates

for the torque disturbance. It is supplied by the engine as a result

of advancing spark.

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IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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These components are shown graphically below:

Engine Torque

Torque Ratio = -------------

Torque @ MBT

Torque Ratio = 1.0 -|--- Torque Ratio at MBT (a value of 1.0 is

| the maximum possible)

|

| This is torque which is not available

| because another calculation such as

| borderline spark has limitted spark.

|

---- TR\_ABS -|--- TORQUE AVAILABLE

{ |

{ | TORQUE RESERVE: Reserve of torque set

{ | aside for load rejection.

{ |

TR\_RES { tr\_eng -|--- Torque Ratio to be delivered by engine.

{ | } Defined: tr\_eng = TR\_ABS - TR\_RES + TR\_COR

{ | }

{ | } TORQUE CORRECTION: Engine torque

{ | } TR\_COR adjustment via spark in

{ | } response to a load disturbance

{ | } to the engine as measured by

---------------|--- an rpm error.

|

.

.

.

|

Torque Ratio = 0.0 -|

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IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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The relationships of the calculations are shown below via variable usage.

the entries in the boxes are headings of sections in the strategy.

SPK\_M\_B\_T SPK\_ABS\_LIM LAST\_LD\_MBT

| SPK\_FLEX\_LIM |

| | |

| | |

| | |

| | |

| | V

| | +-----------------+ +-------+

| | | DESIRED RESERVE | | SPARK |

| | | TORQUE RATIO | | STATE |

| | +-----------------+ +-------+

| | | |

| | | SPK\_STATE

| | tr\_res\_des |

| | | |

| | | +---------------+---+---------------+

| | | | | |

| | | | | |

| | | | | |

| | | | | |

| | V V V |

| | +----------------+ +------------+ |

| +------>| RESERVE TORQUE | | TORQUE | |

+--------------------->| RATIO | | CORRECTION | |

| +----------------+ +------------+ |

| | | |

| | | |

| TR\_RES TR\_COR |

| TR\_ABS | |

| | | |

| | | |

| +--------+ +----------+ |

| | | |

| | | |

| V V |

| +-------------+ |

+---------------------------------->| IDLE SPARK | |

+-------------+ |

| |

| |

SPK\_IDLE\_FB |

| |

V V

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IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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IDLE SPARK

DEFINITIONS

INPUTS

Registers:

- SPK\_M\_B\_T = Spark advance required to achieve Maximum Brake Torque.

- TR\_ABS = Torque ratio calculated from SPK\_ABS\_LIM, unitless.

- TR\_COR = Torque ratio correction required to respond to an rpm dip. This

term is in direct proportion to an rpm error from DSDRPM, unitless.

- TR\_RES = Torque ratio reserve which is created by retarding spark below

MBT. It is available to the system to be added to compensate for an rpm

error by advancing spark up to a maximum limit, unitless.

Bit Flags

- ALT\_CAL\_FLG = Determines when alternate anti plug fouling calibration

should be used; 1 -> use alternate calibration.

Calibration Constants:

- FN799(tr\_eng) = Transfer function which returns a spark retard from MBT

as a function of desired torque ratio, degrees.

- SPK\_FBS\_MIN = Most retarded spark allowed when in Feedback Spark.

- SPK\_ALT\_MIN = Most retarded spark allowed when in feedback spark and

running alternate anti plug fouling calibration.

OUTPUTS

Registers:

- SPK\_IDLE\_FB = Spark by Feedback Spark logic.

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IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

Calculate SPK\_IDLE\_FB:

spk\_feedback < SPK\_ALT\_MIN ------|

|AND -| SPK\_IDLE\_FB = SPK\_ALT\_MIN

ALT\_CAL\_FLG = 1 -----------------| | spk\_source\_fb = 8

|

| --- ELSE ---

|

spk\_feedback < SPK\_FBS\_MIN ------------| SPK\_IDLE\_FB = SPK\_FBS\_MIN

| spk\_source\_fb = 8

|

| --- ELSE ---

|

| SPK\_IDLE\_FB = spk\_feedback

| spk\_source\_fb = 9

spk\_feedback = SPK\_M\_B\_T + FN799(tr\_eng)

tr\_eng = TR\_ABS - TR\_RES + TR\_COR

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IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

RESERVE TORQUE RATIO

DEFINITIONS

INPUTS

Registers:

- BG\_TMR = Background loop time, secs.

- SPK\_ABS\_LIM = Spark is never allowed to go above this value because of

detonation, torque limitation or base spark requirements.

- SPK\_FLEX\_LIM = This is a desirable spark limit which may be exceeded

briefly when torque is required by a strategy such as feedback spark or

oscmod.

- SPK\_M\_B\_T = Spark advance required to achieve Maximum Brake Torque,

degrees.

- TP = Instantaneous throttle position, counts.

- TP\_LAST = Previous A to D reading of TP (throttle position), counts.

- TR\_RES = Torque ratio reserve which is created by retarding spark below

MBT. It is available to the system to be added to compensate for an rpm

error by advancing spark up to a maximum limit, unitless.

- tr\_res\_des = SPK\_LOAD\_RES expressed as a torque ratio with respect to the

current operating LOAD, unitless.

Calibration Constants:

- FBS\_ENTRY\_TC = Time constant which paces the entry into feedback spark,

sec.

- FKEXIT\_MIN = Minimum clip on the exit spark filter constant.

- FN766 = Transfer function which calculates the torque ratio at which an

engine is operating from the spark delta from MBT.

- TARMAX = Minimum value of TAR that will make "fkexit" = 1.0, degrees /

sec.

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IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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OUTPUTS

Registers:

- TP\_LAST = See above.

- TR\_ABS = Torque ratio calculated from SPK\_ABS\_LIM, unitless.

- TR\_RES = Torque ratio reserve which is created by retarding spark below

It is available to the system to be added to compensate for an rpm error

by advancing spark up to a maximum limit, unitless.

- TR\_RES\_LAST = Last pass value of TR\_RES, unitless.

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IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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PROCESS

Upon entry into SPK\_STATE 1, TR\_RES is ramped exponentially from a value of

tr\_flex to a value of tr\_res using a rolling average routine. It remains at

the latter value until the strategy exits via SPK\_STATE 3 to SPK\_STATE 0,

when it decays to a value of tr\_flex at a rate based on throttle angle rate:

the greater the throttle rate, the faster the decay.

Torque ratio reserve calculation:

SPK\_STATE = 1 -------------------------| TR\_RES\_LAST = TR\_RES

| TR\_RES = ROLAV(tr\_res,FBS\_ENTRY\_TC)

|

| --- ELSE ---

|

SPK\_STATE = 2 -------------------------| TR\_RES\_LAST = TR\_RES

| TR\_RES = tr\_res

|

| --- ELSE ---

|

SPK\_STATE = 3 -------------------------| TR\_RES\_LAST = TR\_RES

| TR\_RES = (1 - fkexit) \* TR\_RES

| + fkexit \* tr\_res\_base

| fkexit = spk\_tar / TARMAX

| Clip fkexit between

| FKEXIT\_MIN and 1

|

| --- ELSE ---

|

| TR\_RES\_LAST = TR\_RES

| TR\_RES = tr\_res\_base

Calculate the discrete derivative of throttle position. The factor of 9.57

is the conversion from Analogue to Digital counts into degrees of rotation.

As a result spk\_tar has units of degress per second:

| TP - TP\_LAST

TP - TP\_LAST > 0 ----------------------| spk\_tar = ------------

| BG\_TMR \* 9.57

| TP\_LAST = TP

|

| --- ELSE ---

|

| spk\_tar = 0

| TP\_LAST = TP

9-40

IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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Select the larger of the existing and desired reserve torque ratios:

tr\_res\_des > tr\_res\_base --------------| tr\_res = tr\_res\_des

|

| --- ELSE ---

|

| tr\_res = tr\_res\_base

Torque reserve which is already available due to the difference between the

absolute and flexible spark clips:

tr\_res\_base = TR\_ABS - tr\_flex

Torque ratio calculated from the absolute and flexible spark clips:

SPK\_M\_B\_T > SPK\_ABS\_LIM ---------------| TR\_ABS = FN766(SPK\_M\_B\_T -

| SPK\_ABS\_LIM)

| tr\_flex = FN766(SPK\_M\_B\_T -

| SPK\_FLEX\_LIM)

|

| --- ELSE ---

|

SPK\_M\_B\_T > SPK\_FLEX\_LIM --------------| TR\_ABS = 1

| tr\_flex = FN766(SPK\_M\_B\_T -

| SPK\_FLEX\_LIM)

|

| --- ELSE ---

|

| TR\_ABS = 1

| tr\_flex = 1

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IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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DESIRED RESERVE TORQUE RATIO

OVERVIEW

In order to have the ability to add torque to compensate for a torque

disturbance, it is necessary to design in a torque reserve which is always

available. It is desirable to define this reserve as a fixed value of

torque, however, torque is not measurable in EEC-IV strategies. Load can be

used instead of torque because they are directly proportional to each other.

Torque or load can be expressed as equivalent dimensionless ratios referred

to here as a torque ratio. When a ratio is used many simplifications occur

in the equations. The formulation shown allows the calibration of a torque

reserve which remains constant for all speed load combinations. The reserve

is created by retarding spark.

To determine the desired amount of torque reserve a procedure is recommended

where the calibrator operates the engine at a normal idle noting load and

rpm. He then applies an external load which is representative of the load

rejection desired. The engine is allowed to stabilize to the same rpm as

before and the increase in load required to maintain this rpm is calculated.

This increase in load is calibrated in SPK\_LOAD\_RES.

The amount of retard required to provide appreciable load rejection may

require an unacceptably large spark retard at idle. As a result feedback

spark may be used primarily for stabilizing the idle.

DEFINITIONS

INPUTS

Registers:

- LAST\_LD\_MBT = Load from the last pass corrected to the value load would

have to have if spark was at MBT in order for the engine to generate the

same torque output.

Calibration Constants:

- SPK\_LOAD\_RES = Desired torque (expressed as load) which the feedback

spark calculation can supply to compensate for a torque disturbance to

the engine, unitless.

OUTPUTS

Registers:

- tr\_res\_des = SPK\_LOAD\_RES expressed as a torque ratio with respect to the

current operating LOAD, unitless.

PROCESS

Calculate the desired reserve torque ratio using load corrected to its

equivalent value at MBT.

tr\_res\_des = SPK\_LOAD\_RES / LAST\_LD\_MBT

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IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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TORQUE CORRECTION

DEFINITIONS

INPUTS

Registers:

- DSDRPM = Idle speed control desired RPM.

- N = Engine RPM.

- SPK\_STATE = Defines the use of feedback spark; 0 -> feedback spark is not

being used, 1 -> transitioning into feedback spark, 2 -> using the

feedback spark calculation, 3 -> transitioning out of feedback spark.

Calibration Constants:

- FBS\_ENTRY\_TC = Time constant which paces the entry into feedback spark,

sec.

- SPK\_FBS\_GAIN = Feedback spark control proportional gain term. Normally

calibrated to one in order to exactly compensate for torque disturbances,

unitless.

OUTPUTS

Registers:

- TR\_COR = Torque ratio correction required to respond to an rpm dip. This

term is in direct proportion to an rpm error from DSDRPM, unitless.

PROCESS

tr\_cor = [(DSDRPM - N)/DSDRPM] \* SPK\_FBS\_GAIN

SPK\_STATE = 1 -------------------------| TR\_COR = ROLAV(tr\_cor,FBS\_ENTRY\_TC)

|

| --- ELSE ---

|

SPK\_STATE = 2 -------------------------| TR\_COR = tr\_cor

|

| --- ELSE ---

|

| TR\_COR = 0

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IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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SPARK STATE

DEFINITIONS

INPUTS

Registers:

- APT = At Part Throttle; -1 -> Closed throttle, 0 -> Part throttle, 1 ->

Wide Open throttle.

- DSDRPM = Idle speed control desired RPM.

- ISCFLG = ISC mode indicator flag; -1 -> Dashpot Mode, 0 -> Dashpot

Preposition Mode, 1 -> Closed Loop RPM Control Mode, 2 -> Closed Loop RPM

Control (Lockout entry to RPM control).

- SPK\_STATE = Defines the use of feedback spark; 0 -> feedback spark is not

being used, 1 -> transitioning into feedback spark, 2 -> using the

feedback spark calculation, 3 -> transitioning out of feedback spark.

- TR\_RES = Torque ratio reserve which is created by retarding spark below

MBT. It is available to the system to be added to compensate for an rpm

error by advancing spark up to a maximum limit, unitless.

- TR\_RES\_LAST = Last pass value of TR\_RES, unitless.

- VSBAR = Filtered vehicle speed.

Calibration Constants:

- DRBASE = Base desired engine speed in drive.

- FBS\_ENTRY\_TC = Time constant which paces the entry into feedback spark,

sec.

- MINMPH = Minimum speed to enter C/L RPM control. Applies to systems

having VSS. Should be set below the speed at which an automatic trans.

vehicle rolls along in drive without the brakes. This is to prevent

going into RPM control during parking lot maneuvers. Typical value - 3

MPH.

- NUBASE = Base desired engine speed in neutral.

- SPKCTL = Threshold above base DSDRPM, below which spark feedback can be

entered.

- TR\_DELTA = Deviation from TR\_RES which controls entry into feedback spark

state 2, unitless.

Bit Flags:

- DNDSUP = Delayed Neutral/Drive flag; 0 -> neutral, 1 -> drive.

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IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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OUTPUTS

Registers:

- SPKTMR = Timer used to pace the transition into feedback spark.

- SPK\_STATE = Defines the use of feedback spark, 0 -> feedback spark is not

being used, 1 -> transitioning into feedback spark, 2 -> using the

feedback spark calculation, 3 -> transitioning out of feedback spark.

PROCESS

Spark state transition logic:

SPK\_STATE = 0 -------------------|

(current state is 0) |AND -| SPK\_STATE = 1

| | (transition to idle spark)

fbs\_entry\_ok = 1 ----------------| | SPKTMR = 0

|

| --- ELSE ---

SPK\_STATE = 1 -------------------| |

(current state is 1) |AND -| SPK\_STATE = 3

| | (exit from idle spark)

fbs\_exit\_ok = 1 -----------------| | SPKTMR is running

|

| --- ELSE ---

SPK\_STATE = 1 -------------------| |

(current state is 1) |AND -| SPK\_STATE = 2

| | (start doing feedback spark)

fbs\_entry\_comp = 1 --------------| | SPKTMR is running

|

| --- ELSE ---

SPK\_STATE = 2 -------------------| |

(current state is 2) |AND -| SPK\_STATE = 3

| | (exit from idle spark)

fbs\_exit\_ok = 1 -----------------| | SPKTMR is running

|

| --- ELSE ---

SPK\_STATE = 3 -------------------| |

|AND -| SPK\_STATE = 1

fbs\_entry\_ok = 1 ----------------| | (transition back into state 1)

(see entry logic) | SPKTMR = 0

|

| --- ELSE ---

SPK\_STATE = 3 -------------------| |

|AND -| SPK\_STATE = 0

fbs\_exit\_comp = 1 ---------------| | (transition into state 0)

(see exit complete logic) | SPKTMR is running

|

| --- ELSE ---

|

| No change to SPK\_STATE

| SPKTMR is running

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IGNITION TIMING STRATEGY, TORQUE BASED FEEDBACK SPARK AT IDLE - CDAN2

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Entry conditions to spark state 1. Begin transition into feedback spark

calculation.

ISCFLG >= 1 ---------------------|

(rpm control or lockout) |

|

DNDSUP = 1 ----------| |AND -| fbs\_entry\_ok = 1

|AND -| | |

DSDRPM - DRBASE | | | |

<= SPKCTL ---| | | |

(near idle rpm) |OR --| |

| |

DNDSUP = 0 ----------| | |

|AND -| |

DSDRPM - NUBASE | |

<= SPKCTL ---| |

| --- ELSE ---

|

| fbs\_entry\_ok = 0

Entry conditions to spark state 3. Begin transition out of feedback spark

calculations.

APT >= 0 ------------------------|

(tip in) |OR --| fbs\_exit\_ok = 1

| |

VSBAR > MINMPH ------------------| |

(vehicle moving) |

| --- ELSE ---

|

| fbs\_exit\_ok = 0

Entry conditions to spark state 2. Entry transition to feedback spark is

complete, begin normal feedback spark calculation. Note: This calculation

uses last pass values for TR\_RES and TR\_RES\_LAST.

SPKTMR > FBS\_ENTRY\_TC \* 2 -------|

|OR --| fbs\_entry\_comp = 1

|TR\_RES\_LAST - TR\_RES| | |

< TR\_DELTA ------| |

| --- ELSE ---

|

| fbs\_entry\_comp = 0

Entry conditions to spark state 0. Exit transition from feedback spark is

complete, do not use the feedback spark calculation. Note: This calculation

uses last pass values for TR\_RES and TR\_RES\_LAST.

|TR\_RES\_LAST - TR\_RES| < TR\_DELTA -----| fbs\_exit\_comp = 1

|

| --- ELSE ---

|

| fbs\_exit\_comp = 0

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IGNITION TIMING STRATEGY, OSCILLATION MODULATION - CDAN2

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9.10 OSCILLATION MODULATION (CDAA0)

OVERVIEW

OSCMOD stands for oscillation modulation. Engine torque is modulated via

spark advance as a function of the rate of change of rpm in order to

stabilize oscillations in rpm. This is a derivative control method and

functions as a dashpot. This correction may be useful during closed throttle

or negative crowd decelerations to control shuffle. It can also be used

without interference with feedback spark. The areas and magnitude of

correction are controlled by non-zero values in FN2020.

DEFINITIONS

INPUTS

Registers:

- DNDT\_SPK = Filtered rate of change of RPM for OSCMOD spark, RPM/S\*S.

This parameter is calculated at the start of the spark routine which,

means a recent value of DNDT is used.

- LOAD = Universal load variable. Normalized CYLARC\_BG divided by SARCHG,

unitless.

- N = Engine speed in revolution per minute, RPM.

- NOVS = Ratio of engine speed to vehicle speed used to infer transmission

gear, rpm/mph.

- SPK\_OSC\_OFF = The amount by which the base spark calculation is reduced

to make room for an increase as calculated by the OSCMOD strategy.

Calibration Constants:

- FN013(LOAD) = Normalized LOAD for half-sized spark tables.

- FN017(N) = Normalized RPM for half-sized spark tables.

- FN745(DNDT\_SPK) = Adds spark in order to add torque when engine rpm is

dropping and takes spark away when rpm is increasing. A value of -1

returns all the spark taken out with FN2020.

- FN746(NOVS) = Engine torque transmission is lower in higher gears

(calibrate to a value less than one) reducing the need for the OSCMOD

relative to first gear (calibrate to one), unitless.

- FN2020 = Reduces base spark in order to reduce torque so that there is a

reserve of torque available to be added back in as determined by the

SPK\_OSCMOD calculation.

X = FN017(N)

Y = FN013(LOAD)

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IGNITION TIMING STRATEGY, OSCILLATION MODULATION - CDAN2

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OUTPUTS

Registers:

- SPK\_OSC\_OFF = See above.

- SPK\_OSCMOD = OSCMOD correction to other spark calculations.

PROCESS

STRATEGY MODULE: SPARK\_OSCMOD\_COM1

SPK\_OSCMOD = SPK\_OSC\_OFF \* FN745(DNDT\_SPK)

SPK\_OSC\_OFF = FN2020(N,LOAD) \* FN746(NOVS)

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IGNITION TIMING STRATEGY, TORQUE MODULATION BACKGROUND CALCULATION - CDAN2

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9.11 TORQUE MODULATION BACKGROUND CALCULATION (CDAK0)

OVERVIEW

The transmission strategy calculates the maximum torque required during a

shift (TQ\_LEVEL). The ratio between TQ\_LEVEL and TQ\_MBT is calculated and

used in FN799 to calculate the amount spark must be retarded from MBT in

order to achieve the required torque. The actual spark advance required to

give the required torque (SAF\_DES) is then calculated by subtracting that

amount from the MBT spark advance.

Maximum spark advace is clipped based on transmission oil temperature

(FLG\_TQM\_ENA ). In addition, there is a unconditional maximum clip on the

spark retard requested .

Spark is ramped at the start and end of torque modulation. At the start of

toruqe modulation, a slope (SPKSLP) for the spark ramp is calculated based on

the differential amount of spark retard requested (SAFTOT - SPK\_DELT\_OUT).

and the time calibrated (SPK\_TM\_OUT). At the end of the shift, spark is

stepped back in via discrete steps (SPK\_DELT\_IN) until spark is returned to

its normal state (SAFTOT = SAF\_DES) or the ramp timer expires (SPK\_TM\_IN).

DEFINITIONS

INPUTS Registers:

- GR\_CM = Commanded gear for shift solenoids.

Bit Flags:

- FLG\_SPK\_TQM = Torque modulation spark retard flag.

- FLG\_TQM\_ENA = Flag to signal transmission is sufficiently warmed up to

permit full control over spark retard via torque modulation.

- FLG\_UP\_TQM = Upshift torque modulation flag.

Calibration Constants:

- FN799 = Transfer function which returns a spark retard from MBT as a

function of desired torque ratio, deg.

- SPKDELT = Delta spark stepped in at end of upshift torque modulation,

deg.

- SPKDELT2 = Delta spark stepped in at end of 1-2 upshift torque

modulation, deg.

- SPKTM2\_IN = Time to ramp spark in for 1-2 upshift toruqe modulation,

msec.

- SPKTM2\_OUT = Time to ramp spark out for 1-2 upsfhit torque modulation,

msec.

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IGNITION TIMING STRATEGY, TORQUE MODULATION BACKGROUND CALCULATION - CDAN2

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- SPKTM\_IN = Time to ramp spark in for upshift torque modulation, msec.

- SPKTM\_OUT = Time to ramp spark out for upshift torque modulation, msec.

- TQM\_COLD\_CLP = Maximum delta spark clip for torque modulation; cold

powertrain, deg.

- TQM\_MAX\_CLP = Maximum delta spark clip for torque modulation, deg.

OUTPUTS

Registers:

- RAMP\_TM\_IN = Default time for spark ramp at end of torque modulation,

msec.

- RAMP\_TM\_OUT = Default time for spark ramp start of torque modulation,

msec.

- SAF\_DES = Spark advance required to achieve the desired torque level

during torque modulation, deg.

- SAFTOT = Total spark advance, deg.

- SPK\_M\_B\_T = Spark advance required to achieve maximum brake torque, deg.

- SPKSLP = Spark ramp rate for torque modulation, deg/msec.

- TQ\_MBT = Maximum net torque that could be produced by the engine, ft-lbs.

- TQ\_LEVEL = Maximum torque required by transmission for torque modulation,

ft-lb.

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IGNITION TIMING STRATEGY, TORQUE MODULATION BACKGROUND CALCULATION - CDAN2

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PROCESS

STRATEGY MODULE: SPARK\_TQM\_BG\_COM5

always --------------------------| tr\_mod = TQ\_LEVEL / TQ\_MBT

| delta\_mod = FN799(tr\_mod)

FLG\_TQM\_ENA = 0 -----------|

|AND -| SAF\_DES = SPK\_M\_B\_T + delta\_mod

delta\_mod > TQM\_COLD\_CLP --| |

| --- ELSE ---

|

FLG\_TQM\_ENA = 0 -----------------| SAF\_DES = SPK\_M\_B\_T + TQM\_COLD\_CLP

| (clip spark if powertrain is cold)

|

| --- ELSE ---

FLG\_TQM\_ENA = 1 -----------| |

|AND -| SAF\_DES = SPK\_M\_B\_T + delta\_mod

delta\_mod > TQM\_MAX\_CLP ---| |

| --- ELSE ---

|

FLG\_TQM\_ENA = 1 -----------------| SAF\_DES = SPK\_M\_B\_T + TQM\_MAX\_CLP

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IGNITION TIMING STRATEGY, TORQUE MODULATION BACKGROUND CALCULATION - CDAN2

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GR\_CM = 2 -----------------|

|

FLG\_UP\_TQM = 1 ------------|AND -| SPKSLP = (SAFTOT - SAF\_DES)/

| | SPKTM2\_OUT

FLG\_SPK\_TQM = 0 -----------| | (If SPKTM2\_OUT = 0, set SPKSLP

| to its max value)

| SPK\_DELT\_IN = SPKDELT2

| RAMP\_TM\_IN = SPKTM2\_IN

| RAMP\_TM\_OUT = SPKTM2\_OUT

|

| --- ELSE ---

FLG\_UP\_TQM = 1 ------------| |

|AND -| SPKSLP = (SAFTOT - SAF\_DES)/

FLG\_SPK\_TQM = 0 -----------| | SPKTM\_OUT

| (If SPKTM\_OUT = 0, set SPKSLP

| to its max value)

| SPK\_DELT\_IN = SPKDELT

| RAMP\_TM\_IN = SPKTM\_IN

| RAMP\_TM\_OUT = SPKTM\_OUT

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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9.12 KNOCK CONTROL STRATEGY (CDAN0)

OVERVIEW

The knock control strategy consists of many different sub-strategy pieces.

Some are executed in background, but most are executed in foreground, since

knock is a PIP period related event. The sub-strategies are:

1) KNOCK STRATEGY ENABLE LOGIC (background) This logic determines whether

engine conditions are correct for using the knock strategy.

2) RETARD AND WINDOW CALCULATIONS (background) This logic determines the

knock window position and window width as well as potential retard

increment in background. This is done to ease foreground load.

3) TIP IN SENSE LOGIC (background) This logic anticipates tip in detonation

by sensing rapid tip-ins from closed throttle and setting a flag which is

used by the foreground to retard the spark.

4) KNOCK WINDOW OUTPUT (PIP rising edge) This logic outputs the knock

window, KTS output, at the background determined location relative to

PIP.

5) KNOCK DETECTION LOGIC (PIP rising edge) This logic determines if a

cylinder is knocking by processing the knock indicated input.

6) TIP IN RETARD LOGIC (TIPRET) (PIP rising edge) This logic retards and

advances spark based on tip in conditions.

7) KNOCK RETARD LOGIC (PIP rising edge) This logic retards the SPKAD term

based on knock sensed by the knock detection logic.

8) SPARK ADVANCE LOGIC (background) This logic advances the SPKAD terms to

the advance limit (knk\_advlim) at a calibratable rate.

The logic segments that follow match the order of software execution. The

numbers point to the above descriptions.

DEFINITIONS

Registers:

- ACT = Air charge temperature deg. faren.

- DT12S = Period of time between two adjacent rising edges of PIP, ticks.

- ECT = Engine coolant temperature, deg F.

- ER\_LAM\_DSD = LAMBSE value requested by engine running in-demand self

test.

- ER\_SPARK = Required value of SAF during on demand self test.

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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- ER\_STATUS = State pointer that indicated current state of engine running

on-demand test.

- KNK\_ADVLIM\_D = DISPLAY ONLY; knock advance limiter from FN1135.

- KWCTR = Cancel window counter incorporated each PIP period.

- LOAD = Universal normalized load parameter, unitless.

- N = Engine speed, RPM.

- RETINC = Calculated as a function of RPM and is subtracted from each

SPKAD corresponding to a knocking cylinder. (positive degree)

- RETMAX = Knock retard limit, degrees.

- SAFTOT = Total spark advance.

- SPKAD = Spark adder term. It is added to SAF, may be positive or

negative degrees.

- SPK\_MBT\_DELT = Difference between MBT spark and SAFTOT.

- SPK\_TIPMAX = Initial amount of retard following a Tip-in. (Must be a

negative number; units are degrees)

- TBART = Average Filtered Throttle Position = ROLAV (TP,TCTPT)

- TCF = Value of the difference between Throttle position (TP) and TBART.

- TIPRET = Tip-in retard.

- TIP\_COUNT = Number of PIP cycles that have elapsed following a tip-in

retard.

- TP = Instantaneous throttle position, counts.

- TSLADV = Free-running millisecond timer which counts the time since the

spark was last advanced by the KNOCK Strategy.

- WINDOW\_BETA = Fraction of PIP period at which to issue knock window.

- WINDOW\_DELTA = Knock window width, clock ticks.

Bit Flags:

- CTFLG = 1 -> closed throttle Tip-in.

- GOOS\_KNK\_DET = Knock detected during goose test.

- KNK\_HIGH = Knock input level.

- KNK\_INT = Knock data available when set.

- KNOCK\_DETECTED = 1 -> Knock occured in current PIP half period.

- KNOCK\_ENABLED = Knock Strategy enabled.

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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- KNOCK\_OCCURRED = 1 -> (in the knock routine) knock occured in the current

or last PIP period.

- NEW\_PIP = New PIP rising edge occurred this background loop.

- PIP\_HIGH = PIP input level.

- PxxxMALF = Malfunction flag for code PXXX; 1 -> a malfunction currently

exists for fault PXXX.

- SYNFLG = SYNCTR in SYNC with SIG PIP.

- TIPFLG = 1 -> Tip-in.

- VIP\_KNOCK = Knock was detected in VIP mode when set.

Calibration Constants:

- ECTIP = Minimum ECT to enable Tip-in Retard, deg F.

- ECTNOK = Disable Knock control below this value of ECT, deg F.

- FN013(LOAD) = Load normalizing function; used for table lookup.

Input = Load

Output = Normalized load

- FN013A(LOAD) = Load normalizing function; used for table lookup.

Input = Load

Output = Normalized load

- FN017(N) = Engine speed normalizing function; used for table lookup.

Input = N (rpm)

Output = Normalized N (rpm)

- FN017C(N) = Engine speed normalizing function; used for table lookup.

Input = N

Output = Normalized N

- FN030A(ACT) = KTS window multiplier based on air charge temperature.

Input = ACT

Output = KTS window multiplier.

- FN033A(ACT) = Air charge temperature normalizing function; used for table

lookup.

Input = ACT

Output = Normalized ACT

- FN070(N) = Engine speed Normalizing function; used for table lookup.

Input = N

Output = Normalized N

- FN070F(N) = Engine speed normalizing function; used for table lookup for

FN1144C(N,LOAD).

Input = N

Output = Normalized N

- FN070O(N) = Engine speed normalizing function for

FN1147B(N,SPK\_MBT\_DELT).

Input = N

9-55

IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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Output = Normalized N

- FN071(LOAD) = Load normalizing function; used for table lookup.

Input = LOAD

Output = Normalized load

- FN071A(LOAD) = Load Normalizing function; used for table FN1144C.

Input = LOAD

Output = Normalized load

- FN097B(SPK\_MBT\_DELT) = Normalizing function for retard from MBT.

Input = SPK\_MBT\_DELT

Ouput = Normalized SPK\_MBT\_DELT

- FN143A(N) = Retard increment versus RPM, deg.

- FN145A(N) = Variable knock threshold window position. Input = engine

Speed in RPM Output = fraction of PIP period.

- FN146B(N) = Spark advance Rate versus RPM, sec/deg.

- FN1132(ACT,LOAD) = Knock retard limit adder, degrees.

X = FN033A(ACT)

Y = FN013A(LOAD)

- FN1134(N,LOAD) = Nominal knock retard limit based on engine speed and

load, degrees.

X = FN017C(N)

Y = FN013A(LOAD)

- FN1135(N,LOAD) = Knock advance limit table as a function of RPM and LOAD,

deg. If FN1135 is calibrated to 0, the knock strategy will not be able

to advance spark past SAF. FN1135 is an 8 X 10 table and shares

normalizing functions with all the other spark tables.

X = FN070(N)

Y = FN071(LOAD)

FN1135(N,LOAD) is stored as KNK\_ADVLIM\_D for ease of development.

- FN1144C(N,LOAD) = Variable knock threshold window open time, fraction of

PIP period.

X = FN070F(N)

Y = FN071A(LOAD)

- FN1147B(N,SPK\_MBT\_DELT) = KTS window modifier based on retard from MBT.

X = FN070O(N)

Y = FN097B(SPK\_MBT\_DELT)

- FN2290(N,LOAD) = Initial retard angle following a tip-in.

X = FN017(N)

Y = FN013(LOAD)

- GOOSE\_KTS\_B = Knock window width during goose test, fraction of PIP

period.

- GOOSE\_LAM = Required value of LAMBSE during goose test, unitless.

- GOOS\_ER\_CODE = Value of ER\_STATUS to indicate that goose response

detected.

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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- GOOS\_ER\_INIT = Value for state of ER\_STATUS to initialize the goose test.

- GOOS\_ER\_TEST = Value for state of ER\_STATUS to require goose test to be

run.

- GOOS\_SPK\_INT = Spark advance used during goose test to induce knock, deg.

- GOOS\_SPK\_TST = Spark advance used during goose test once knock has been

detected, deg.

- KACRAT = Change in TP equivalent to a Tip-in Retard, counts.

- KIHP = Knock Hardware Present Switch; 1 -> Knock sensor present.

- LODNOK = Minimum load for knock control, unitless.

- NTIP = Maximum RPM to enable Tip-in retard (restricted to less than or

equal to 2000 to assure TIPRET ramp back function.)

- RPMCNL = Threshold RPM below which the window is always open.

- RPMMIN = Disable Knock control below this RPM.

- RPMMAX = SPKAD is not updated above this RPM.

- TCTPT = Time constant for TBART (TP filter).

- TIPINC = Advance per PIP following a Tip-in retard. (Must be a positive

number; units are degrees)

- TIPLOD\_SL = Maximum Load to set CTFLG for Tip-in Retard.

- TIPLOD\_CH = Minimum Load to clear CTFLG for Tip-in Retard.

- TIP\_RMP\_DLY = Number of PIP cycles to delay ramping back spark following

a tip-in retard.

- WINCLD = Number of PIPs threshold window is to be closed.

- WINLEN\_B = Minimum amount of time threshold window is open, fraction of

PIP period.

- WOPEN = Position of window opening, fraction of PIP period.

OTHER

- spark\_codes = set of {P0325}.

- P0325 = Fault code, for knock sensor failure.

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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PROCESS

STRATEGY MODULE: SPARK\_CYL\_KNOCK\_COM1

Background module KNK\_WINDOW\_CALCULATION

(called from background manager)

RETARD AND WINDOW CALCULATIONS

NEW\_PIP = 1 -----------------------------| WINDOW\_BETA = WOPEN + FN145A(N)

(new PIP came in this | (calculate window opening as a

background loop) | fraction of PIP period)

| SPK\_MBT\_DELT := SPK\_M\_B\_T - SAFTOT

| WINDOW\_DELTA :=

| [ WINLEN\_B

| + FN1144C(N,LOAD)

| - FN1147B(N,SPK\_MBT\_DELT) ]

| \* FN030A(ACT)

| \* DT12S

|

| (calculate window width in

| clock ticks)

| RETINC = FN143A(N)

| (determine retard amount in case

| of knock)

| RETMAX = FN1134(N,LOAD)

| + FN1132(ACT,LOAD)

| (maximum retard allowed)

ER\_STATUS = GOOS\_ER\_INIT ----------------| WINDOW\_DELTA =

| GOOSE\_KTS\_B \* DT12S

| (Window width used during

| goose test)

| ER\_SPARK = GOOS\_SPK\_INT

| (Set initial spark advance

| for goose test)

| ER\_LAM\_DSD = GOOSE\_LAM

| (set lambse for goose test)

| GOOS\_KNK\_DET = 0

| (Clear knock detected during

| goose test flag)

|

| --- ELSE ---

|

ER\_STATUS = GOOS\_ER\_TEST ----------------| WINDOW\_DELTA =

| GOOSE\_KTS\_B \* DT12S

| (Window width used during

| goose test)

|

| --- ELSE ---

ER\_STATUS = GOOS\_ER\_CODE ----------| |

|AND -| store\_code(P0325)

GOOS\_KNK\_DET = 0 ------------------| | P0325MALF = 1

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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8)

SPARK ADVANCE LOGIC

NEW\_PIP = 1 -----------------------|

|

KNOCK\_ENABLED = 1 -----------------|

|AND -| SPKAD = SPKAD + 0.25 deg

TSLADV >= FN146B/4 ----------------| | clip SPKAD to

| | FN1135(N,LOAD) as a maximum

N < RPMMAX ------------------------| | TSLADV = TSLADV - FN146B/4

NOTE: FN1135 is stored as KNK\_ADVLIM\_D for ease of development.

If the Knock Strategy is enabled and engine speed is less than RPMMAX, the

spark adder SPKAD is incremented 0.25 degrees every FN146B/4 seconds. SPKAD

is clipped to FN1135(N,LOAD) as a maximum. If FN1135 = 0, the KNOCK STRATEGY

will not advance the spark beyond SAF.

NOTE: If the Knock Strategy is enabled and no cylinders are knocking, the

spark to each cylinder will advance to SAF + FN1135 If a particular cylinder

is knocking, the Retard Strategy will tend to dominate the advancing

mechanism. To insure that the spark to knocking cylinders is retarded more

than the strategy can advance it, FN146B should be greater than or equal to

1/FN143A. FN146B is in degrees of advance per second while FN143 is in

degrees of retard per PIP, therefore, FN143 must be converted to degrees per

second at a given RPM for a valid comparison to be made. When FN146B is

large, then the spark advance rate is small. For example, FN146B = 0.5 is

equivalent to a spark advance rate of 2 degrees/sec. FN146B = 0.25 is

equivalent to spark advance rate of 4 degrees/sec.

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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3)

TIP IN SENSE LOGIC

This logic responds to Tip-in detonation, and even to potential Tip-in

detonation, by retarding the spark TIPRET degrees.

Tip-in detonation is a result of the relatively slow response of both LOAD

and N, which are average values during a PIP period, to the sudden increase

in manifold pressure and decrease in engine speed, respectively, which occur

within a PIP period during a Tip-in. The result is that the delivered spark

is over-advanced for the instantaneous conditions until the LOAD calculation

has updated to reflect the higher manifold pressure and the engine speed has

recovered. The recovery from a Tip-in is normally complete within a few PIP

periods.

The KNOCK STRATEGY is designed to anticipate detonation following a Tip-in

from idle (the worst case Tip-in condition) and respond by retarding the

spark before detonation occurs. Tip-in from part- throttle results in

retarded spark only if knock is sensed. In both cases, Tip-in retard is

applied to whichever cylinders follow the Tip-in, not to individual cylinders

as is usually done in the individual cylinder knock strategy. Thus, there is

no need to wait an entire engine cycle before responding to Tip-in

detonation.

The Tip-in condition is recognized by comparing TP to a filtered TP, called

TBART. (NOTE that TBART is initialized to the same initialization value as

RATCH) If TCF, the difference between TP and TBART, exceeds KACRAT, and if

either the Tip-in occurred from idle or if the knock is sensed following a

Tip-in from part-throttle, then the spark for the next PIP is retarded by

TIPMAX degrees. On the ensuing PIPS, the amount of retard is decremented by

TIPINC degrees until all Tip-in retard is removed. The Tip-in logic can be

disabled by setting KACRAT = 1023.

always ----------------------------------| TBART = ROLAV(TP,TCTPT)

| (filter TP for rate calculation)

| TCF = TP - TBART

LOAD < TIPLOD\_SL ------------------|S Q -| CTFLG

|

LOAD > TIPLOD\_CH ------------------|C

ECT > ECTIP -----------------------|

|

TCF >= KACRAT ---------------------|

|AND -| TIPFLG = 1

N < NTIP --------------------------| |

| |

CTFLG = 1 -------------------------| |

(last pass value) |

| --- ELSE ---

|

| TIPFLG = 0

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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Logic to set amount of tip-in retard based on engine speed and load. This is

done to optimize tip-in knock control and engine power at all engine speeds

and loads so that the worst-case retard angle does not have to be used all

the time.

always -----------------| SPK\_TIPMAX = FN2290(N,LOAD)

1)

KNOCK STRATEGY ENABLE LOGIC

KIHP = 1 --------------------------|

|

LOAD > LODNOK ---------------------|

|

ECT > ECTNOK ----------------------|

|

N > RPMMIN ------------------------|AND -| KNOCK\_ENABLED = 1

| |

SYNFLG = 1 ------------------------| |

| --- ELSE ---

|

| KNOCK\_ENABLED = 0

| TSLADV = 0

| SPKAD = 0

LODNOK, ECTNOK, and RPMMIN define the minimum engine operating conditions to

enable the Knock Control Strategy.

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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4)

KNOCK WINDOW OUTPUT (KTS)

The software periodically opens a window which allows a Noise threshold

charging pulse called KTS to raise the Knock Threshold level of the Hardware

circuit. The window always opens once per PIP period unless the RPM exceeds

RPMCNL. The engine developer defines the window during which the charging

pulse is on by means of two fox functions and two calibration constants. The

pulsewidth of KTS defines the period of time that the capacitor in the RC

circuit will be charged. Wide KTS pulses cause the threshold to increase. The

timing of the KTS pulse must coincide with the optimum non-knocking portion

of the PIP period over all engine RPM. Since Knock tends to to extend longer

through the PIP period with increasing RPM, the KTS pulse should be timed

late in the current PIP period or early in the following PIP period (95-110%

PIP period).

Noise threshold elevation will result when the capacitor charging rate

greatly exceeds the discharge rate or when the KTS pulse is output during

conditions of Knock. When knock occurs at high RPM, the charging pulse window

is kept closed for WINCLD PIP periods to prevent elevating the NOISE

threshold to the level of KNOCK, thereby preventing the EEC hardware circuit

from sensing additional spark knock.

The calculations shown below are checked every rising edge of PIP:

The pulsewidth of KTS is equal to:

WINDOW\_DELTA = [WINLEN\_B + FN1144C(N,LOAD) - FN1147B(N,SPK\_MBT\_DELT)] \*

FN030A(ACT) \* DT12S in clock ticks

Where, WINLEN\_B is minimum KTS pulsewidth, as a fraction of PIP period,

FN1144C(N,LOAD) is expressed as a fraction of PIP period.

The timing of KTS is equal to:

WINDOW\_BETA = WOPEN + FN145A(N), fraction of PIP period

Where, WOPEN is the minimum delay after the rising edge of PIP before the

KTS pulse will be output,

FN145A(N) is a fraction of PIP period.

Note: The KTS pulse is output even if the knock strategy is disabled to

refresh the threshold level in the event that the Knock strategy becomes

enabled. The absence of the KTS pulse for more than a few PIP periods would

result in full retard upon entering Knock strategy.

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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5)

KNOCK DETECTION LOGIC

Foreground module SINGLE\_KNOCK (EOS\_WINDOW\_OUTPUT)

KIHP = 0 --------------------------------| NO KNOCK SENSOR

| Do not output KTS

|

| --- ELSE ---

N <= RPMCNL -----------------------| |

| |

KWCTR >= WINCLD -------------------|OR --| KWCTR = 0

| | OPEN WINDOW AT CALCULATED TIME

KWCTR = 0 -------------------| | |

|AND -| |

KNOCK\_DETECTED = 0 ----------| |

(no KNOCK in current PIP half period) |

| --- ELSE ---

|

| INCREMENT KWCTR

| DO NOT OPEN WINDOW

RPMCNL is the threshold RPM below which the WINDOW is always open. The

WINDOW is not opened during a signature PIP period (if Signature PIP

distributor is present), or if KNOCK has been detected during the current PIP

first half period.

Foreground segment located in PIP\_DATA.

KNOCK\_DETECTED = 1 ----------------|

|AND -| KNOCK\_OCCURRED = 1

KNK\_HIGH = 1 ----------------------| |

| --- ELSE ---

KNOCK\_DETECTED = 1 ----------------| |

|AND -| KNOCK\_OCCURRED = 1

KNK\_HIGH = 0 ----------------------| | KNOCK\_DETECTED = 0

(KI currently indicates |

NO KNOCK) |

| --- ELSE ---

|

| KNOCK\_OCCURRED = 0

Foreground module SINGLE\_KNOCK (EOS\_INPUT)

KIHP = 0 --------------------------------| Prevent knock interrupts

| from being recognized

|

| --- ELSE ---

|

KNK\_INT = 1 -----------------------------| Service knock input handler

(Knock input transition occurred) | KNOCK\_DETECTED = 1

| VIP\_KNOCK = 1

| KNK\_INT = 0

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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KNOCK SIGNAL DETECTION

: :

:............. PIP PERIOD ..............:

: :

--------------------- ----------

| | |

PIP | | |

| | |

------ ---------------------

: :

:<-- WINDOW\_BETA = WOPEN + FN145A(N) --> :

: :

------ ------

| | | |

KTS --->| |<--- WINDOW\_DELTA = | |

| | [WINLEN\_B + FN1144C]\*DT12S | |

---------- ------------------------------------ ----

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: : \* \* : :

: :------- \* \* : :---

NOISE : /: ----\*-- \* : /:

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: : \* : : \* : :

KNOCK : : \* : : \* : :

SENSOR : : \* : : \* : :

\*\*\*\*\*\*\*\*\*\*\*\*\* : : \*\*\*\*\*\*\*\*\*\*\*\*

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--------------

| |

KI | |

| |

----------------------- -------------------

(IF KNOCK > NOISE, KI=1; OTHERWISE, KI=0)

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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|<--"LAST PIP PERIOD"-->|

\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_

| | | | |

| | | | |

| | | | |

PIP \_\_\_| |\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_|

|<-----------A------->|

\_\_\_\_\_ \_\_\_\_\_

| | | |

|<B>| | | | | | |

| | | |

KTS \_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_

| |

| | | | | | |

| |

KI ---------| |------------------------------------

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| | | | |

KNOCK \_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|\_\_\_\_

DETECTED

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| |

| | | | |

| |

KNOCK \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_

OCCURRED

Where A = (WOPEN + FN145A)\*("LAST PIP PERIOD")

B = [WINLEN\_B + FN1144C]\*DT12S = KTS

Note: Range of A is typically 90 - 110 % of PIP period.

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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6)

TIP IN RETARD LOGIC (TIPRET)

Foreground segment in HDR\_SPOUT\_KNOCK\_CALCULATION

The following Tip-in logic is checked before SPOUT issues (rising or falling edge

of PIP). Note that the tip-in retard spark value is based on engine speed and

load and is calculated in the background tip-in sense logic.

This logic includes a delay before spark is ramped back following a tip-in retard.

The logic waits TIP\_RMP\_DELAY PIP cycles before performing the ramp.

TIPRET = 0 ------------------------|

|AND -| TIPRET := SPK\_TIPMAX

TIPFLG = 1 ------------------------| | TBART := TP

| TIP\_COUNT := 0

|

| --- ELSE ---

|

TIP\_COUNT >= TIP\_RMP\_DLY ----------| |

| |

TIPRET <> 0 -----------------------|AND -| TIPRET := TIPRET + TIPINC

| | ; Clip max TIPRET to 0

PIP\_HIGH = 1 ----------------------| |

|

| --- ELSE ---

|

TIPRET <> 0 -----------------------| |

|AND -| TIP\_COUNT := TIP\_COUNT + 1

PIP\_HIGH = 1 ----------------------|

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IGNITION TIMING STRATEGY, KNOCK CONTROL STRATEGY - CDAN2

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7)

KNOCK RETARD LOGIC

Whenever the Knock strategy is enabled, the software calculates RETINC in

background as a function of RPM. RETINC is subtracted from SPKAD. To prevent

excessive retard (perhaps due to erroneous knock sense) SPKAD is clipped to

RETMAX.

During a particular PIP period, the software makes adjustments to SPKAD based on

whether Knock was sensed during the previous PIP period and uses SPKAD, calculated

during the previous engine cycle (NUMCYL PIP periods ago) to determine the final

value of spark advance for the next spark output. If knock is detected during the

goose test (on demand self test), the GOOS\_KNK\_DET flag is set and the spark

advance set to a new lower value. Spark advance would have been set to a high

value in order to induce knock. Once knock is detected, spark advance is reduced

to avoid engine damage.

If the engine speed is greater than RPMMAX, SPKAD is not updated.

Foreground segment in HDR\_SPOUT\_KNOCK\_CALCULATION

ER\_STATUS = GOOS\_ER\_TEST ----------|

|AND -| GOOS\_KNK\_DET = 1

KNOCK\_OCCURRED = 1 ----------------| | ER\_SPARK = GOOS\_SPK\_TST

| (Set spark to lower value once

| knock has beeb detected)

KNOCK\_ENABLED = 1 -----------------|

|

KNOCK\_OCCURRED = 1 ----------------|

(knock sensed during last PIP |

Period) |

|AND -| SPKAD = SPKAD - RETINC

TIPRET = 0 ------------------------| | (Clip min. SPKAD to RETMAX)

|

N < RPMMAX ------------------------|

|

PIP\_HIGH = 1 ----------------------|

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IGNITION TIMING STRATEGY, SPOUT CALCULATION - CDAN2

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9.13 SPOUT CALCULATION (CDAN0)

OVERVIEW

This module determines the total desired foreground spark angle. Supported

in this calculation are the following features:

Knock sensor-based knock control

Air charge-based tip-in knock control

Throttle-based tip-in knock control

Torque modulation during shift events

DEFINITIONS

Registers:

- SAF = Final spark advance in degrees.

- SAF\_MOD = Maximum spark advance when torque modulation is required, deg.

- SAFTOT = Final spark advance including both background and foreground

modifiers.

- SAFTOT\_PREV = Last pass value of SAFTOT.

- SPKAD = Spark adder for knock. It is added to SAF and may be posative or

negative, degrees.

- SPK\_BDL\_CLP = Borderline detonation spark limit modified for change in

cylinder air charge from when borderline detonation limit (SPK\_BDL) was

computed.

- SPK\_RMP\_TMR = Spark ramp timer for torque moduleation, msec.

- SPK\_SOURCE = Identifies the source calculation for the final spark value.

- TIPRET = Tip in retard, degrees.

Bit Flags:

- FLG\_SPK\_TQM = Torque modulation required flag; 1 -> torque modulation

required.

- OSC\_SAF\_FLG = Flag denoting control of SAF by output state control; 1 ->

SAF determined by OSC, 0 -> SAF determined regularly.

9-68

IGNITION TIMING STRATEGY, SPOUT CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SPARK\_SPOUT\_COM4

BEGIN: spark\_spout\_pid\_definitions

; This section is defining a pid. It does not necessarily have to be

; implemented in the foreground.

unconditionally ----------| saf\_pid := (2 \* SAFTOT) + 128

pid\_def(j1979\_01\_0E, saf\_pid)

END: spark\_spout\_pid\_definitions

BEGIN: spark\_spout\_main

unconditionally ----------| Call "Knock retard logic"

| Call "Tip-in retard logic"

; Add retard for cylinder knock and tip-in retard if not in output state

; control mode. Only allow spark to advance past nominal value if

; borderline-limited.

OSC\_SAF\_FLG <> 1 -------|

|AND -| t\_saftot := SAF + TIPRET + SPKAD

SPKAD < 0 --------| | |

|OR --| |

SPK\_SOURCE = 2 ---| |

| --- ELSE ---

|

OSC\_SAF\_FLG <> 1 -------------| t\_saftot := SAF + TIPRET

|

| --- ELSE ---

|

| t\_saftot := SAF

; Compare value to that desired by torque modulation if not in output state

; control mode.

FLG\_SPK\_TQM = 1 ------------|

|OR --|

SPK\_RMP\_TMR > 0 ------------| |

|AND -| t\_saftot := SAF\_MOD

t\_saftot > SAF\_MOD ---------------|

|

OSC\_SAF\_FLG <> 1 -----------------|

9-69

IGNITION TIMING STRATEGY, SPOUT CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUE: spark\_spout\_main

; Apply foreground borderline update if it is more retarded than current

; value of spark advance.

OSC\_SAF\_FLG <> 1 ---------|

|AND -| t\_saftot := SPK\_BDL\_CLP

SPK\_BDL\_CLP < t\_saftot ---|

; Store value of SAFTOT from previous cylinder event and call high data

; rate spark module.

unconditionally ----------| SAFTOT\_PREV := SAFTOT

| SAFTOT := t\_saftot

| Do: high\_data\_rate\_spark

END: spark\_spout\_main

9-70

IGNITION TIMING STRATEGY, PIP HIGH/LOW TRANSITION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.14 PIP HIGH/LOW TRANSITION (CDAA0)

OVERVIEW

The spark routine (SPOUT\_CALCULATION) is called from the PIP edge processing

routine. If the engine speed is low, the SPOUT\_CALCULATION is called from

both the high-to-low (down) edge of PIP and the low-to-high (up) edge of PIP,

otherwise SPOUT\_CALCULATION is only called from the low-to-high (up) edge of

PIP. When the engine speed is low and a spark retard is requested, a make-up

SAPW pulsewidth is output from the low-to-high edge of PIP.

DEFINITIONS

INPUTS

Registers:

- UNDSP = Run/Underspeed flag; 1 -> underspeed (or CRANK), 0 -> run.

Bit Flags:

- SAPW\_HI\_FLG = Edge to calculate main SAPW; 1 -> use PIP up edge, 0 -> use

PIP down edge.

PROCESS

STRATEGY MODULE: SPARK\_PIP\_HI\_LO\_COM1

PIP High Transition

UNDSP = 0 --------------------------------| Call SPOUT\_CALCULATION

(in RUN mode) | "Continue with PIP processing"

|

| --- ELSE ---

|

| "Continue with PIP processing"

PIP Low Transition

SAPW\_HI\_FLG = 0 --------------------------| Call SPOUT\_CALCULATION

(engine speed low) | "Continue with PIP processing"

|

|

| --- ELSE ---

|

| "Continue with PIP processing"

9-71

IGNITION TIMING STRATEGY, SPARK INTAKE MANIFOLD RUNNER CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.15 SPARK INTAKE MANIFOLD RUNNER CONTROL LOGIC (CDAL0)

OVERVIEW

The Intake Manifold Runner Control (IMRC) Logic adds several degrees of spark

based on engine speed, load and rate of IMRC valve transition from open to

closed.

DEFINITIONS

Registers:

- IMRCSPK\_W = Weighting factor for IMRC spark modifiers. Unitless

multiplier. from 0 (IMRC valve fully Closed) to (IMRC valve fully open).

- LOAD = Universal load variable.

- N = Engine RPM.

- SPKBASE\_IMRC = Base spark adder when using intake manifold runner

control, set to zero otherwise. Degrees, positive for advance.

- SPK\_BDL\_IMRC = Borderline spark adder when using intake manifold runner

control, set to zero otherwise. Degrees, positive for advance.

- SPK\_MBT\_IMRC = Maximum brake torque adder when using intake manifold

runner control, set to zero otherwise. Degrees, positive for advance.

Calibration Constants:

- FN011(N) = Normalized engine speed. Intended to span only the upper RPM

range for "high rpm" features.

- FN013(LOAD) = Normalized LOAD for half-sized spark tables.

- FN2160A(N,LOAD) = Spark adder for base spark calculation with IMRC

control.

X = FN011(N)

Y = FN013(LOAD)

- FN2260A(N,LOAD) = Spark adder for borderline spark calculation with IMRC

control.

X = FN011(N)

Y = FN013(LOAD)

- FN2360A(N,LOAD) = Spark adder for maximum brake torque spark calculation

with IMRC control.

X = FN011(N)

Y = FN013(LOAD)

- IMRCHP = IMRC hardware present flag; 1 -> IMRC hardware present.

9-72

IGNITION TIMING STRATEGY, SPARK INTAKE MANIFOLD RUNNER CONTROL LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SPARK\_IMRC\_COM3

BEGIN: SPARK\_IMRC\_ADDERS

; This module executes once every background loop before the base,

; borderline and maximum brake torque spark calculations.

IMRCHP = 1 ------------------| SPKBASE\_IMRC := IMRCSPK\_W \* FN2160A(N,LOAD)

| SPK\_BDL\_IMRC := IMRCSPK\_W \* FN2260A(N,LOAD)

| SPK\_MBT\_IMRC := IMRCSPK\_W \* FN2360A(N,LOAD)

|

| --- ELSE ---

|

| SPKBASE\_IMRC := 0

| SPK\_BDL\_IMRC := 0

| SPK\_MBT\_IMRC := 0

END: SPARK\_IMRC\_ADDERS

9-73

IGNITION TIMING STRATEGY, HIGH DATA RATE ELECTRONIC SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.16 HIGH DATA RATE ELECTRONIC SPARK (CDAM0)

The High Data Rate Electronic Spark System consists of three components:

a) EEC-IV processor

b) EDIS module

c) A 36-tooth wheel and sensor

The 36-tooth wheel is located on the crankshaft with a variable reluctance

sensor (VRS) to produce a signal. The wheel is missing one tooth at 90 BTDC

for 4-cyl, at 60 BTDC for 6-cyl, and at 50 BTDC for 8-cyl engines for one

cylinder to allow signal reference.

The EDIS module is an EED-supplied module which has the capability to receive

the output of the VRS sensor, as well as a signal from the EEC-IV processor.

The EDIS module provides coil switching for distributorless ignition and

outputs signals to the coil for charging and firing. In addition, the module

provides a signal to the EEC-IV processor, specifically, a synthetic 50% duty

cycle with the low-to-high transition occuring at 10 degrees BTDC for each

cylinder and a high-to-low transition occuring at (180/ENGCYL) after the

low-to-high transition. The module also provides LOS function whenever the

EEC-IV processor fails to provide a Spark Angle Pulse Width (SAW). Included

within these LOS conditions is the SPOUT line remaining in either a high or

low state for more than five PIP periods or if the pulsewidth of the signal

is outside the clip limits. LOS spark is positioned at 10 BTDC.

The EEC-IV processor uses the synthetic 50% duty cycle as reference for

scheduling fuel and spark pulse widths. The EEC-IV processor calculates: 1)

The time that the Spark Output (SPOUT) line to the EDIS should be

transitioned from low-to-high; 2) The SAPW; and 3) The time of the SPOUT

high-to-low transition.

During low engine speeds, SAPW\_HI\_FLG = 0, the pulsewidth is calculated on

both the PIP up and down edge, with the output of the main SAPW on the PIP

down edge and when required, the output of the makeup SAPW on the PIP up

edge. During higher engine speeds, SAPW\_HI\_FLG = 1, the pulsewidth is

calculated on the PIP up edge and output at 20 degrees ATDC. The makeup SAPW

requirement exists when the requested spark is retarded between 5 and some

variable amount dependent on engine speed from the inital requested position

that was output on the main SAPW on the PIP down edge.

Below 1000 RPM, multiple spark firing attempts can be requested. When the

calibration constant REP\_SPK\_DSRD = 1, the strategy will modify the output

pulsewidth to indicate to the EDIS module to fire the coil at the desired

spark angle and successively until reaching TDC. This provides the increased

probability of igniting the mixture and not creating a mis-fire. Repetitive

spark is initialized by writing sending a 2048 SAPW. It is initialized each

time it is first requested.

9-74

IGNITION TIMING STRATEGY, HIGH DATA RATE ELECTRONIC SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

REQUESTED SPARK ANGLE TO SAPW TRANSFER FUNCTION

SAPW |

(usec) |

|

2048..| <- Crank with Repetitive Spark

|

|

|

|

1796..|

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1284..|.........\ <- Crank and underspeed in Normal Spark

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68 ------------------------------------------- SAFTOT

| | | (degrees BTDC)

-10 10 57.5

9-75

IGNITION TIMING STRATEGY, HIGH DATA RATE ELECTRONIC SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- DT12S = The period of time between two adjacent rising edges of PIP.

- HFDLTA = Time period from last PIP up edge to last PIP down edge.

- LAST\_HI\_PIP = Time of most recent high PIP edge.

- N = Engine RPM.

- NEXT\_SPOUT\_BETA = Time period from the reference pip edge to the desired

transition of the SPOUT/SAPW output from low to high.

- SAFTOT = Final spark advance including both background and foreground

modifiers.

- SAFTOT\_PREV = Last pass value of SAFTOT.

- SAPW = HDR spark pulsewidth, microseconds.

- SPOUT\_LOW\_TIME = Time period during which the SPOUT/SAPW output is high

and used to calculate the time of transition from low to high.

Bit Flags:

- CRKFLG = Engine Mode Flag; 1 -> Crank Mode, 0 <> Crank Mode.

- MAKUPSPK\_FLG = Within the SPOUT\_CALCULATION module, indicates if the

current PIP edge is an up edge, if the main calculation is performed on

the PIP down edge, and if the change in requested spark is in the retard

direction; 1 -> meets conditions for make up SAPW, 0 -> does not meet

conditions.

- PIP\_HIGH = State of PIP transition; 1 -> low-to-high transition, 0 ->

high-to-low transition

- REPET\_SPK = Indicates when to use repetitive spark; ignition module to

discharge the coil across the spark plug.

- SAPW\_HI\_FLG = A flag indicating which PIP edge to calculate the main

spark angle pulsewith; 1 -> PIP up edge, 0 -> PIP down edge.

- UNDSP = Flag that indicates when not in run mode.

Calibration Constants:

- ENGCYL = The number of cylinders in one engine revolution.

- REP\_SPK\_DSRD = Flag; 1 -> repetitive spark desired when conditions

permit.

- REPET\_SPK\_HI = Repetitive spark disabled above this engine speed,

rev/min.

9-76

IGNITION TIMING STRATEGY, HIGH DATA RATE ELECTRONIC SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- REPET\_SPK\_LO = Repetitive spark enabled below this engine speed, rev/min.

- SAPW\_UP\_SH = Engine speed set for SAPW\_HIGH = 1.

- SAPW\_UP\_CL = Engine speed clear for SAPW\_HIGH.

Non-Calibratible Constants:

- ustcf = Microsecond-to-ticks conversion.

OUTPUTS

Registers:

- NEW\_TIME = The time on the master clock when the SAPW output will

transition from low to high.

- NEXT\_SPOUT\_BETA = See above.

- SAPW = See above.

- SPOUT\_LOW\_TIME = See above.

Bit Flags:

- IMMEDIATE = A flag that indicates that the output is to be placed in the

hardware output carousel as soon as possible.

- MAKUPSPK\_FLG = Within the SPOUT\_CALCULATION module, indicates if the

current PIP edge is an up edge, if the main calculation is performed on

the PIP down edge, and if the change in requested spark is in the retard

direction; 1 -> meets conditions for make up SAPW, 0 -> does not meet

conditions.

- REPET\_SPK = See above.

- SAPW\_HI\_FLG = A flag indicating which PIP edge to calculate the main

spark angle pulsewith; 1 -> PIP up edge, 0 -> PIP down edge.

9-77

IGNITION TIMING STRATEGY, HIGH DATA RATE ELECTRONIC SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SPARK\_HDR\_COM1

BEGIN: HIGH\_DATA\_RATE\_SPARK

Unconditionally -------------------| DO: ENGINE\_SPEED\_FLIP\_FLOP

UNDSP = 1 -------------------|

|

PIP\_HIGH = 0 ----------------|OR --| MAKUPSPK\_FLG := 0

| |

SAPW\_HI\_FLG = 1 -------| | |

|AND -| |

PIP\_HIGH = 1 ----------| |

| --- ELSE ---

UNDSP = 0 -------------------| |

| |

SAPW\_HI\_FLG = 0 -------------| |

|AND -| MAKUPSPK\_FLG := 1

PIP\_HIGH = 1 ----------------| |

| |

SAFTOT < SAFTOT\_PREV --------| |

| --- ELSE ---

|

| MAKUPSPK\_FLG := 0

| EXIT: HIGH\_DATA\_RATE\_SPARK

Compute the pulsewidth which is equivalent to the desired spark and clip to

minimum and maximum limits equivalent to 10 ATDC and 57.5 BTDC. In

repetitive spark mode, maximum limit is 50 BTDC. During CRANK and

UNDERSPEED, SAPW is set to the equivalent of 10 degree BTDC.

UNDSP = 0 --------------------------| t\_sapw := 1540 - (256 \* SAFTOT/10)

|

| --- ELSE ---

|

| t\_sapw := 1284

t\_sapw < 260 usec ------------|

|AND -| t\_sapw := 260 usec

REPET\_SPK = 1 ----------------| |

| --- ELSE --

|

t\_sapw < 68 usec -------------------| t\_sapw := 68 usec

|

| --- ELSE ---

|

t\_sapw > 1796 usec -----------------| t\_sapw := 1796 usec

9-78

IGNITION TIMING STRATEGY, HIGH DATA RATE ELECTRONIC SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUE: HIGH\_DATA\_RATE\_SPARK

If repetitive spark is desired, the calibration parameter REP\_SPK\_DSRD is set

to one (1); and a calibration value of 2048 usec will be sent in CRANK mode.

During the transition from UNDERSPEED to RUN modes, there is no SAPW sent

out. When repetitive spark is desired and the engine speed is below a

calibratable value, the value of 2048 usec is added to the computed SAPW.

Repetitive spark is enabled when the engine speed is less than the

calibratable value REPET\_SPK\_LO and disabled when engine speed is greater

than the calibratable value REPET\_SPK\_HI.

REP\_SPK\_DSRD = 1 ---------------|

|AND -| t\_sapw := 2048 usec

CRKFLG = 1 ---------------| | | REPET\_SPK := 1

|OR --| |

N < REPET\_SPK\_LO ---| | |

|AND -| |

REPET\_SPK = 0 ------| |

| --- ELSE ---

REP\_SPK\_DSRD = 1 ---------------| |

| |

N < REPET\_SPK\_HI ---------------|AND -| t\_sapw := t\_sapw + 2048 usec

| | REPET\_SPK := 1

REPET\_SPK = 1 ------------------| |

| --- ELSE ---

|

| REPET\_SPK := 0

9-79

IGNITION TIMING STRATEGY, HIGH DATA RATE ELECTRONIC SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUE: HIGH\_DATA\_RATE\_SPARK

Compute spark angle pulsewidth in ticks and store as SPOUT\_LOW\_TIME. Round

up the result if the remainder is greater than or equal to a half tick. If

main SAPW is output from the PIP high edge, compute the on time for SAPW to

be at 20 ATDC.

always -----------------------------| t\_angle := (30 \* ENGCYL / 360) \* DT12S

SAPW\_HI\_FLG = 1 --------------------| NEXT\_SPOUT\_BETA := t\_angle

| t\_slt := t\_sapw \* ustcf

| (high speed main pulse)

|

| --- ELSE ---

SAPW\_HI\_FLG = 0 --------------| |

|AND -| t\_slt := t\_sapw \* ustcf

MAKUPSPK\_FLG = 0 -------------| | (crank, underspeed, & low speed main

| pulse)

|

| --- ELSE ---

MAKUPSPK\_FLG = 1 -------------| |

| |

t\_sapw - SAPW > 128 ----------|AND -| SPOUT\_LOW\_TIME := (t\_sapw - SAPW)

| | \* ustcf

t\_sapw - SAPW < | | (low speed makeup pulse)

(t\_angle / 3) ---------------| |

| --- ELSE ---

MAKUPSPK\_FLG = 1 -------------| |

| |

t\_sapw - SAPW > 128 ----------|AND -| SPOUT\_LOW\_TIME := (t\_angle / 3)

| | (low speed makeup pulse clip)

(t\_sapw - SAPW) >= | |

(t\_angle / 3) ---------------| |

| --- ELSE ---

|

| Do not put out pulse

| Exit routine

9-80

IGNITION TIMING STRATEGY, HIGH DATA RATE ELECTRONIC SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUE: HIGH\_DATA\_RATE\_SPARK

Prevent a pulsewidth that is too long.

SAPW\_HI\_FLG = 1 --------------|

|AND -| SPOUT\_LOW\_TIME := (DT12S -

t\_slt > = | | NEXT\_SPOUT\_BETA)

(DT12S - NEXT\_SPOUT\_BETA) --| |

| SAPW := SPOUT\_LOW\_TIME / ustcf

|

| REPET\_SPK := 0

|

| --- ELSE ---

SAPW\_HI\_FLG = 0 --------------| |

|AND -| SPOUT\_LOW\_TIME := HFDLTA

t\_slt >= HFDLTA --------------| |

| SAPW := HFDLTA / ustcf

|

| REPET\_SPK := 0

|

| --- ELSE ---

|

MAKUPSPK\_FLG = 0 -------------------| SPOUT\_LOW\_TIME := t\_slt

|

| SAPW := t\_sapw

9-81

IGNITION TIMING STRATEGY, HIGH DATA RATE ELECTRONIC SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUE: HIGH\_DATA\_RATE\_SPARK

Determine when to start the spark angle pulse. When the make-up pulsewidth

is output, it must be sent as soon as possible after the PIP up edge to

ensure that the off edge goes out prior to 10 ATDC. The limit of 1.0

millisecond on the make-up pulse should meet this requirement since the worst

case is an 8 cylinder engine at 1500 RPM allows 2.2 milliseconds between the

PIP up-edge and the the 10 ATDC position. The main SAPW is sent from either

20 ATDC or the PIP down edge, dependent on the state of SAPW\_HI\_FLG.

MAKUPSPK\_FLG = 1 -------------------| IMMEDIATE := 1

| (put out makeup pulsewidth equal to

| SPOUT\_LOW\_TIME)

|

| --- ELSE ---

|

SAPW\_HI\_FLG = 0 --------------------| IMMEDIATE := 1

| (put out main SAPW with up\_edge at

| PIP low edge and pulsewidth equal to

| SPOUT\_LOW\_TIME)

|

| --- ELSE ---

|

SAPW\_HI\_FLG = 1 --------------------| NEW\_TIME := LAST\_HI\_PIP +

| NEXT\_SPOUT\_BETA

| (put out main SAPW with up\_edge at

| NEW\_TIME and pulsewidth equal to

| SPOUT\_LOW\_TIME)

|

| --- ELSE ---

|

| Do not put out pulse

| Exit routine

END: HIGH\_DATA\_RATE\_SPARK

9-82

IGNITION TIMING STRATEGY, HIGH DATA RATE ELECTRONIC SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ENGINE\_SPEED\_FLIP\_FLOP

; This process executes when called from HIGH\_DATA\_RATE\_SPARK. Note that it

; reads top down.

The SAPW\_HI\_FLG logic determines when the high data rate spark main

calculation is performed. When the flag is set, the main SAPW calculation

occurs on the PIP low-to-high (high,up) transition and is delivered at 20

degrees ATDC. When the flag is clear, the main SAPW calculation occurs on

the PIP high-to-low (low, down) transition and is delivered immediately. The

maximum recommended value for SAPW\_UP\_SH is:

3750 RPM -- 4 cylinder engine

2500 RPM -- 6 cylinder engine

1875 RPM -- 8 cylinder engine

The recommended value for SAPW\_UP\_CL is 300 RPM below the value of

SAPW\_UP\_SH.

UNDSP = 0 ------------|

|AND -|S Q -| SAPW\_HI\_FLG

N > SAPW\_UP\_SH -------| |

|

UNDSP = 1 ------------| |

|OR --|C

N < SAPW\_UP\_CL -------|

END: ENGINE\_SPEED\_FLIP\_FLOP

9-83

IGNITION TIMING STRATEGY, HIGH DATA RATE ELECTRONIC SPARK - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HIGH DATA RATE SPARK

(High speed operation)

PIP

\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ \_\_

| | | | | | | | |

\_\_| |\_\_\_\_\_\_\_\_|<-\ |\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_|

. \ . . .

. \LAST\_HI\_PIP . . .

. . . .

t\_sapw . . . .

\_\_ . \_\_ . \_\_ . . \_\_

\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_.\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_.\_\_\_\_\_\_\_\_\_.| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_|

20 ATDC --.>| . .

--.>| |<-- SPOUT\_LOW\_TIME . .

desired spark . --->. .<-----

(SAFTOT) computed . |\_\_ desired spark \_\_|

prior to ---------->.<-- t\_sapw computed delivered here

HIGH RATE SPARK

(Low speed with retard in progress)

PIP

\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ \_\_

| | | | | | | | |

\_\_| |\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_|

: . : .

t\_sapw : . : .

:\_\_ .\_ :\_\_\_ \_. \_\_\_\_ \_\_\_

\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_| |\_\_\_\_\_\_| |\_\_\_\_||\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_

: . : .

: . : .

|<-t\_sapw computed here and .

delivered within this range |<------->|

.

|<-make-up SAPW computed here

9-84

IGNITION TIMING STRATEGY, VARIABLE CAM TIMING SPARK CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.17 VARIABLE CAM TIMING SPARK CONTROL LOGIC (CDAK0)

OVERVIEW

This module produces incremental base, borderline, and MBT spark timing

adjustments which are desired for engines with variable cam timing. These

incremental adjustments are included in determination of the overall spark

timing by the spark strategy.

Note that this module is intended to be used for strategies that do not

intend to use variable cam timing and thus set the adders to zero.

DEFINITIONS

OUTPUTS

Registers:

- SPKBASE\_VCT = Base spark adder when using variable cam timing, set to

zero otherwise. Degrees, negative for retard, positive for advance.

- SPK\_BDL\_VCT = Borderline spark adder when using variable cam timing, set

to zero otherwise. Degrees, negative for retard, positive for advance.

- SPK\_MBT\_VCT = Maximum brake torque spark adder when using variable cam

timing, set to zero otherwise. Degrees, negative for retard, positive

for advance.

PROCESS

STRATEGY MODULE: SPARK\_NO\_VCT\_COM1

BEGIN: SPARK\_VCT\_ADDERS

; This routine is executed once every background loop.

unconditionally ------------------------| SPKBASE\_VCT := 0

| SPK\_BDL\_VCT := 0

| SPK\_MBT\_VCT := 0

END: SPARK\_VCT\_ADDERS

9-85

IGNITION TIMING STRATEGY, SPARK FOR FLEXIBLE FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.18 SPARK FOR FLEXIBLE FUEL (CDAL0)

OVERVIEW

The spark advance at which borderline detonation occurs will vary according

to the proportion of methanol in the fuel. This logic calculates an offset

which is dependant on Engine Speed, Load and the proportion of methanol in

the fuel.

This module is a placeholder for strategies that do not use flexible fuel.

It sets the spark adder to zero.

DEFINITIONS

OUTPUTS

Registers:

- SPK\_BDL\_FFS = Borderline spark adder when using flexible fuel, set to

zero otherwise. Degrees, negative for retard, positive for advance.

9-86

IGNITION TIMING STRATEGY, SPARK FOR FLEXIBLE FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SPARK\_NO\_FLEX\_FUEL\_COM1

BEGIN: SPARK\_FLEX\_FUEL\_ADDERS

; This module executes once every background loop.

unconditionally ----------| SPK\_BDL\_FFS := 0

END: SPARK\_FLEX\_FUEL\_ADDERS

9-87

IGNITION TIMING STRATEGY, TORQUE MODULATION RAMP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.19 TORQUE MODULATION RAMP (CDAK0)

OVERVIEW

To insure a smooth transition in torque changes during torque modulation,

spark is tapered in and out via a ramp. The ramp is executed on a 16 msec

repeater.

The flag FLG\_REP\_ENA is controlled in background to insure that the 16 msec

repeater is executed only when necessary.

DEFINITIONS

INPUTS

Registers:

- SPKSLP = Spark ramp rate for torque modulation, deg/msec.

- SPK\_RMP\_TMR = Timer used to control the duration of spark ramps for

torque modulation, msec.

9-88

IGNITION TIMING STRATEGY, TORQUE MODULATION RAMP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- FLG\_DN\_TQM = Downshift Torque Modulation Flag.

- FLG\_REP\_ENA = Indicates 16 msec repeater is enabled for spark ramps for

torque modulation.

- FLG\_SPK\_TQM = Torque Modulation Spark Retard flag.

OUTPUTS

Registers:

- SAF\_DES = Spark advance required to achieve the desired torque level

during torque modulation, deg.

- SAF\_MOD = Maximum total spark advance during torque modulation, deg.

- SAF\_MOD\_LST = Last pass value of SAF\_MOD, deg.

- SPK\_CLK\_LST = Last pass value of CLOCK; used to compute spark ramps for

toruqe modulation, msec.

- SPK\_DELT\_IN = Delta spark stepped in during torque modulation, deg.

- SPK\_DELT\_OUT = Delta spark stepped out during torque modulation, deg.

Bit Flags:

- FLG\_REP\_ENA = See above.

9-89

IGNITION TIMING STRATEGY, TORQUE MODULATION RAMP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SPARK\_TQMOD\_RMP\_COM2

BEGIN: MAIN

; This process is executed every background loop.

FLG\_SPK\_TQM = 1 ---------------|

|OR --| FLG\_REP\_ENA := 1

FLG\_SPK\_TQM = 0 ---------| | |

|AND -| |

SPK\_RMP\_TMR > 0 ---------| |

| --- ELSE ---

|

| FLG\_REP\_ENA := 0

| ; disable 16 msec repeater

END: MAIN

9-90

IGNITION TIMING STRATEGY, TORQUE MODULATION RAMP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: 16\_MSEC\_REPEATER

; This process is executed once every 16 milliseconds. Note that

; SPK\_DELT\_IN is set in SPARK\_TQM\_BG\_COMn.

FLG\_REP\_ENA = 0 ---------------------| EXIT: 16\_MSEC\_REPEATER

|

| --- ELSE ---

FLG\_SPK\_TQM = 1 ---------------| |

|AND -| spk\_tm := ( current CLOCK time

SPK\_RMP\_TMR > 0----------------| | - SPK\_CLK\_LST )

| SPK\_DELT\_OUT := SPKSLP \* spk\_tm

| ; Convert spk\_tm to milliseconds

| ; for the SPK\_DELT\_OUT calculation

| SAF\_MOD := SAF\_MOD\_LST - SPK\_DELT\_OUT

| SAF\_MOD := max( SAF\_MOD, SAF\_DES )

|

| --- ELSE ---

|

FLG\_SPK\_TQM = 1 ---------------------| SAF\_MOD := SAF\_DES

|

| --- ELSE ---

|

| SAF\_MOD := SAF\_MOD\_LST + SPK\_DELT\_IN

always ------------------------------| SAF\_MOD\_LST := SAF\_MOD

| SPK\_CLK\_LST := current CLOCK time

END: 16\_MSEC\_REPEATER

9-91

CONTINUOUS SELF TEST, SPARK OUTPUT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.20 SPARK OUTPUT TEST (CDAN0)

OVERVIEW

This strategy detects a fault (P1359malf) in the SAW output. If the EDIS

module does not receive a SAW pulse, it fires the coil at a default 10

degrees BTDC. The IDM low to high transition (IDMUPEDGTM) happens when the

coil is fired, so it is possible to calculate the actual spark advance. If

the required spark advance (SAFTOT\_OLD2) is greater than the actual spark

advance (SPK\_ACTUAL) by a calibrateable amount (SPK\_POS\_ERR), a failure is

indicated.

There is a two PIP delay between the calculation of SAFTOT and the EDIS

module giving that spark advance to the engine. For this reason the value of

SAFTOT which occurred two PIP periods ago (SAFTOT\_OLD2) is saved and compared

with the current actual spark advance.

A free run timer (SAW\_ER\_TMR) is set to zero every time a failure is not

detected. Therefore if a failure is detected the counter is allowed to count

up. When this counter reaches a calibrateable value (SAW\_ER\_TIM), the

failure code is set.

During rapid accelerations or decelerations the PIP period is changing

rapidly. This could cause the test to incorrectly detect an error.

Therefore the test is disabled under these conditions (DT12S/DT23S or

DT23S/DT12S > V\_DIS\_PIPDOT) and also, if the IDM pulse doesn't occur within

the Spout test window.

IDM\_TM will be calculated only if the requested spark advance (SAFTOT\_OLD2)

is between B and C as shown in Fig.3. If the requested spark advance

(SAFTOT\_OLD2) falls within A to B or C to D, spout test will set IGNTST\_RSIR

= 0, skip calculation of IDM\_TM.

9-92

CONTINUOUS SELF TEST, SPARK OUTPUT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

|<---------------- DT12S ---------------->|

|--------------------| |------------

PIP | | |<-- LAST\_HI\_PIP

---| |--------------------|

IDM\_TM |<---->|

|--|

IDM IDMUPEDGTM ---->| |

---------------------------------------| |---------------

Fig. 1

|<---------------- DT12S ---------------->|

|--------------------| |------------

PIP | | |<-- LAST\_HI\_PIP

---| |--------------------|

IDM\_TM |<--->|

|--|

IDM IDMUPEDGTM ---->| |

---------------------------------------------------| |----

Fig. 2

DEFINITIONS

Registers:

- DATA\_TIME = 3 byte time of transition.

- DT12S = The period of time between two adjacent rising edges of PIP,

ticks/pip.

- DT23S = Last DT12S time.

- IDM\_TM = Time between last PIP up-edge and last IDM up-edge.

- IDMUPEDGTM = IDM up edge transition time.

- IGNTSTMAXADV = Requested spark advance above which Spout test is

performed ,degrees BTDC

- IGNTSTMINADV = Requested spark retard (a negative number) above which

Spout test is performed ,degrees ATDC

- LAST\_HI\_PIP = Most recent PIP up edge transition time.

- SAFTOT = Total spark advance, degrees

- SAFTOT\_OLD1 = Value of SAFTOT one PIP period ago, degrees.

- SAFTOT\_OLD2 = Value of SAFTOT two PIP periods ago, degrees.

9-93

CONTINUOUS SELF TEST, SPARK OUTPUT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SAW\_ER\_TMR = Timer that runs when a fault with the SAW output is

detected, sec.

- SPK\_ACTUAL = Actual spark advance as determined from IDM signal, degrees.

Bit Flags:

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag, (1 => test

enabled).

- ER\_DONE = Value of ER\_STATUS when engine running test is complete

- ER\_INIT = Value for state of ER\_STATUS when engine running test first

inits.

- ER\_STATUS = State pointer that indicated current state of engine running

on demand test.

- KAM\_ERROR = When set to 1, it indicates Keep Alive Memory is invalid.

- OBDII\_RESET = Flag used to simulate the receipt of obdii scan tool

message.

- PxxxMALF = Malfunction flag for code Pxxx; 1 -> a malfunction currently

exists for fault Pxxx.

- IGNTST\_RSIR = It is set to 1, when the requested spark advance

(SAFTOT\_OLD2) is within the spout testing range.

Calibration Constants:

- ENGCYL = Number of PIP's per engine revolution.

- IGNTSTADVTOL = Number of degrees from the pip edge (either up or down)

spout test is not performed.

- SAW\_ER\_TIM = Time SAPW failure must be detected for in order to set

failure code.

- SPK\_POS\_ERR = Maximum possible no fault spark error, degrees.

- SPTST\_CONT = When set to 1, spout testing is performed during continuous

ccm test is enabled (ccm\_tst\_ena = 1).

- SPTST\_ER\_ENA = When set to 1, spout testing is performed during engine

running on demand ccm test is enabled(ccm\_er\_ena = 1).

- V\_DIS\_PIPDOT = PIP period maximum rate of change to recognize an IDM

fault unitless.

OTHER

- P1359 = Fault code, SAPW failure.

9-94

CONTINUOUS SELF TEST, SPARK OUTPUT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Guideline for IGNTSTMAXADV and IGNTSTMINADV parameters:

:<---- spout test enabled ---->:

: :

: : : :

----------| : |--------------------|

PIP | : | : |

|-------------------| : |--------

: : : :

: : : :

tolerance ->: :<-- -->: :<- tolerance

A B C D

Fig. 3

IDM\_TM will be calculated only if the requested spark advance (SAFTOT\_OLD2)

is between B and C as shown in Fig.3. If the requested spark advance

(SAFTOT\_OLD2) falls within A to B or C to D, spout test will set IGNTST\_RSIR

= 0, skip calculation of IDM\_TM and IDMUPEDGTMO

IGNTSTMAXADV := last PIP Down degrees - degrees of tolerance

or

B := A - tolerance

IGNTSTMINADV := next PIP Down degrees + degrees of tolerance

or

C := D + tolerance

|-----------------------------------------------------------------|

|ENGCYL|NUMCYL| A | | | D |

| | |Last PIPDown|IGNTSTMAXADV|IGNTSTMINADV|Next PIPDown|

|-----------------------------------------------------------------|

| | | | | | |

| 2 | 4 | 100 | B | C | -80 |

|-----------------------------------------------------------------|

| | | | | | |

| 3 | 6 | 70 | B | C | -50 |

|-----------------------------------------------------------------|

| | | | | | |

| 4 | 8 | 55 | B | C | -35 |

|-----------------------------------------------------------------|

| | | | | | |

| 5 | 10 | 46 | B | C | -26 |

|-----------------------------------------------------------------|

9-95

CONTINUOUS SELF TEST, SPARK OUTPUT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE:SPARK\_SPOUT\_TEST\_COM1

BEGIN: SPOUT\_POWERUP\_INIT

;execute only once during power-up

unconditionally -----------------| IGNTSTMAXADV :=

| (360/(ENGCYL \* 2)) + 10 - IGNTSTADVTOL

| IGNTSTMINADV :=

| (-360/(ENGCYL \* 2)) + 10 + IGNTSTADVTOL

END: SPOUT\_POWERUP\_INIT

BEGIN: SPOUT\_PIPUP\_FG

;perform the following in the PIP up routine prior to spout calculation

unconditionally ------------------| SAFTOT\_OLD2 = SAFTOT\_OLD1

| SAFTOT\_OLD1 = SAFTOT

| DT23S := MIN(65535, DT12S)

| DT12S := DATA\_TIME - LAST\_HI\_PIP

| LAST\_HI\_PIP := DATA\_TIME

END: SPOUT\_PIPUP\_FG

BEGIN: SPOUT\_IDMUP\_FG

;execute this logic in the IDM up interrupt routine

uncondtionally -------------------| IDMUPEDGTM := DATA\_TIME

| ;save the value of idm rising edge

END: SPOUT\_IDMUP\_FG

BEGIN: SPOUT\_PIPDOWN\_FG

;execute in the pip down routine

SAFTOT\_OLD2 < IGNTSTMAXADV -|

|AND -| IDM\_TM := LAST\_HI\_PIP - IDMUPEDGTM

SAFTOT\_OLD2 > IGNTSTMINADV -| | ;idm-up to pip-up time

| IGNTST\_RSIR := 1

| ;requested spark advance in spout

| ;testing range

|

| --- ELSE

|

| IGNTST\_RSIR := 0

| ;requested spark advance out of

| ;spout testing range

END: SPOUT\_PIPDOWN\_FG

9-96

CONTINUOUS SELF TEST, SPARK OUTPUT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;begin background processing

BEGIN: SPOUT\_TEST\_BG

;execute once per bg loop

KAM\_ERROR = 1 -----------------------|

|

CCM\_TST\_ENA = 0 ---------------------|

;cont test enbld by obdii exec |

|

SPTST\_CONT = 0 ----------------------|

;spout cont test cal'd out |

|

CCM\_ER\_ENA = 0 ----------------------|

;er test enabld by obdii exec |

|

SPTST\_ER\_ENA = 0 --------------------|

;spout er test cal'd out |

|

OBDII\_RESET = 1 ---------------------|OR --| SAW\_ER\_TMR := 0

;scan tool reset msg | | ;reset timer

| |

ER\_STATUS = ER\_INIT -----------------| | (exit spout\_test\_bg)

;start self-test | |

| |

ER\_STATUS = ER\_DONE -----------------| |

;end self-test | |

| |

IGNTST\_RSIR = 0 ---------------------| |

;req. SA out of spout test range | |

| |

(Min(DT12S, 65535)/DT23S) | |

> V\_DIS\_PIPDOT ---| |

| |

(DT23S/Min(DT12S, 65535)) | |

> V\_DIS\_PIPDOT ---| |

;rapid accels/decels detected |

| --- ELSE ---

|

| Do: SPOUT\_CALC\_SPKACTUAL

| ;calc actual spark advance

| Do: SPOUT\_MALF

| ;set/clear malf code

END: SPOUT\_TEST\_BG

9-97

CONTINUOUS SELF TEST, SPARK OUTPUT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: SPOUT\_CALC\_SPKACTUAL

;execute when called

unconditionally ---| SPK\_ACTUAL =

| ((IDM\_TM / Min(DT12S, 65535)) \* (360 / ENGCYL)) + 10

END: SPOUT\_CALC\_SPKACTUAL

BEGIN: SPOUT\_MALF

;execute when called

abs(SAFTOT\_OLD2 - SPK\_ACTUAL)

< SPK\_POS\_ERR ---| SAW\_ER\_TMR = 0

;difference is less than possible error | ;no fault, reset timer

|

| clear\_malf(P1359)

|

| --- ELSE ---

|

SAW\_ER\_TMR > SAW\_ER\_TIM ------------| |

|AND -| malfunction(ccm,P1359)

P1359MALF = 0 -----------------------|

;failure has been present for the required

;time and code has not been previously set

END: SPOUT\_MALF

;end background processing

9-98

IGNITION TIMING STRATEGY, TRANSIENT SPARK FOR DETONATION PREVENTION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.21 TRANSIENT SPARK FOR DETONATION PREVENTION (CDAN0)

OVERVIEW

This is the foreground portion of the transient spark for detonation

prevention. It is based on cylinder air charge.

The borderline spark value is calculated in the background and does not

reflect the rapidly changing air charge value during a tip-in event. This

incorrect borderline value means knock cannot be controlled via the

borderline calculation and other means must be employed.

The value of the cylinder air charge is stored in the background such that

the current foreground value may be compared to it. If the difference in the

background to foreground values is significant, it is marked as a tip-in.

The difference in cylinder air charge is multiplied by a gain value such that

the result determines the amount of spark to retard from the borderline

value. This is known as the "foreground borderline update."

The foreground logic executes in 4 states (SPK\_TIPSTATE):

0 = No tip-in is present

1 = Tip-in event has been sensed

2 = Searching for the peak rise-rate of the cylinder air charge

3 = End of tip-in event has been sensed

The presence of a tip-in event is sensed based on the difference between the

background and foreground values of cylinder air charge. If the difference

exceeds a threshold, a tip-in event has been sensed.

The peak rise-rate of the cylinder air charge is required to denote when it

is valid to begin searching for the end of the tip-in event. The end of the

event is sensed when the cylinder-to-cylinder difference in air charge is

smaller than some threshold.

Once the end of the tip-in event has been found, the background manager is

informed that the borderline spark module should be executed on a priority

basis (after the current background module is completed). Once a new

borderline value has been calculated, it is used for the spark advance value

and the tip-in event is over.

DEFINITIONS

Registers:

- CYL\_AIR\_CHG = Current cylinder air charge.

- SPKAD = Spark adder for knock. It is added to SAF and may be posative or

negative, degrees.

- SPK\_AIR\_CHG = Cylinder air charge used to calculate load for use in spark

calculations.

9-99

IGNITION TIMING STRATEGY, TRANSIENT SPARK FOR DETONATION PREVENTION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SPK\_ARCH\_PRV = Cylinder air charge value for previous cylinder event.

- SPK\_BDL\_CAL = Borderline detonation spark limit, degrees, including

effects of SPK\_ADD, SPK\_MUL and SPKAD modifiers.

- SPK\_BDL\_CLP = Borderline detonation spark limit modified for change in

cylinder air charge from when borderline detonation limit (SPK\_BDL) was

computed.

- SPK\_DARCHMAX = Maximum rise rate of cylinder air charge during tip-in.

- SPK\_MAX\_TRET = Maximum spark retard during air-charge based tip-in knock

control.

- SPK\_TIPSTATE = Spark state transition variable during tip-in event.

Bit Flags:

- PIP\_HIGH = PIP input level.

- SPK\_BDL\_UPDT = Flag to inform the background manager that the borderline

spark module must be executed on a priority basis.

Calibration Constants:

- SPK\_ARCH\_MIN = Cylinder-to-cylinder difference in air charge to sense end

of tip-in event.

- SPK\_D\_AIRCHG = Minimum difference in cylinder air charge to allow a

tip-in retard event.

- SPK\_TIP\_BDL = Multiplier to increase in aircharge, the product of which

is subtracted from SPK\_BDL.

9-100

IGNITION TIMING STRATEGY, TRANSIENT SPARK FOR DETONATION PREVENTION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SPARK\_TIPIN\_CONTROL\_FG\_COM1

BEGIN: spark\_tipin\_control\_fg\_main

; This process executes on each rising PIP edge. The timing relative

; to the up edge is not critical but this must be executed after the

; foreground knock control logic that sets the value of SPKAD and

; before the SPOUT/HDR modules. Note that it reads top down.

; Execute this logic only once per cylinder event on the high PIP edge.

PIP\_HIGH = 0 -------------| EXIT: spark\_tipin\_control\_fg\_main

; Calculate the change in cylinder air charge between the background and

; foreground. Calculate difference in cylinder air charge from value

; during last cylinder event. SPK\_AIR\_CHG should be initialized to its

; maximum value to ensure that a tip-in event is not triggered when this

; module is first executed. SPK\_ARCH\_PRV should be initialized to zero

; to maximize the difference in cylinder-to-cylinder air charge values

; when this module is first executed.

unconditionally ----------| d\_air\_chg := CYL\_AIR\_CHG - SPK\_AIR\_CHG

| d\_air\_chg := MAX(d\_air\_chg,0)

| d\_cyl\_air\_chg := CYL\_AIR\_CHG - SPK\_ARCH\_PRV

| d\_cyl\_air\_chg := MAX(d\_cyl\_air\_chg,0)

| SPK\_ARCH\_PRV := CYL\_AIR\_CHG

; Determine, based on the change in cylinder air charge between the

; background and foreground, if a tip-in is occurring. If no tip-in is

; in progress, the borderline clip value includes the knock adder so that

; spark is allowed to advance past the nominal borderline value.

d\_air\_chg < SPK\_D\_AIRCHG ---------| SPK\_BDL\_CLP := SPK\_BDL\_CAL + SPKAD

| EXIT: spark\_tipin\_control\_fg\_main

|

| --- ELSE ---

|

SPK\_TIPSTATE = 0 -----------------| SPK\_TIPSTATE := 1

| SPK\_DARCHMAX := 0

; Clip spark adder for knock control to a maximum advance of zero if a

; tip-in is in progress to ensure that spark is not over-advanced.

unconditionally -----------------| SPKAD := MIN(SPKAD,0)

9-101

IGNITION TIMING STRATEGY, TRANSIENT SPARK FOR DETONATION PREVENTION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUE: spark\_tipin\_control\_fg\_main

; Calculate value of SPK\_BDL\_CLP which is the retard from the borderline

; calculation modified by the calibration adder and multiplier.

unconditionally ----------| t\_spk\_bdl\_clp := SPK\_BDL\_CAL

| - SPK\_TIP\_BDL \* d\_air\_chg

| SPK\_BDL\_CLP := MAX(t\_spk\_bdl\_clp,SPK\_MAX\_TRET)

; Search for peak rate of increase of cylinder air charge during tip-in

; event. Once this has been found, it is okay to search for the end of

; the tip-in event.

SPK\_DARCHMAX < d\_cyl\_air\_chg ---------| SPK\_DARCHMAX := d\_cyl\_air\_chg

| ; Still searching for peak

|

| --- ELSE ---

|

SPK\_TIPSTATE = 1 ---------------------| SPK\_TIPSTATE := 2

| ; Peak has been found

; Once the peak cylinder-to-cylinder air charge value has been found,

; determine when end of tip-in event occurs. If the change in

; cylinder air charge has become small enough and the peak change has

; been reached, the tip-in event is determined to be over and a flag,

; SPK\_BDL\_UPDT, is set to inform the background manager that the

; borderline spark module must be executed on a priority basis. This

; is to be accomplished by inserting the borderline module as the next

; background task. When the borderline value has been calculated, the

; background manager should return to the module that was next on the

; list before being pre-empted by the borderline module.

d\_cyl\_air\_chg <= SPK\_ARCH\_MIN --|

|AND -| SPK\_BDL\_UPDT := 1

SPK\_TIPSTATE = 2 ---------------| | SPK\_TIPSTATE := 3

; If SPK\_BDL\_UPDT has been cleared by the borderline module, the value of

; SPK\_BDL has been updated so the tip-in retard event may be completed.

; Since the tip-in event is over, the borderline clip includes the knock

; adder so that spark is allowed to advance past the nominal borderline

; value.

SPK\_BDL\_UPDT = 0 ---|

|AND -| SPK\_BDL\_CAL := (SPK\_BDL \* SPK\_MUL) + SPK\_ADD

SPK\_TIPSTATE = 3 ---| | SPK\_BDL\_CLP := SPK\_BDL\_CAL + SPKAD

| SPK\_AIR\_CHG := CYL\_AIR\_CHG

| SPK\_TIPSTATE := 0

END: spark\_tipin\_control\_fg\_main

9-102

IGNITION TIMING STRATEGY, TRANSIENT SPARK FOR DETONATION PREVENTION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9.22 TRANSIENT SPARK FOR DETONATION PREVENTION (CDAM0)

OVERVIEW

This is the background portion of the transient spark for detonation

prevention. It is based on cylinder air charge.

The borderline spark value is calculated in the background and does not

reflect the rapidly changing air charge value during a tip-in event. This

incorrect borderline value means knock cannot be controlled via the

borderline calculation and other means must be employed.

The value of the cylinder air charge is stored in the background such that

the current foreground value may be compared to it. If the difference in the

background to foreground values is significant, it is marked as a tip-in.

The background value is not updated during a tip-in event.

DEFINITIONS

Registers:

- CYL\_AIR\_CHG = Current cylinder air charge.

- N = Engine speed (RPM).

- SPK\_AIR\_CHG = Cylinder air charge used to calculate load for use in spark

calculations.

- SPK\_BDL = Borderline detonation spark limit.

- SPK\_BDL\_CAL = Borderline detonation spark limit, degrees, including

effects of SPK\_ADD, SPK\_MUL and SPKAD modifiers.

- SPK\_DARCHMAX = Maximum rise rate of cylinder air charge during tip-in.

- SPK\_MAX\_TRET = Maximum spark retard during air-charge based tip-in knock

control.

- SPK\_TIPSTATE = Spark state transition variable during tip-in event.

Calibration Constants:

- FN704(N) = Maximum spark retard during air-charge based tip-in knock

control.

- SPK\_ADD = Calibration adder to over-all spark equation. Explicitly

specificy spark advance with SPK\_MUL = 0.

- SPK\_MUL = Calibration multiplier to over-all spark equation. Set to zero

and control spark with SPK\_ADD.

9-103

IGNITION TIMING STRATEGY, TRANSIENT SPARK FOR DETONATION PREVENTION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SPARK\_TIPIN\_CONTROL\_BG\_COM1

BEGIN: spark\_tipin\_control\_bg\_main

; This process executes once each background loop. It must be executed

; after the borderline spark module. Note that it reads top-down.

; If a tip-in is not occurring (based on the change in cylinder air charge

; between the background and foreground calculations), set the value of

; air charge for this background loop. Also set maximum amount of retard

; during a tip-in. During a tip-in event, the value of SPK\_AIR\_CHG is not

; updated so that there is a reference of the air charge value when the

; tip-in event began.

; SPK\_BDL\_CAL does not include the knock adder since it is undesirable to

; over-retard and unsafe to over-advance.

SPK\_TIPSTATE = 0 ---------| SPK\_AIR\_CHG := CYL\_AIR\_CHG

| SPK\_BDL\_CAL := (SPK\_BDL \* SPK\_MUL) + SPK\_ADD

| SPK\_MAX\_TRET := FN704(N)

| SPK\_DARCHMAX := 0

END: spark\_tipin\_control\_bg\_main

9-104

CHAPTER 10

CATALYST BYPASS CONTROL STRATEGY

10-1

CATALYST BYPASS CONTROL STRATEGY

10.1 FEATURE: EXHAUST TEMPERATURE MODEL - V1.9\_CAT\_TEMP\_MODEL (CDAN0)

10.1.1 EXHAUST TEMPERATURE CALCULATION (CDAN0)

OVERVIEW

The below algorithm implements the real-time time exhaust temperature

prediction algorithm. The predicted temperature has at least the following

uses:

1) HEGO heater control, provides input to turn on and off the HEGO heaters.

2) The open loop fuel scheduling for catalyst temperature protection.

3) Torque control via spark retard is limited by exhaust temperatures.

Variables currently accounted for include:

- Engine speed, N.

- Engine air charge (EEC variable LOAD).

- Distance from MBT spark (SPK\_M\_B\_T - SAF), or EEC register SPK\_DELTA.

Note, spark is often retarded in real time to prevent engine knock.

So SPK\_DELTA is a function of air charge temperature ACT and engine

coolant temperature ECT.

- Actual percent EGR, EGRACT.

- Desired equivalence (air/fuel) ratio SPK\_LAMBSE. This is LAMBSE without

the perturbations in closed loop feedback air/fuel control mode.

- Ratio of number of cylinders on over the total number of

cylinders, INJ\_TR. Temperatures for cylinder cutout are only accounted

for during Torque Controlled events, and is assumed that the A/F is

scheduled lean during cutout. This model will not be accurate for

conditions with rich A/f and cylinder cutout. A temperature of

(ACT+ECT)/2 is assumed to be the temperature of non-firing cylinders.

10-2

CATALYST BYPASS CONTROL STRATEGY, EXHAUST TEMPERATURE CALCULATION - CDAN2

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The real time exhaust calculation is used to control the front and rear HEGO

heaters. A summary of the HEGO heater control algorithm is as follows:

Maintain a min. HEGO temperature via the heater so it properly senses the

A/F.

Subject to:

1) Keep the HEGO below its high temperature design limit by turning off

the heater at high inferred exhaust gas temperatures. This applies

mainly to the front HEGO since the exhaust gas cools down quite a bit

before reaching the rear HEGO.

2) Delay turning on the heater until water vapor has been burned off the

sensor element, or it may crack. This applies mainly to the rear

HEGO since it takes relatively long to warm up.

In the design of the initialization algorithm, the following was assumed:

1) For V engines the left and right front HEGOs are assumed to be at

equal temperatures.

2) For V engines the left and right rear HEGOs (if so equipped) may be

at different temperatures, but the functions defining the drop in

temperature from the catalyst midbed to the rear HEGO should be

entered for the longest (coolest) side. No provision for unequal

length pipes were made in the strategy.

The purpose of the inferred ambient temperature is initially to support the

HEGO heater control algorithm wherein inferred ambient is used to seed the

rear HEGO temperature. It is expect to have other applications in the

future. The goal of the algorithm is:

Infer the ambient temperature in Deg.F. as accurately as possible upon

key-on and during engine running modes.

The inferred ambient temperature algorithm has three basic modes:

1) KEY-ON

2) RUNNING RATCH algorithm

3) RUNNING ROLLING AVERAGE algorithm

10-3

CATALYST BYPASS CONTROL STRATEGY, EXHAUST TEMPERATURE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The KEY-ON algorithm:

1) Ambient temperature on keyon is the assigned the lowest value of

the previously stored ambient or current ACT reading.

2) If ECT is within AM\_KEON\_DLT (small value) of ACT on startup, it is

assumed that the engine is at equilibrium or ambient temperature.

This check is redundant to the SOAK\_CAT logic, but was put back

to bulletproof the SOAK\_CAT logic from being zeroed due to

key-on bounce/gitter.

The RUNNING RATCH algorithm:

1) When the engine is running the ACT sensor always reads a value

greater than or equal to ambient. No matter what the rolling

average equation predicts if ACT is less than the current

INFAMB\_KAM value plus a tolerance (AMB\_ACT\_TOL) then INFAMB\_KAM will

be ratcheted down. If the rolling average tends to runs +- 15

Deg.F. then might be very satisfied to be within 10 Deg.F. with the

certainty of the ratchet algorithm, so AMB\_ACT\_TOL is recommended to

be about 10 Deg.F.

The RUNNING ROLLING AVERAGE algorithm:

1) While underhood temperatures are potentially very high at idle,

the nature of the inferred ambient strategy is such that we can

exclude idle updates and wait for the vehicle to achieve a minimum

speed for updates (AMB\_VS\_MIN). The delta between ACT and ambient

was found to be smaller and more predictable in a moving vehicle.

It is calibrated via AMB\_DELTA with values on the order of 20-50

degrees observed. It is recommended that the average observed

delta value be used so that under very hot underhood conditions

INFAMB\_KAM will be on the higher end of the 15 degree error band,

and when the underhood conditions are cooler the RUNNING RATCH

algorithm will take over.

2) The ratchet algorithm will dominate during the warm up period so

the task of the rolling average algorithm is to provide INFAMB\_KAM

for fully warmed up engines. To this end the gate AMB\_ECTMIN is

recommended to be set just above thermostat temperature.

3) The status the air conditioning clutch (ACCFLG=1 when engaged)

has a significant effect on underhood temperatures and is applied

as a subtractor (AMB\_ACC\_SUB) to INFAMB\_KAM. This delta is

calibrated with the clutch on full time. The higher the duty cycle

of the A/C the greater the influence of the A/C on the rolling

average INFAMB value.

10-4

CATALYST BYPASS CONTROL STRATEGY, EXHAUST TEMPERATURE CALCULATION - CDAN2

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DEFINITIONS

Registers:

- ACT = Air charge temperature, degrees.

- AM = Air mass flow, ppm.

- ECT = Coolant temp. deg. faren.

- ECTCNT = Number of times ECT sensor input was read.

- EGRACT = Actual percent EGR.

- EXT\_CATMID = Unsigned inferred Catalyst midbed temperature, degrees.

- EXT\_CIN = Signed inferred Catalyst inlet temperature, degrees.

- EXT\_CMD = Signed inferred Catalyst midbed temperature, degrees.

- EXT\_CMS = Instantaneous catalyst midbed gas temperature at stoichiometric

A/F, Deg.F.

- EXT\_EXO\_MLT = Catalyst exotherm multiplier used when cylinders are

disabled.

- EXT\_EXD = Instantaneous difference in catalyst exotherm temperatures

between current lambse and stoich A/F, degrees.

- EXT\_FEH = Inferred heat rise in front EGO tip temperature due to heater

on., degrees.

- EXT\_FEG = Inferred signed exhaust tip temperature at the front hego

sensor location (hego furthest from flange), degrees.

- EXT\_FEU = Inferred unheated tip temperature at the front HEGO sensor

location, degrees.

- EXT\_FL = Instantaneous inferred signed exhaust Flange temperature,

degrees.

- EXT\_LS\_CIN = Signed steady state exhaust gas temperature drop per degree

of potential drop between flange and catalyst inlet, deg F / deg F.

- EXT\_LS\_FEU = Signed steady state exhaust gas temperature drop per degree

of potential drop between flange and front hego tip, deg F / deg F.

- EXT\_LS\_REG = Signed steady state exhaust gas temperature drop per degree

of potential drop between catalyst midbed and rear hego, deg F / deg F.

- EXT\_REG = Inferred temperature at the Rear hEGo location, degrees. Note,

for a dual bank HEGO application, this represents the rear HEGO on the

bank having the longest path from the flange to the rear HEGO.

- EXT\_SS\_CMS = steady state catalyst midbed gas temperature at

stoichiometric A/F, Deg.F.

10-5

CATALYST BYPASS CONTROL STRATEGY, EXHAUST TEMPERATURE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- EXT\_SS\_EXD = Steady State signed difference in exotherm temperature of

the catalyst from stoich air fuel exotherm, degrees F.

- EXT\_SS\_EXO = Steady state temperature difference between the catalyst

inlet and catalyst midbed; positive temp. delta due to exothermic

reation, Deg.F.

- EXT\_SS\_FEH = Steady-state heat rise in front EGO tip temperature due to

heater on., degrees.

- EXT\_SS\_FEU = Steady-state unheated tip temperature at the front hego

sensor location. , degrees.

- EXT\_SS\_FL = Steady State signed exhaust FLange temperature, degrees.

- EXT\_SS\_FLS = Steady State signed gas exhaust FLange temperature at a

Stoich air/fuel mixture, degrees.

- EXT\_SS\_REG = Steady state signed temperature at the Rear hEGo location,

degrees.

- INFAMB\_KAM = Inferred ambient air temperature, degrees F.

- INJ\_TR = Torque ratio obtained from turning off a number of injectors.

- LOAD = air inducted per intake stroke (air charge) normalized by a engine

design specific constant (SARCHG).

- N = engine speed (RPM).

- SAF = Final spark advance in degrees.

- SOAK\_CAT = Elapsed time since the EEC was powered down until the catalyst

temperature model has been initialized, min.

- SPK\_LAMBSE = equals the equivalence ratio (EEC-IV variable LAMBSE) when

open loop, equals 1.0 when closed loop.

- SPK\_DELTA = Retard from MBT = SPK\_M\_B\_T - SAF.

- SPK\_M\_B\_T = Spark advance required to achieve maximum brake torque.

- TC\_CNTR = Used to extend the range of the ROLAV() beyond the current one

minute limit (extends it up to a 16 minute time constant).

- VSBAR = Filtered vehicle speed.

Bit Flags:

- ACCFLG = A/C clutch status 0 = disengaged, 1 = engaged.

- AFMFLG = ACT sensor failure flag.

- CFMFLG = ECT sensor failure flag.

- DFSFLG = Indicates decel fuel shutoff.

10-6

CATALYST BYPASS CONTROL STRATEGY, EXHAUST TEMPERATURE CALCULATION - CDAN2

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- EXT\_FMM\_FLG = Inferred temperature calculations are potentially wrong due

to a sensor failure.

- EXT\_INIT = Initialization flag to indicate if the catalyst temperature

model has been seeded with the correct intial conditions.

- HEGOHTR11 = HEGO heater 11 state, 1 -> heater on.

- KAM\_ERROR = Indicates keep alive ram is invalid.

- MFMFLG = Air meter failure flag.

- UNDSP = Run/Underspeed Flag; 1 -> Underspeed (or CRANK), 0 -> Run.

Calibration Constants:

- AMB\_ACC\_SUB = Adjustment needed when calculating the ambient due to the

increase in underhood temepratures from the A/C (which increases ACT).

- AMB\_ACT\_TOL = If the ACT is less than the current INFAMB\_KAM plus this

tolerance value, INFAMB\_KAM is allowed to be rached down.

- AMB\_DELTA = Average observed temperature delta (ACT from ambient).

- AMB\_ECT\_MIN = Minimum ECT temperature to enable using the ACT sensor when

calculating the ambient temperature.

- AMB\_KEON\_DLT = A delta temperature used on key-ons between ACT and ECT

below which you can conclude that the car has been sitting off for a

while, degree.

- AMB\_VS\_MIN = Minimum vehicle speed to enable using the ACT sensor when

calculating the ambient temperature.

- EXT\_EXO\_CL = Temperature below which exothermic reations in the midbed do

not occur.

- EXT\_EXO\_SH = Midbed temperature above which exothermic reations occur.

- EXT\_FEH\_INT = Intercept of linear equation describing temperature rise of

front EGO tip due to heater on versus the temperature of the tip with

heater off, Deg.F.

- EXT\_FEH\_SLP = Slope of linear equation describing temperature rise of

front EGO tip due to heater on versus the temperature of the tip with

heater off, Deg.F.

- FN4441(N,LOAD) = Base steady-state exhaust flange temperature versus

speed and LOAD at 14.6 A/F, 0% EGR, MBT spark, degrees.

X = F070C(N)

Y = FN034A(LOAD)

- FN441A(SPK\_LAMBSE) = Effect of LAMBSE on inferred exhaust flange

temperature, multiplier.

- FN441B(SPK\_DELTA) = Effect of SPK on inferred exhaust flange temperature,

multiplier.

10-7

CATALYST BYPASS CONTROL STRATEGY, EXHAUST TEMPERATURE CALCULATION - CDAN2

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- FN441C(EGRACT) = Effect of EGR on inferred exhaust flange temperature,

multiplier.

- FN441T(AM) = Exhaust temperature modifier for eninge coolant temperature,

degrees exhaust flange temperature per degees engine coolant temperature.

- FN442(AM) = Time constant for instantaneous exhaust flange temperature

versus airmass, seconds.

- FN443(AM) = Time constant for front hego unheated tip temperature versus

airmass, seconds.

- FN443L(AM) = Temperature loss per degree of potential loss between flange

and front hego unheated tip versus airmass, Deg.F./Deg.F.

- FN445L(AM) = Temperature loss per degree of potential loss between flange

and catmid location versus airmass, Deg.F./Deg.F.

- FN448(AM) = Multiplier of FN448A(SPK\_LAMBSE) to reflect the loss of

catalyst efficiency at high space velocities.

- FN448A(SPK\_LAMBSE) = Steady-state increase in exhaust temperature in the

catalyst , the "exotherm", as a function of SPK\_LAMBSE, in degrees.

- FN449(AM) = Time constant of the catalyst substrate as a function of AM,

seconds.

- FN449A(AM) = Time constant for the change in catalyst exotherm with A/F,

seconds.

- FN450(AM) = Time constant for instantaneous rear HEGO location

temperature versus airmass, seconds.

- FN450L(AM) = Temperature loss per degree of potential loss between catmid

and rear HEGO location versus airmass, Deg.F./Deg.F.

- FNEXP(x) = Exponential function, e raised to the x.

- TC\_DFSO\_FL = Time constant for for the change in flange temp. when all

cylinders are off (decel fuel shut off), seconds.

- TC\_INFAMB = Inferred ambient air temperature filter constant.

- TC\_RUN\_FEH = Time constant during engine running for the rise in front

hego tip temperature due to the heater, sec.

- TC\_SOAK\_CMS = Time constant during soak time for the catmid, sec.

- TC\_SOAK\_FEH = Time constant during soak time for the front hego heater

contribution temperature, sec.

- TC\_SOAK\_FEU = Time constant during soak time for the unheated front hego

tip temperature, sec.

- TC\_SOAK\_FL = Time constant during soak time for the flange, sec.

- TC\_SOAK\_REG = Time constant during soak time for the rear hego, sec.

10-8

CATALYST BYPASS CONTROL STRATEGY, EXHAUST TEMPERATURE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CAT\_TEMP\_COM1

AFMFLG = 1 -----------------|

;ACT failure |

|

MFMFLG = 1 -----------------|OR --| EXT\_FMM\_FLG = 1

;Air meter failure | |

| |

CFMFLG = 1 -----------------| |

;ECT falilure |

| --- ELSE ---

|

| EXT\_FMM\_FLG = 0

Setup a counter to extend the range of the ROLAV(), allowing time

constants greater than one minute.

TC\_CNTR <= 1 ---------------------| TC\_CNTR = 16

|

| --- ELSE ---

|

| TC\_CNTR = TC\_CNTR - 1

Catalyst Temperature Calling Routine.

KAM\_ERROR = 0 --------------|

|AND -| ;no action

ECTCNT < 8 -----------------| |

;reading sensors still suspect |

| --- ELSE ---

KAM\_ERROR = 1 --------------| |

;stored values corrupt |OR --| Do: initialize\_cat\_model

| |

EXT\_INIT = 0 ---------------| |

;model not initialized |

| --- ELSE ---

|

UNDSP = 0 ------------------------| Do: cat\_temp\_model

;engine is running | Do: inferred\_ambient

|

| --- ELSE ---

|

| Do: inferred\_ambient

10-9

CATALYST BYPASS CONTROL STRATEGY, EXHAUST TEMPERATURE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: initialize\_cat\_model

Calculate the initial conditions (temps) prior to engine running.

abs(ACT - ECT) <

AMB\_KEON\_DLT ---|

|OR --| INFAMB\_KAM = ACT

KAM\_ERROR = 1 -------| | EXT\_SS\_FL = ECT

;stored values corrupt | EXT\_FL = ECT

| EXT\_FEU = ECT

| EXT\_FEH = 0

| EXT\_CMS = ACT

| EXT\_REG = ACT

| SOAK\_CAT = 0.0

| EXT\_INIT = 1

|

| --- ELSE ---

|

| INFAMB\_KAM = min(ACT,INFAMB\_KAM)

| texp = FNEXP(-SOAK\_CAT / TC\_SOAK\_FL)

| EXT\_FL = ((EXT\_FL - INFAMB\_KAM) \*

| texp ) + INFAMB\_KAM

| EXT\_SS\_FL = EXT\_FL

| texp = FNEXP(-SOAK\_CAT / TC\_SOAK\_FEH)

| EXT\_FEH = EXT\_FEH \* texp

| texp = FNEXP(-SOAK\_CAT / TC\_SOAK\_FEU)

| EXT\_FEU = ((EXT\_FEU - INFAMB\_KAM) \*

| texp ) + INFAMB\_KAM

| texp = FNEXP(-SOAK\_CAT / TC\_SOAK\_CMS)

| EXT\_CMS = ((EXT\_CMS - INFAMB\_KAM) \*

| texp ) + INFAMB\_KAM

| texp = FNEXP(-SOAK\_CAT / TC\_SOAK\_REG)

| EXT\_REG = ((EXT\_REG - INFAMB\_KAM) \*

| texp ) + INFAMB\_KAM

| SOAK\_CAT = 0.0

| EXT\_INIT = 1

END: initialize\_cat\_model

10-10

CATALYST BYPASS CONTROL STRATEGY, EXHAUST TEMPERATURE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: cat\_temp\_model

Calculate the steady-state exhaust flange gas temperature for speed,

LOAD, spark, EGR and air/fuel, number of cylinders on.

unconditionally ----------------| SPK\_DELTA = SPK\_M\_B\_T - SAF

| EXT\_SS\_FLS = [((FN4441(N,LOAD) \*

| FN441B(SPK\_DELTA) \* FN441C(EGRACT)) +

| FN441T(AM)\*(ECT-200) ) \* INJ\_TR ] +

| ((1 - INJ\_TR) \* (ACT + ECT)/2 )

| EXT\_SS\_FL = EXT\_SS\_FLS \*

| FN441A(SPK\_LAMBSE)

Calculate the gas temperature at the flange.

DFSFLG = 0 ---------------------| EXT\_FL = ROLAV(EXT\_SS\_FL, FN442(AM))

;not in decel shutoff |

| --- ELSE ---

|

TC\_CNTR <= 1 -------------------| EXT\_FL = ROLAV(EXT\_SS\_FL, TC\_DFSO\_FL)

|

| --- ELSE ---

|

| no change to EXT\_FL

Calculate the temperature at the front unheated tip temperature (EXT\_FEU).

TC\_CNTR <= 1 -------------------| EXT\_LS\_FEU = FN443L(AM) \*

| (EXT\_FEU(old) - INFAMB\_KAM)

| EXT\_SS\_FEU = EXT\_FL - EXT\_LS\_FEU

| EXT\_FEU = ROLAV(EXT\_SS\_FEU,FN443(AM))

HEGOHTR11 = 1 ------------|

;front heater on |AND -| EXT\_SS\_FEH = EXT\_FEH\_INT -

| | (EXT\_FEH\_SLP \* EXT\_FEU)

TC\_CNTR <= 1 -------------| |

| --- ELSE ---

|

| EXT\_SS\_FEH = 0.0

TC\_CNTR <= 1 -------------------| EXT\_FEH = ROLAV(EXT\_SS\_FEH,TC\_RUN\_FEH)

| EXT\_FEG = EXT\_FEH + EXT\_FEU

Calculate the steady-state temperature drop in exhaust gas traveling from

the flange to the catalyst inlet and calculate the catalyst inlet temp.

TC\_CNTR <= 1 -------------------| EXT\_LS\_CIN = FN445L(AM) \* ((EXT\_FL +

| EXT\_CIN(old))/2 - INFAMB\_KAM )

| EXT\_CIN = EXT\_FL - EXT\_LS\_CIN

10-11

CATALYST BYPASS CONTROL STRATEGY, EXHAUST TEMPERATURE CALCULATION - CDAN2

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Determine if the cataylst is lit off.

EXT\_CMD < EXT\_EXO\_CL -------------| EXT\_EXO\_MLT = 0

|

| --- ELSE ---

TC\_CNTR <= 1 ---------------| |

|AND -| EXT\_EXO\_MLT = FN448(AM) \* INJ\_TR

EXT\_CMD > EXT\_EXO\_SH -------| |

| --- ELSE ---

|

| no change to EXT\_EXO\_MLT

Calculate the steady state exotherm temperature needed/used by the open

loop fuel A/F controller.

unconditionally ----------------| EXT\_SS\_EXO = EXT\_EXO\_MLT \*

| FN448A(SPK\_LAMBSE)

Calculate a midbed temperature as if at stoic, an exotherm difference

from stoic and actual A/F, then the total (sum) is the catmid temperature.

TC\_CNTR <= 1 -------------------| EXT\_SS\_EXD = ( FN448A(SPK\_LAMBSE) -

| FN448A(1) ) \* EXT\_EXO\_MLT

| ;steady-state temp. diff. in exotherm from

| ;running stoic and running current a/f.

| EXT\_SS\_CMS = (FN448A(1) \*

| EXT\_EXO\_MLT ) + EXT\_CIN

| ;steady-state cat midbed temp at stoic.

| EXT\_EXD = ROLAV(EXT\_SS\_EXD,FN449A(AM))

| EXT\_CMS = ROLAV(EXT\_SS\_CMS,FN449(AM))

| EXT\_CMD = EXT\_CMS + EXT\_EXD

| ;add stoich value and difference to form

| ;catalyst midbed temp

| EXT\_CATMID = max(EXT\_CMD,0)

10-12

CATALYST BYPASS CONTROL STRATEGY, EXHAUST TEMPERATURE CALCULATION - CDAN2

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Calculate the steady-state temperature drop in exhaust gas traveling from

the catalyst midbed to the rear hego location.

TC\_CNTR <= 1 ---------------------| EXT\_LS\_REG = FN450L(AM) \* ((EXT\_CMD +

| EXT\_REG(old))/2 - INFAMB\_KAM)

Calculate the steady-state drop in exhaust gas temperature.

TC\_CNTR <= 1 ---------------------| EXT\_SS\_REG = EXT\_CMD - EXT\_LS\_REG

Calculate the current wall temperature at the rear HEGOx2 location.

TC\_CNTR <= 1 ---------------------| EXT\_REG = ROLAV(EXT\_SS\_REG,FN450(AM))

END: cat\_temp\_model

BEGIN: inferred\_ambient

Account for the A/C before calculating the ambient.

ACCFLG = 1 -----------------------| amb\_adj = AMB\_ACC\_SUB

|

| --- ELSE ---

|

| amb\_adj = 0

Store a value of inferred ambient air temperature for initializing the

model on the next restart.

ECT > AMB\_ECT\_MIN ----------|

|

VSBAR > AMB\_VS\_MIN ---------|AND -| ambient = ACT - AMB\_DELTA - amb\_adj

| | INFAMB\_KAM = ROLAV(ambient,TC\_INFAMB)

TC\_CNTR <= 1 ---------------| |

| --- ELSE ---

|

| no change to INFAMB\_KAM

Allow the inferred ambient to be ratched down.

ACT - AMB\_ACT\_TOL < INFAMB\_KAM ---| INFAMB\_KAM = ACT - AMB\_ACT\_TOL

|

| --- ELSE ---

|

| no change to INFAMB\_KAM

END: inferred\_ambient

10-13

INPUT AND FAILURE MODE AND SELF TEST - CDAN2

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10.1.2 SOAK TIME CALCULATION (CDAN0)

OVERVIEW

This logic uses the hardware present on the AICE2 chip to determine EEC power

off time.

DEFINITIONS

Registers:

- ENG\_OFF\_TMR = Elapsed time of the most recent EEC module key-off

powered-down period, minutes.

- SOAK\_HICOMP = Soak time duration in minutes. This copy is used only by

the Hot Injector Compensation logic.

- SOAK\_CAT = Soak time duration in minutes. This copy is used only by the

exhaust temperature model logic.

PROCESS

STRATEGY MODULE: INPUT\_SOAK\_TIMER\_COM2

BEGIN: input\_soak\_timer

;Execute the following process once during RAM initialization.

unconditonally ------------------| ;read ENG\_OFF\_TMR

| SOAK\_HICOMP = SOAK\_HICOMP + ENG\_OFF\_TMR

| SOAK\_CAT = SOAK\_CAT + ENG\_OFF\_TMR

| ENG\_OFF\_TMR = 0.0

END: input\_soak\_timer

10-14

INPUT AND FAILURE MODE AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

10.2 FEATURE: CATALYST\_MONITOR (STANDARD) - V1.8A\_CAT\_FTP\_MONITOR (CDAN0)

10.2.1 FTP CATALYST MONITOR (CDAN0)

OVERVIEW

The Catalyst Monitor is an algorithm designed to detect when the Catalsyt is

displaying poor emission conversion efficiency. The detection capability is

based on the premis that the ratio of rear HEGO switches to front HEGO

switches is related directly to Catalyst efficieny. As the Catalyst

efficiency reduces the ratio of REAR to FRONT HEGO switches increases. The

monitor collects HEGO switch data and after a sufficient number of switches

are collected it calculates the REAR/FRONT switch ratio. When the ratio

exceeds a pre-determined value the Catalyst considered to be exceeding the

threshold emissions limit. This sets a Catalyst failed flag which is used by

the OBDII executive to light the MIL.

The Catalyst Monitor is divided into several modules to simplify the control

structure. There is a main control module that contains the entry conditions

for the monitor as well as calling the other modules that are necessary to

run the module. The entry conditions to run the monitor include coolant

temperature, closed loop fuel control, midbed catalyst temperature, and being

enable by the OBDII executive. If these conditions are met, the monitor runs

and the other modules are called.

The other modules are used to perform the following functions;

The ftp\_codes module:- reports fault codes if they are requested and the test

has been completed.

The ftp\_reset\_bank modules:- reset the counters for front and rear HEGO

switches when a test has been completed or a reset is demanded.

The ftp\_trackingsp\_bank module:- processes the raw HEGO voltage data and

generates switch flags that correspond to HEGO voltage swings/switches. This

module detects voltage maxima-minima and corresponding voltage amplitdue

changes. This data is used to confirm that a true HEGO voltage switch has

occured.

The ftp\_filter module:- filters the HEGO switches to ensure that HEGO Buzz

does not intefere with the test.

The ftp\_am\_cell module:- sets up an air mass cell array and indicates in

which cell of the array the test is currently operating.

The ftp\_switch\_bank modules:- count the front and rear HEGO switches. The

switches are stored in different air mass cell registers. These registers

are used to ensure that sufficient number of switches have been collected in

all air mass cells before a trip is considered complete and a switch ratio

calculated.

The ftp\_ratio\_bank modules:- Determines that a suffiecient number of switches

have been collected using the TIER1/2 test. It then take a rear to front

ratio of the HEGO switches and indicates whether or not the catalyst is good

or bad based on that ratio.

10-15

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

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+-------------+

| ftp\_monitor | ; main module

+-------------+

|

|

| +-------------+

|--------------> | ftp\_codes | ; set and clear codes

| +-------------+

|

| +-----------------+

|--------------> | ftp\_reset\_bank1 | ; reset counters

| +-----------------+

|

| +-----------------+

|--------------> | ftp\_reset\_bank2 | ; reset counters

| +-----------------+

|

| +----------------------+

|--------------> | ftp\_trackingsp\_bank1 | ; Tracking Switchpoint

| +----------------------+ Algorithm

|

|

| +----------------------+

|--------------> | ftp\_trackingsp\_bank2 | ; Tracking Switchpoint

| +----------------------+ Algorithm

|

| +-------------+

|--------------> | ftp\_filter | ; filter HEGO switches

| +-------------+

|

| +-------------+

|--------------> | ftp\_am\_cell | ; select air mass cell

| +-------------+

|

| +------------------+

|--------------> | ftp\_switch\_bank1 | ; count switches

| +------------------+

|

| +------------------+

|--------------> | ftp\_switch\_bank2 | ; count switches

| +------------------+

|

| +-----------------+

|--------------> | ftp\_ratio\_bank1 | ; rear to front switch ratio

| +-----------------+

|

| +-----------------+

|--------------> | ftp\_ratio\_bank2 | ; rear to front switch ratio

+-----------------+

10-16

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

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DEFINITIONS

Registers:

- ACT = Air charge temperature, degrees F.

- CAT\_ACT\_MAX = Maximum ACT for entry into Catalyst Monitor.

- CAT\_ACT\_MIN = Minimum ACT for entry into Catalyst Monitor.

- AM = Air Mass.

- AM\_CELL = Ftp Catalyst Monitor air mass cell identifier.

- APT = At Part Throttle flag.

- ATMR1\_HI\_RES = Time since engine start with higher resolution than ATMR1.

- BG\_TMR = Background loop time.

- CAT\_ACT\_TF1 = Actuated timer flag associated with timer CAT\_TMR\_ACT.

- CAT\_SW\_AMP12 = TSP maxima-minima amplitude.

- CAT\_SW\_AMP21 = TSP maxima-minima amplitude.

- CAT\_SW\_AMP22 = TSP maxima-minima amplitude.

- CAT\_TMR\_ACT = Time spent collecting HEGO switch data.

- CAT\_TP\_LAST = Last Back Ground value of Throttle Position.

- CAT\_TP\_RATE = Throttle rate.

- CAT\_TST\_TMR = Time since start of test, sec.

- DELTA\_VEGO12 = The voltage difference between two succesive HEGO voltage

samples.

- DELTA\_VEGO22 = The voltage difference between two succesive HEGO voltage

samples.

- ECT = Engine Coolant Temperature.

- EGO1\_RF\_AVE = Rear to front EGO1 average switch ratio.

- EGO2\_RF\_AVE = Rear to front EGO2 average switch ratio.

- EGO1\_RF\_RAT = Rear to front EGO1 switch ratio.

- EGO2\_RF\_RAT = Rear to front EGO2 switch ratio.

- EXT\_CATMID = Midbed catalyst temperature.

- FEGO1\_CT1 THROUGH FEGO1\_CT9 = Front EGO1 switch count cells.

- FEGO1\_CT21 = Bank 1 first air mass cell front hego alternative count.

10-17

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FEGO1\_CT22 = Bank 1 second air mass cell front hego alternative count.

- FEGO1\_CT23 = Bank 1 third air mass cell front.

- FEGO1\_CT24 = Bank 1 fourth air mass cell front.

- FEGO1\_CT25 = Bank 1 fifth air mass cell front.

- FEGO1\_CT26 = Bank 1 sixth air mass cell front.

- FEGO1\_CT27 = Bank 1 seventh air mass cell front.

- FEGO1\_CT28 = Bank 1 eigth air mass cell front.

- FEGO1\_CT29 = Bank 1 ninth air mass cell front.

- FEGO2\_CT1 THROUGH FEGO2\_CT9 = Front EGO2 switch count cells.

- FEGO2\_CT21 = Bank 2 first air mass cell front h.

- FEGO2\_CT22 = Bank 2 second air mass cell front he.

- FEGO2\_CT23 = Bank 2 third air mass cell front.

- FEGO2\_CT24 = Bank 2 fourth air mass cell front.

- FEGO2\_CT25 = Bank2 5th cell alt count.

- FEGO2\_CT26 = Bank2 sixth cell alt count.

- FEGO2\_CT27 = Bank2 seventh cell alt count.

- FEGO2\_CT28 = Bank2 8th cell alt count.

- FEGO2\_CT29 = Bank2 9th cell alt count.

- FEGO1\_CT\_TOT = Total front EGO1 switches (sum of all switch count cells).

- FEGO2\_CT\_TOT = Total front EGO2 switches (sum of all switch count cells).

- KAM\_ERROR = Indicates keep alive RAM invalid.

- KWUCTR = Warmup counter for adaptive learning.

- LOAD = Universal load as ratio of air charge over standard, unitless.

- OBD\_RCLK\_DIF = Time since last EGO conversion in seconds.

- OBD\_RCLK\_LST = Last clock ticks.

- OBD\_SW11\_DUR = Time since last front EGO1 switch.

- OBD\_SW12\_DUR = Time since last rear EGO1 switch.

- OBD\_SW21\_DUR = Time since last front EGO2 switch.

- OBD\_SW22\_DUR = Time since last rear EGO2 switch.

10-18

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PTTMR = Time since exiting closed throttle.

- QD\_CL\_TMR2 = Time for catalyst test since entering run mode.

- REGO1\_CT = Total rear EGO1 switches.

- REGO1\_CT2 = Bank 1 total rear ego switches, alternative count.

- REGO2\_CT = Total rear EGO2 switches.

- REGO2\_CT2 = Bank 2 total rear ego switches, alternative count.

- TP = Throttle position.

- TP\_REL = RElative TP (TP-RATCH).

- TSP\_MXMN\_V12 = TSP HEGO voltage amplitude values during maxima/minima,

volts.

- TSP\_MXMN\_V22 = TSP HEGO voltage amplitude values during maxima/minima,

volts.

- UNDSP = Underspeed flag.

- VEGO11 = Bank1 upstream HEGO voltage.

- VEGO12 = Rear bank-1 EGO voltage for catalyst tests.

- VEGO21 = Bank2 upstream HEGO voltage.

- VEGO22 = Rear bank-2 EGO voltage for catalyst tests.

- VEGO22 = TSP HEGO voltage input -new value bank 2 rear.

- VEGO\_OLD11 = TSP HEGO voltage input -old value.

- VEGO\_OLD12 = TSP HEGO voltage input -old value bank1, rear.

- VEGO\_OLD21 = TSP HEGO voltage input - old value bank2, front.

- VEGO\_OLD22 = TSP HEGO voltage input -old value bank2 rear.

- VEGO\_SLOPE12 = Flag to indicate the gradient sign of the bank1, rear HEGO

voltage; 1 -> Positive gradient, 0 -> Negative gradient.

- VEGO\_SLOPE22 = Flag to indicate the gradient sign of the bank2, rear HEGO

voltage; 1 -> Positive gradient, 0 -> Negative gradient.

Bit Flags:

- CAT\_AQU\_LS1 = Cat-1 data acquisition start flag.

- CAT\_AQU\_LS2 = Cat-2 data acquisition start flag.

- CAT\_DN1\_FLG = Catalyst monitor completed on Bank 1.

- CAT\_DN2\_FLG = Catalyst monitor completed on Bank 2.

10-19

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- CAT1\_FAILED = Bank 1 catalyst failed indicator.

- CAT2\_FAILED = Bank 2 catalyst failed indicator.

- CAT\_MON = Monitor flag for catalyst test; 1 -> monitored at least once.

- CAT\_SWTFL11 = Front EGO bank 1 switch flag, filtered.

- CAT\_SWTFL12 = Rear EGO bank 1 switch flag, filtered.

- CAT\_SWTFL21 = Front EGO bank 2 switch flag, filtered.

- CAT\_SWTFL22 = Rear EGO bank 2 switch flag, filtered.

- CAT\_TST\_PRG = Catalyst Test in Progress Flag.

- CAT\_TST\_ENA = Catalyst Monitor enable by executive.

- CAT\_TST\_RDY = Data ready to be reported by the test.

- CCM\_TST\_ENA = Continuous component monitor flag.

- GRAD\_CHNG12 = TSP HEGO voltage gradient change has occurred - HEGO12.

- GRAD\_CHNG22 = TSP HEGO voltage gradient change has occurred - HEGO22.

- LAM\_MOD\_FLG = Flag used to initiate high frequency fuel modulation for

the upstream EGO monitor.

- MIN\_FLG\_BK1 = Minimum number of counts in all air mass cells.

- MIN\_FLG\_BK2 = Minimum number of counts in all air mass cells.

- OBDII\_RESET = Test reset by executive.

- OBD\_PARM\_RST = OBDII parameter reset signal; 1-> reset parameters.

- OLFLG = Open Loop Flag.

- P0420MALF = Fault code, Bank-1 catalyst failed.

- P0430MALF = Fault code, Bank-2 catalyst failed.

- SAIR\_TST\_ENA = OBD-II Secondary Air Test enable flag; 1 -> test enabled.

- SWTFL11 = Front EGO bank 1 switch flag, unfiltered.

- SWTFL21 = Front EGO bank 2 switch flag, unfiltered.

- TST\_SW\_FLG12 = TSP rear EGO bank 1 switch flag, unfiltered.

- TST\_SW\_FLG22 = TSP rear EGO bank 2 switch flag, unfiltered.

Calibration Constants:

- AM1\_MIN through AM9\_MIN = Minimum value to enter air mass windows.

10-20

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- AM1\_MAX through AM9\_MAX = Maximum value to exit air mass windows.

- CAT\_AMPCAL12 = Minimum voltage difference to counts VOLTS.

- CAT\_AMPCAL22 = Minimum voltage difference to count HEGO switches.

- CAT\_APT\_FLG = Calibration to prevent counting of EGO switches when APT =

-1.

- CAT\_COLD\_TME = Catalyst warm up time if temperature at start is low.

- CAT\_CTPT\_TME = Time after leaving closed throttle before Catalyst Monitor

will collect data.

- CAT\_ECT\_MAX = Maximum ECT to exit catalyst monitor.

- CAT\_ECT\_MIN = Minimum ECT to enter catalyst monitor.

- CAT\_HOT\_TME = Catalyst warm-up time when temp at start is a high value.

- CAT\_KWU\_CNT = KAM warm up value above/below which catalyst filter

contstant is scheduled, unitless.

- CAT\_LOW\_LOAD = Low load to deactivate catalyst monitor, unitless.

- CAT\_LOW\_TP = Low throttle position to deactivate catalyst monitor,

unitless

- CAT\_MAX\_MID = Maximum midbed temperature to run test.

- CAT\_MED\_TME = Catalyst warm-up time if temp at start is a medium

temperature.

- CAT\_MIN\_MID = Minimum midbed temperature to run test.

- CAT\_TIER1 = Catalyst Monitor timer value used to complete the Catalyst

Monitor time out value, seconds.

- CAT\_TM\_CL = Minimum time since closed loop to enter catalyst monitor.

- CAT\_TP\_MAX = Maximum rate for the throttle to perform test.

- CAT\_TP\_TC = Time constant to filter throttle rate.

- CAT\_TM\_STRT = Minimum time since start to enter catalyst monitor.

- EGO1\_FL\_RAT = Value at which Bank 1 catalyst is considered failed.

- EGO2\_FL\_RAT = Value at which Bank 2 catalyst is considered failed.

- EGO\_CAT\_FKA = Filter constant for catalyst test, used for initial average

calculation, unitless.

- EGO\_CAT\_FKB = Filter constant for catalyst test, mature calculations,

unitless.

- EGO\_INIT\_RF1 = Initial Rear/front EGO switch ratio - bank 1.

10-21

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- EGO\_INIT\_RF2 = Initial Rear/front EGO switch ratio - bank 2.

- EGO\_RF\_DEL = Rear/front EGO switch ratio delta.

- FEGO1\_C\_MIN1 through FEGO1\_C\_MIN9 = Minimim ego switches for air mass

cells 1-9 :- bank1.

- FEGO1\_MX\_CT1 through FEGO1\_MX\_CT9 = Maximum EGO1 switch count.

- FEGO1\_MX\_TOT = Total EGO1 switch counts.

- FEGO2\_MX\_CT1 through FEGO2\_MX\_CT9 = Maximum EGO2 switch count.

- FEGO2\_MX\_TOT = Total EGO2 switch counts.

- HEGO\_CONFIG = HEGO configuration register.

- NUMEGO = Indicates the number of upstream EGOs.

- OBD\_MINPER = Minimum half-period for ego buzz filter in CATALYST MONITOR.

- TSP\_DBAND1 = Cat Monitor TSP voltage deadband (bank1) value, volts.

- TSP\_DBAND2 = Cat Monitor TSP voltage deadband (bank2) value, volts.

OTHER

- malfunction = defined routine to store trouble codes.

- clear\_malf = defined routine to clear trouble codes.

10-22

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CAT\_FTP\_STANDARD\_MONITOR

BEGIN: ftp\_monitor

;This module is executed once every background loop.

;KAM reset logic.

KAM\_ERROR = 1 --------------------------| EGO1\_RF\_AVE := EGO\_INIT\_RF1

;KAM has been corrupted | EGO2\_RF\_AVE := EGO\_INIT\_RF2

| ;reset averages

;Timer logic

UNDSP = 1 ------------------------------| CAT\_TST\_TMR := 0

; Underspeed | ;free running timer

| ;time since engine start

OLFLG = 1 ------------------------------| QD\_CL\_TMR2 := 0

;in open loop | ;free running timer

| ;time in closed loop

;Try to report malfunctions

;Perform Filtering operation

APT = -1 -------------------------------| PTTMR := 0

| ;free running timer

| ;time since leaving closed loop

unconditionally ------------------------| Do: ftp\_codes

| Do: ftp\_trackingsp\_bank1

| Do: ftp\_trackingsp\_bank2

| Do: ftp\_filter

; try to report codes, start

; tracking immediately.

;Calculate throttle angle

unconditionally ------------------------| tp\_rate := ABS[(TP -

| CAT\_TP\_LAST)\*1/9.57)]/BG\_TMR

| ;take absolute value of

| ;throttle rate

| CAT\_TP\_RATE :=

| ROLAV\_TC(tp\_rate,CAT\_TP\_TC)

| ;calculate throttle rate

| CAT\_TP\_LAST := TP

| ;store throttle postion

10-23

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;Entry conditions for catalyst monitor.

CAT\_TST\_TMR > CAT\_TM\_STRT -----------------------|

;Time since start exceeded X sec. |

|

TCSTRT < ECTCOLD --------------------| |

|AND -| |

ATMR1\_HI\_RES > CAT\_COLD\_TME ---------| | |

| |

ECTCOLD < TCSTRT < ECTHOT -----------| | |

|AND -|OR --|

ATMR1\_HI\_RES > CAT\_MED\_TME ----------| | |

| |

TCSTRT >= ECTHOT --------------------| | |

|AND -| |

ATMR1\_HI\_RES > CAT\_HOT\_TME ----------| |

;special temperature stabalization logic |AND -| CAT\_TST\_RDY := 1

| | ;test can be run

ECT > CAT\_ECT\_MIN -------------------------------| |

;coolant warm enough for test | |

| |

ECT < CAT\_ECT\_MAX -------------------------------| |

;coolant cool enough for test | |

| |

QD\_CL\_TMR2 > CAT\_TM\_CL2 -------------------------| |

;Catalyst warmed up | |

| |

EXT\_CATMID < CAT\_MAX\_MID ------------------------| |

;catalyst midbed temp low enough | |

| |

EXT\_CATMID > CAT\_MIN\_MID ------------------------| |

;catalyst midbed temp high enough | |

| |

ACT > CAT\_ACT\_MIN -------------------------| | |

|AND--| |

ACT <= CAT\_ACT\_MAX ------------------------| |

| |

LOAD >= CAT\_LOW\_LOAD ---------------------| | |

|AND -| |

TP\_REL >= CAT\_LOW\_TP ----------------------| |

| --- ELSE ---

|

| CAT\_TST\_RDY := 0

| ;test not ready

10-24

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

LAM\_MOD\_FLG <> 1 -----------------|

|

SAIR\_TST\_ENA = 0 -----------------|

|

OBDII\_RESET = 0 ------------------|

;no reset from exec |

|

CAT\_TST\_ENA = 1 ------------------|

;Continuous monitor |

|AND -| CAT\_TST\_PRG := 1

CAT\_TST\_RDY = 1 ------------------| | ;Test in progress

;test ready | | Do: ftp\_am\_cell

| | Do: ftp\_switch\_bank1

CAT\_MON = 0 ----------------------| | Do: ftp\_switch\_bank2

| Do: ftp\_ratio\_bank1

| Do: ftp\_ratio\_bank2

|

| CAT\_ACT\_TF1 = 1

| ; actuate CAT\_TMR\_ACT

|

| --- ELSE ---

OBD\_PARM\_RST = 1 -----------------| |

;reset from exec | |

| | CAT\_TST\_PRG := 0

CAT\_TST\_ENA = 0 ------------| | | ;test aborted/reset

|AND -|OR --|

CAT\_TST\_RDY = 1 ------------| | |

| | Do: ftp\_reset\_bank1

CAT\_MON = 1 ----------------------| | ;reset bank1 counters

| Do: ftp\_reset\_bank2

| ;reset bank2 counters

| CAT\_DN1\_FLG := 0

| CAT\_DN2\_FLG := 0

| ;reset done flags

|

| CAT\_ACT\_TF1 = 0

| CAT\_TMR\_ACT = 0

| ;reset timer

|

| --- ELSE ---

|

| CAT\_TST\_PRG := 0

| ;test suspended

|

| CAT\_ACT\_TF1 = 0

| ;Suspend timer CAT\_TMR\_ACT

END: ftp\_monitor

10-25

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ftp\_reset\_bank1

;This module is executed only when explicitly called

;reset counter for bank1

unconditionally ------------------------| FEGO1\_CT1 := 0

| FEGO1\_CT2 := 0

| FEGO1\_CT3 := 0

| FEGO1\_CT4 := 0

| FEGO1\_CT5 := 0

| FEGO1\_CT6 := 0

| FEGO1\_CT7 := 0

| FEGO1\_CT8 := 0

| FEGO1\_CT9 := 0

| REGO1\_CT := 0

| FEGO1\_C2\_TOT := 0

| FEGO1\_CT\_TOT := 0

| REGO1\_CT := 0

| REGO1\_CT2 := 0

| FEGO1\_CT21 := 0

| FEGO1\_CT22 := 0

| FEGO1\_CT23 := 0

| FEGO1\_CT24 := 0

| FEGO1\_CT25 := 0

| FEGO1\_CT26 := 0

| FEGO1\_CT27 := 0

| FEGO1\_CT28 := 0

| FEGO1\_CT29 := 0

END: ftp\_reset\_bank1

10-26

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ftp\_reset\_bank2

;This module is executed only when explicitly called

;reset counter for bank2

unconditionally ------------------------| FEGO2\_CT1 := 0

| FEGO2\_CT2 := 0

| FEGO2\_CT3 := 0

| FEGO2\_CT4 := 0

| FEGO2\_CT5 := 0

| FEGO2\_CT6 := 0

| FEGO2\_CT7 := 0

| FEGO2\_CT8 := 0

| FEGO2\_CT9 := 0

| FEGO2\_CT\_TOT := 0

| REGO2\_CT := 0

| FEGO2\_C2\_TOT := 0

| FEGO2\_CT\_TOT := 0

| REGO2\_CT := 0

| REGO2\_CT2 := 0

| FEGO2\_CT21 := 0

| FEGO2\_CT22 := 0

| FEGO2\_CT23 := 0

| FEGO2\_CT24 := 0

| FEGO2\_CT25 := 0

| FEGO2\_CT26 := 0

| FEGO2\_CT27 := 0

| FEGO2\_CT28 := 0

| FEGO2\_CT29 := 0

END: ftp\_reset\_bank2

10-27

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ftp\_tracking\_bank1

;This module executes a tracking switchpoint algorithm. This algorithm will

;effectively detrend the HEGO input voltage data i.e. it will count HEGO

;voltage switches that are superimposed upon a floating DC voltage. The

;algorithm detects a change in gradient sof the hego voltage signal. Upon

;detecting a gradient change it then compares the hego voltages between this

;gradient change and the last detected change. If the voltage is

;sufficiently high it recognizes that a switch has occurred.

unconditionally ------------------------| slope\_temp = VEGO\_SLOPE12

| DELTA\_VEGO12 =

| (VEGO12 - VEGO\_OLD12)

| CAT\_SW\_AMP12 =

| ABS(VEGO12 - TSP\_MXMN\_V12)

ABS(DELTA\_VEGO12) < TSP\_DBAND1 ---------| exit this routine

| ; the signal amplitude is

| ; considered to be noise.

DELTA\_VEGO12 > 0 -----------------------| VEGO\_SLOPE12 = 1

| ;positive slope

|

| --- ELSE ---

|

| VEGO\_SLOPE12 = 0

| ;negative edge

VEGO\_SLOPE12 <> slope\_temp -------------| GRAD\_CHNG12 = 1

| TSP\_MXMN\_V12 = VEGO12

|

|

|

| VEGO\_OLD12 = VEGO12

|

| --- ELSE ---

|

| GRAD\_CHNG12 = 0

| VEGO\_OLD12 = VEGO12

CAT\_SW\_AMP12 > CAT\_AMPCAL12 ------|

|AND -| TST\_SW\_FLG12 = 1

GRAD\_CHNG12 = 1 ------------------| | GRAD\_CHNG12 = 0

|

|

| --- ELSE ---

|

| GRAD\_CHNG12 = 0

| TST\_SW\_FLG12 = 0

END: ftp\_trackingsp\_bank1

10-28

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ftp\_tracking\_bank2

;This module executes a tracking switchpoint algorithm. This algorithm will

;effectively detrend the HEGO input voltage data i.e. it will count HEGO

;voltage switches that are superimposed upon a floating DC voltage. The

;algorithm detects a change in gradient sof the hego voltage signal. Upon

;detecting a gradient change it then compares the hego voltages between this

;gradient change and the last detected change. If the voltage is sufficiently

;high it recognizes that a switch has occurred.

unconditionally ------------------------| slope\_temp = VEGO\_SLOPE22

| DELTA\_VEGO22 =

| (VEGO22 - VEGO\_OLD22)

| CAT\_SW\_AMP22 =

| ABS(VEGO22 - TSP\_MXMN\_V22)

ABS(DELTA\_VEGO22) < TSP\_DBAND2 ---------| exit this routine

| ; the signal amplitude is

| ; considered to be noise.

DELTA\_VEGO22 > 0 -----------------------| VEGO\_SLOPE22 = 1

| ;positive slope

|

| --- ELSE ---

|

| VEGO\_SLOPE22 = 0

| ;negative edge

VEGO\_SLOPE22 <> slope\_temp -------------| GRAD\_CHNG22 = 1

| VEGO\_OLD22 = VEGO22

| TSP\_MXMN\_V22 = VEGO22

|

| --- ELSE ---

|

| GRAD\_CHNG22 = 0

| VEGO\_OLD22 = VEGO22

CAT\_SW\_AMP22 > CAT\_AMPCAL22 ------|

|AND -| TST\_SW\_FLG22 = 1

GRAD\_CHNG22 = 1 ------------------| | GRAD\_CHNG22 = 0

|

| --- ELSE ---

|

| GRAD\_CHNG22 = 0

| TST\_SW\_FLG22 = 0

END: ftp\_trackingsp\_bank2

10-29

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ftp\_filter

;This module is executed only when explicitly called. The filter uses time

;intervals between successive detected HEGO switches. If these switches time

;interval is below a calibratable amount they are considered to be noise or

;HEGO BUZZ and are discarded.

;Ego filter logic

unconditionally ------------------------| OBD\_RCLK\_DIF := (clock -

| OBD\_RCLK\_LST) \*

| [stfc]

| ;Time since last EGO conversion

|

| OBD\_RCLK\_LST := clock

| ;Save current clock

;Bank 1.

unconditionally ------------------------| OBD\_SW11\_DUR := OBD\_SW11\_DUR +

| OBD\_RCLK\_DIF

| ;Time since last front EGOn switch

|

| OBD\_SW12\_DUR := OBD\_SW12\_DUR +

| OBD\_RCLK\_DIF

| ;Time since last rear EGO1 switch

SWTFL11 = 1 ----------------------|

;front switch |AND -| CAT\_SWTFL11 := 1

| |

OBD\_SW11\_DUR > OBD\_MINPER --------| |

| --- ELSE ---

|

| CAT\_SWTFL11 := 0

TST\_SW\_FLG12 = 1 -----------------|

;rear switch |AND -| CAT\_SWTFL12 := 1

| |

OBD\_SW12\_DUR > OBD\_MINPER --------| |

| --- ELSE ---

|

| CAT\_SWTFL12 := 0

SWTFL11 = 1 ----------------------------| OBD\_SW11\_DUR := 0

;reset time if switch seen

TST\_SW\_FLG12 = 1 -----------------------| OBD\_SW12\_DUR := 0

;reset time if switch seen

10-30

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;Bank 2.

NUMEGO = 1 -----------------------|

|AND -| Exit ftp\_filter

HEGO\_CONFIG = 1 ------------------| | ;single bank application.

unconditionally ------------------------| OBD\_SW21\_DUR := OBD\_SW21\_DUR +

| OBD\_RCLK\_DIF

| ;Time since last front EGOn switch

|

| OBD\_SW22\_DUR := OBD\_SW22\_DUR +

| OBD\_RCLK\_DIF

| ;Time since last rear EGO2 switch

SWTFL21 = 1 ----------------------|

;front switch |AND -| CAT\_SWTFL21 := 1

| |

OBD\_SW21\_DUR > OBD\_MINPER --------| |

| --- ELSE ---

|

| CAT\_SWTFL21 := 0

TST\_SW\_FLG22 = 1 -----------------|

;rear switch |AND -| CAT\_SWTFL22 := 1

| |

OBD\_SW22\_DUR > OBD\_MINPER --------| |

| --- ELSE ---

|

| CAT\_SWTFL22 := 0

SWTFL21 = 1 ----------------------------| OBD\_SW21\_DUR := 0

;reset time if switch seen

TST\_SW\_FLG22 = 1 -----------------------| OBD\_SW22\_DUR := 0

;reset time if switch seen

END: ftp\_filter

10-31

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ftp\_am\_cell

;This module is executed only when explicitly called.

;If AM\_CELL := 0 we are not in an air mass cell and no

;ego, front or rear, switches are to be counted.

AM > AM1\_MIN ---------------------|

|AND -| AM\_CELL := 1

AM < AM1\_MAX ---------------------| | Exit ftp\_am\_cell

;AM in cell 1 |

| --- ELSE ---

AM > AM2\_MIN ---------------------| |

|AND -| AM\_CELL := 2

AM < AM2\_MAX ---------------------| | Exit ftp\_am\_cell

;AM in cell 2 |

| --- ELSE ---

AM > AM3\_MIN ---------------------| |

|AND -| AM\_CELL := 3

AM < AM3\_MAX ---------------------| | Exit ftp\_am\_cell

;AM in cell 3 |

| --- ELSE ---

AM > AM4\_MIN ---------------------| |

|AND -| AM\_CELL := 4

AM < AM4\_MAX ---------------------| | Exit ftp\_am\_cell

;AM in cell 4 |

| --- ELSE ---

AM > AM5\_MIN ---------------------| |

|AND -| AM\_CELL := 5

AM < AM5\_MAX ---------------------| | Exit ftp\_am\_cell

;AM in cell 5 |

| --- ELSE ---

AM > AM6\_MIN ---------------------| |

|AND -| AM\_CELL := 6

AM < AM6\_MAX ---------------------| | Exit ftp\_am\_cell

;AM in cell 6 |

| --- ELSE ---

AM > AM7\_MIN ---------------------| |

|AND -| AM\_CELL := 7

AM < AM7\_MAX ---------------------| | Exit ftp\_am\_cell

;AM in cell 7 |

| --- ELSE ---

AM > AM8\_MIN ---------------------| |

|AND -| AM\_CELL := 8

AM < AM8\_MAX ---------------------| | Exit ftp\_am\_cell

;AM in cell 8 |

| --- ELSE ---

AM > AM9\_MIN ---------------------| |

|AND -| AM\_CELL := 9

AM < AM9\_MAX ---------------------| | Exit ftp\_am\_cell

;AM in cell 9 |

| --- ELSE ---

|

| AM\_CELL := 0

END: ftp\_am\_cell

10-32

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ftp\_switch\_bank1

;This module is executed only when explicitly called.

;Rear/front ego switch ratio subroutine

;Bank 1.

APT = -1 -------------------|

|AND -|

CAT\_APT\_FLG = 1 ------------| |

;closed throttle |

|

CAT\_TP\_RATE > CAT\_TP\_MAX ---------|

;Throttle stable |

|

AM\_CELL = 0 ----------------------|

;not in an AM cell |OR --| Exit ftp\_switch\_bank1

| | ;not appropriate to count

FEGO1\_CT[AM\_CELL] >= | | ;HEGO switch.

FEGO1\_MX\_CT[AM\_CELL] --| |

;The current air mass cell | |

;has been filled | | CAT\_AQU\_RDY1 = 0

| | CAT\_AQU\_TMR1 = 0

CAT\_DN1\_FLG = 1 ------------------| | ;zero free running timer

| |

PTTMR < CAT\_CTPT\_TME -------------| |

;Time since leaving closed | |

;throttle for transient condition | |

;stabalization |

| --- ELSE ---

|

|

| CAT\_AQU\_RDY1 = 1

CAT\_AQU\_TMR1 <= CAT\_STBLE\_TME ----------| CAT\_AQU\_LS1 = 0

| Exit ftp\_switch\_bank1

|

| --- ELSE ---

|

| CAT\_AQU\_LS1 = 1

CAT\_SWTFL11 = 1 ------------------|

;FEGO for bank 1 switched |

|AND -| FEGO1\_CT[AM\_CELL] :=

FEGO1\_CT[AM\_CELL] | | FEGO1\_CT[AM\_CELL] + 1

> FEGO1\_C\_MIN[AM\_CELL] --| | FEGO1\_CT\_TOT :=

| FEGO1\_CT\_TOT + 1

| ;count switch for cell

| ;and total (main count only)

10-33

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CAT\_SWTFL11 = 1 ------------------|

;FEGO for bank 1 switched |

|AND -| FEGO1\_CT[AM\_CELL] :=

FEGO1\_CT[AM\_CELL] | | FEGO1\_CT[AM\_CELL] + 1

< FEGO1\_C\_MIN[AM\_CELL] -| | FEGO1\_CT\_TOT :=

| FEGO1\_CT\_TOT + 1

| ;count switch for cell

| ;and total

|

| FEGO1\_CT2[AM\_CELL] :=

| FEGO1\_CT2[AM\_CELL] + 1

| FEGO1\_C2\_TOT :=

| FEGO1\_C2\_TOT + 1

| ;count switch for cell

| ;and total (alterrnative counts)

CAT\_SWTFL12 = 1 ------------------|

;REGO for bank 1 switched |

|AND -| REGO1\_CT := REGO1\_CT + 1

FEGO1\_CT[AM\_CELL] | | ;count switch for rear total

<= FEGO1\_C\_MIN[AM\_CELL] ----| |

| REGO1\_CT2 := REGO1\_CT2 + 1.

| ;count alternative method

CAT\_SWTFL12 = 1 ------------------|

;REGO for bank 1 switched |

|AND -| REGO1\_CT := REGO1\_CT + 1

FEGO1\_CT[AM\_CELL] | | ;count switch for rear total

> FEGO1\_C\_MIN[AM\_CELL] -----|

FEGO1\_CT1 >= FEGO1\_C\_MIN1 --------|

|

FEGO1\_CT2 >= FEGO1\_C\_MIN2 --------|

|

FEGO1\_CT3 >= FEGO1\_C\_MIN3 --------|

|

FEGO1\_CT4 >= FEGO1\_C\_MIN4 --------|

|

FEGO1\_CT5 >= FEGO1\_C\_MIN5 --------|AND -| MIN\_FLG\_BK1 = 1

| |

FEGO1\_CT6 >= FEGO1\_C\_MIN6 --------| |

| |

FEGO1\_CT7 >= FEGO1\_C\_MIN7 --------| |

| |

FEGO1\_CT8 >= FEGO1\_C\_MIN8 --------| |

| |

FEGO1\_CT9 >= FEGO1\_C\_MIN9 --------| |

| --- ELSE ---

|

| MIN\_FLG\_BK1 = 0

END: ftp\_switch\_bank1

10-34

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ftp\_switch\_bank2

;Rear/Front EGO Switch Ratio Subroutine

;Bank 2.

APT = -1 -------------------|

|AND -|

CAT\_APT\_FLG = 1 ------------| |

;closed throttle |

|

CAT\_TP\_RATE > CAT\_TP\_MAX ---------|

;Throttle stable |

|

AM\_CELL = 0 ----------------------|OR --| Exit ftp\_switch\_bank2

;not in an AM cell | | ;not appropriate to count

| | ;HEGO switches

FEGO2\_CT[AM\_CELL] >= | |

FEGO2\_MX\_CT[AM\_CELL] --| |

;The current air mass cell | | CAT\_AQU\_RDY2 = 0

;has been filled | | CAT\_AQU\_TMR2 = 0

| | ;zero free running timer

NUMEGO = 1 -----------------| | |

|AND -| |

HEGO\_CONFIG = 1 ------------| | |

| |

CAT\_DN2\_FLG = 1 ------------------| |

| --- ELSE ---

|

|

| CAT\_AQU\_RDY2 = 1

CAT\_AQU\_TMR2 <= CAT\_STBLE\_TME ----------| CAT\_AQU\_LS2 = 0

| Exit ftp\_switch\_bank1

|

| --- ELSE ---

|

| CAT\_AQU\_LS2 = 1

CAT\_SWTFL21 = 1 ------------------|

;FEGO for bank 1 switched |

|AND -|

FEGO2\_CT[AM\_CELL] | | FEGO2\_CT[AM\_CELL] :=

> FEGO2\_C\_MIN[AM\_CELL] --| | FEGO2\_CT[AM\_CELL] + 1

| FEGO2\_CT\_TOT :=

| FEGO2\_CT\_TOT + 1

| ;count switch for cell

| ;and total (main count only)

10-35

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CAT\_SWTFL21 = 1 ------------------|

;FEGO for bank 2 switched |

|AND -| FEGO2\_CT[AM\_CELL] :=

FEGO2\_CT[AM\_CELL] | | FEGO2\_CT[AM\_CELL] + 1

< FEGO2\_C\_MIN[AM\_CELL] -| | FEGO2\_CT\_TOT :=

| FEGO2\_CT\_TOT + 1

| ;count switch for cell and total

|

| FEGO2\_CT2[AM\_CELL] :=

| FEGO2\_CT2[AM\_CELL] + 1

| FEGO2\_C2\_TOT :=

| FEGO2\_C2\_TOT + 1

| ;count switch for cell

| ;and total (alterrnative counts)

CAT\_SWTFL22 = 1 ------------------|

;REGO for bank 1 switched |

|AND -| REGO2\_CT := REGO2\_CT + 1

FEGO2\_CT[AM\_CELL] | | ;count switch for rear total

<= FEGO2\_C\_MIN[AM\_CELL] ----| |

| REGO2\_CT2 := REGO2\_CT2 + 1

| ;count alternative method

CAT\_SWTFL22 = 1 ------------------|

;REGO for bank 1 switched |

|AND -| REGO2\_CT := REGO2\_CT + 1

FEGO2\_CT[AM\_CELL] | | ;count switch for rear total

> FEGO2\_C\_MIN[AM\_CELL] -----|

FEGO2\_CT1 >= FEGO2\_C\_MIN1 --------|

|

FEGO2\_CT2 >= FEGO2\_C\_MIN2 --------|

|

FEGO2\_CT3 >= FEGO2\_C\_MIN3 --------|

|

FEGO2\_CT4 >= FEGO2\_C\_MIN4 --------|

|

FEGO2\_CT5 >= FEGO2\_C\_MIN5 --------|AND -| MIN\_FLG\_BK2 = 1

| |

FEGO2\_CT6 >= FEGO2\_C\_MIN6 --------| |

| |

FEGO2\_CT7 >= FEGO2\_C\_MIN7 --------| |

| |

FEGO2\_CT8 >= FEGO2\_C\_MIN8 --------| |

| |

FEGO2\_CT9 >= FEGO2\_C\_MIN9 --------| |

| --- ELSE ---

|

| MIN\_FLG\_BK2 = 0

END: ftp\_switch\_bank2

10-36

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ftp\_ratio\_bank1

;This module is executed only when explicitly called.

;Ratio calculation.

;Bank 1.

CAT\_DN1\_FLG = 1 ------------------------| exit routine

| ; bank already completed once this

| ; trip

FEGO1\_CT\_TOT = 0 -----------------------| EGO1\_RF\_RAT1 := 0

| ;prevent divide by zero

|

| --- ELSE ---

|

| EGO1\_RF\_RAT1 :=

| REGO1\_CT / FEGO1\_CT\_TOT

| ;Compute switch ratio

FEGO1\_C2\_TOT = 0 -----------------------| EGO1\_RF\_RAT2 := 0

| ;prevent divide by zero

|

| --- ELSE ---

|

| EGO1\_RF\_RAT2 :=

| REGO1\_CT2/ FEGO1\_C2\_TOT

| ;Compute switch ratio

10-37

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CAT\_TMR\_ACT > CAT\_TIER1 ----------|

;exceeded minimum time in test |

;TIER1 TEST |AND -| CAT\_DN1\_FLG := 1

| | ;Catalyst test completed (alt)

MIN\_FLG\_BK1 = 1 ------------------| | EGO1\_RF\_RAT := EGO1\_RF\_RAT2

;The result is valid only if all |

;cells have at least minimum number |

;of switches - TIER2 TEST. |

| --- ELSE ---

|

FEGO1\_CT\_TOT >= FEGO1\_MX\_TOT -----------| CAT\_DN1\_FLG := 1

| ;Catalyst test completed

| EGO1\_RF\_RAT := EGO1\_RF\_RAT1

|

| --- ELSE ---

|

| Exit ftp\_ratio\_bank1

| ;test not yet complete

;Test completed -- reset counters

;decide which filter constant to use based on KAM warm-up counter value.

;NOTE: If you need to use a single filter constant value then set EGO\_CAT\_FKA

; equal to EGO\_CAT\_FKB.

; IF EGO\_CAT\_FKA DOES NOT EQUAL ECG\_CAT\_FKB THEN 1.3 X THRESHOLD

EMISSIONS

MUST BE MET

!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

KWUCTR < CAT\_KWU\_CNT -------------------| fk\_temp = EGO\_CAT\_FKA

|

| --- ELSE ---

|

| fk\_temp = EGO\_CAT\_FKB

EGO1\_RF\_RAT > EGO1\_RF\_AVE + EGO\_RF\_DEL -| EGO1\_RF\_AVE := EGO1\_RF\_RAT

;ratio out of believable range | ;use new ratio for average

;-- catastrophic failure |

| --- ELSE ---

|

| EGO1\_RF\_AVE := ROLAV(EGO1\_RF\_RAT,

| fk\_temp)

| ;put ratio in averaging function

EGO1\_RF\_AVE > EGO1\_FL\_RAT --------------| CAT1\_FAILED := 1

;ratio indicates failure |

| --- ELSE ---

|

| CAT1\_FAILED := 0

unconditionally ------------------------| Do: ftp\_reset\_bank1

| ;reset counters

END: ftp\_ratio\_bank1

10-38

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ftp\_ratio\_bank2

;This module is executed only when explicitly called.

;Ratio calculation.

;Bank 2.

NUMEGO = 1 -----------------------|

|AND -| Exit ftp\_ratio\_bank2

HEGO\_CONFIG = 1 ------------------|

CAT\_DN2\_FLG = 1 ------------------------| exit routine

| ; bank already completed once this

| ; trip

FEGO2\_CT\_TOT = 0 -----------------------| EGO2\_RF\_RAT1 := 0

|

| ;prevent divide by zero

|

| --- ELSE ---

|

| EGO2\_RF\_RAT1 :=

| REGO2\_CT / FEGO2\_CT\_TOT

| ;Compute switch ratio

FEGO2\_C2\_TOT = 0 -----------------------| EGO2\_RF\_RAT2 := 0

| ;prevent divide by zero

|

| --- ELSE ---

|

| EGO2\_RF\_RAT2 :=

| REGO2\_CT2/ FEGO2\_C2\_TOT

| ;Compute switch ratio

10-39

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CAT\_TMR\_ACT > CAT\_TIER1 ----------|

;exceeded minimum time in test |

;TIER1 TEST |AND -| CAT\_DN2\_FLG := 1

| | ;Catalyst test completed (alt)

MIN\_FLG\_BK2 = 1 ------------------| | EGO2\_RF\_RAT := EGO2\_RF\_RAT2

;The result is valid only if all |

;cells have at least minimum number |

;of switches - TIER2 TEST. |

| --- ELSE ---

|

| CAT\_DN2\_FLG := 1

| ;Catalyst test completed

FEGO2\_CT\_TOT >= FEGO2\_MX\_TOT -----------| EGO2\_RF\_RAT := EGO2\_RF\_RAT1

|

| --- ELSE ---

|

| Exit ftp\_ratio\_bank2

| ;test not yet complete

;Test completed -- reset counters

;decide which filter constant to use based on KAM warm-up counter value.

;NOTE: If you need to use a single filter constant value then set EGO\_CAT\_FKA

; equal to EGO\_CAT\_FKB.

; IF EGO\_CAT\_FKA DOES NOT EQUAL ECG\_CAT\_FKB THEN 1.3 X THRESHOLD

EMISSIONS

MUST BE MET

!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

KWUCTR < CAT\_KWU\_CNT -------------------| fk\_temp = EGO\_CAT\_FKA

|

| --- ELSE ---

|

| fk\_temp = EGO\_CAT\_FKB

EGO2\_RF\_RAT > EGO2\_RF\_AVE + EGO\_RF\_DEL -| EGO2\_RF\_AVE := EGO2\_RF\_RAT

;ratio out of believable range | ;use new ratio for average

;-- catastrophic failure |

| --- ELSE ---

|

| EGO2\_RF\_AVE := ROLAV(EGO2\_RF\_RAT,

| fk\_temp)

| ;put ratio in averaging function

EGO2\_RF\_AVE > EGO2\_FL\_RAT --------------| CAT2\_FAILED := 1

;ratio indicates failure | ;Catalyst failed

|

| --- ELSE ---

|

| CAT2\_FAILED := 0

| ;Catalyst passed

10-40

CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

unconditionally ------------------------| Do: ftp\_reset\_bank2

| ;reset counters

END: ftp\_ratio\_bank2

BEGIN: ftp\_codes

;This module is executed only when explicitly called.

;Set trouble codes if Catalyst failed.

CAT\_DN1\_FLG = 1 ------------------|

;test complete once |

|

CAT1\_FAILED = 1 ------------------|AND -| Do: malfunction(catalyst,P0420)

;bank one failed | |

| |

CAT\_TST\_ENA = 1 ------------------| |

;enabled by exec |

| --- ELSE ---

CAT\_TST\_ENA = 1 ------------------| |

;enabled by exec |AND -| Do: clear\_malf(P0420MALF)

|

CAT\_DN1\_FLG = 1 ------------------|

;test complete once

CAT\_DN2\_FLG = 1 ------------------|

;test complete once |

|

CAT2\_FAILED = 1 ------------------|AND -| Do: malfunction(catalyst,P0430)

;bank two failed | |

| |

CAT\_TST\_ENA = 1 ------------------| |

;enabled by exec |

| --- ELSE ---

CAT\_TST\_ENA = 1 ------------------| |

;enabled by exec |AND -| Do: clear\_malf(P0430MALF)

|

CAT\_DN2\_FLG = 1 ------------------|

;test complete once

CAT\_DN1\_FLG = 1 ------------------|

;bank1 done |

|

CAT\_DN2\_FLG = 1 ------------| |

;bank2 done | |AND -| CAT\_MON := 1

|OR --| | CAT\_DN1\_FLG := 0

NUMEGO = 1 -----------| | | | CAT\_DN2\_FLG := 0

;only one bank |AND -| | | ;test completed at least once

| |

HEGO\_CONFIG = 1 ------| |

|

CAT\_TST\_ENA = 1 ------------------|

;test enabled

END: ftp\_codes

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CATALYST BYPASS CONTROL STRATEGY, FTP CATALYST MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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CHAPTER 11

EGO MONITOR CONTROL STRATEGY

11-1

EGO MONITOR CONTROL STRATEGY

11.1 FEATURE: HEGO MONITOR - V10.6\_EGO\_MONITOR (CDAN0)

11.1.1 EGO MONITOR CONTROL (CDAN0)

+----------------------------+

| EGO\_MONITOR\_CONTROL\_COM10 |

+----------------------------+

|PUBLIC PROCEDURES: |

|. ego\_monitor\_controller |

+----------------------------+

|PRIVATE PROCEDURES: |

|. disable\_fuel\_modulation |

|. ego\_tst\_rdy\_control |

+------------------+---------+

|

+-----------------------------+ |

| EGO\_INPUT\_COM10 | |

+-----------------------------+ | (This process called

|. ego\_input\_init |<-- RAM init. | in the background.)

|. background\_ego\_input |<-----X ------|

+-----------------------------+ |

|

+-----------------------------+ |

| EGO\_CSD\_DETECTION\_COM | | (CSD FFG\_CSD flag

+-----------------------------+ | logic)

|. csd\_detection\_init |<-----------------| COM1 -> FFG\_CSD algo

|. csd\_detection\_kam\_reset |<-----------------| COM2 -> stub

|. csd\_detection\_process |<-----------------|

+-----------------------------+ |

|

+----------------------------------+ |

| EGO\_CONTINUOUS\_TEST\_COM10 | |

+----------------------------------+ |

|PUBLIC PROCEDURES: | |

|. bg\_check\_entry\_conditions |<------------|

+----------------------------------+ |

|

+----------------------------------+ |

| EGO\_US\_MONITOR\_COM10 | |

+----------------------------------+ |

|PUBLIC PROCEDURES: | |

|. check\_upstream\_entry\_conditions |<------------|

|. check\_upstream\_results |<------------|

|. check\_upstream\_static\_shift |<------------|

|. upstream\_ego\_monitor |<------------|

|. upstream\_ego\_sampling |<-- 8ms |

|. upstream\_initialization |<------------|

|. upstream\_overvoltage\_check |<------------|

|. reset\_overvoltage\_us |<------------|

+----------------------------------+ |

|

(continued on next page)

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EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

+----------------------------------+ |

| EGO\_DS\_MONITOR\_COM10 | |

+----------------------------------+ |

|PUBLIC PROCEDURES: | |

|. detect\_ds\_ego\_malf |<------------|

|. downstream\_ego\_monitor |<------------|

|. downstream\_initialization |<-- RAM init.|

|. forced\_downstream\_excursion |<------------|

|. determine\_flg\_ego\_idle |<------------|

|. abort\_ds\_ego\_monitor |<------------|

|. stop\_excursion\_check |<------------|

|. downstream\_overvoltage\_check |<------------|

|. reset\_overvoltage\_ds |<------------|

+----------------------------------+ |

|

+-----------------------------+ |

| EGO\_HEATER\_CONTROL\_COM10 | |

+-----------------------------+ |

|PUBLIC PROCEDURES: | |

|. heater\_initialization |<-- RAM init. |

|. ego\_heater\_monitor |<-----------------|

+-----------------------------+ |

|

+-----------------------------+ |

| EGO\_REV\_COUNTER\_COM | | (update sync count)

+-----------------------------+ | COM2 -> V10 engine

|. rev\_counting\_process |<-----------------+ COM1 -> all others

+-----------------------------+

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EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO MONITOR INTERFACE REQUIREMENTS TO

REMAINDER OF CONTROL STRATEGY

+-----------------+

| FUEL\_LAMBSE\_MOD |<------+---- LAM\_MOD\_FLG

+-----------------+ |

|

+------------+ |

| FUEL\_ADAPT |<-----------+ (disable adaptive)

+------------+ |

|

+-------------------+ |

| CANP\_PCOMP\_ENABLE |<----+ (disable purge)

+-------------------+ |

|

+----------------+ |

| FUEL\_CL\_LAMBSE |<-------+ (use unique bias, tdrevs)

+----------------+ |

|

+--------------+ |

| FUEL\_BG\_CALC |<---------+ (modify commanded A/F ratio)

+--------------+ |

|

+----------------+ |

| FUEL\_REGO\_TRIM |<-------+ (disable R\_BIAS updates)

+----------------+

+----------------+<----------- DS\_EGO\_RICHn (rich excursion)

| FUEL\_OL\_LAMBSE |<----------- DS\_EGO\_LEANn (lean excursion)

+----------------+

+------------+

| FUEL\_OLFLG |<---------------- DS\_EGO\_OL (force open loop

+------------+ during excursion)

Main entry point for the HEGO Monitor. All HEGO tests, with the exception of

the KOER self test, are called from this module.

This module is used to control the OBDII EGO monitor for Y-pipe, dual bank

and single bank applications using FAOSC method #2. This includes control

and coordination of the upstream, and downstream EGO monitors as well as the

EGO heater monitor. OBDII regulations require monitoring of the upstream EGO

sensors to detect when the deterioration of the sensor has proceeded to a

point where the emissions requirements have been exceeded by 1.5 times the

standard for a new vehicle.

Five main software modules are used to fulfill this monitoring requirement.

These modules are shown above pictorially and include the

EGO\_MONITOR\_CONTROL, EGO\_US\_MONITOR, EGO\_DS\_MONITOR, EGO\_HEATER\_CONTROL, and

EGO\_CONTINUOUS\_TEST.

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EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

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Shown in the diagram above are the names of the processes contained within

each one of the modules. Some of the processes are PUBLIC. That means they

are invoked from somewhere external to the module. The remainder of the

processes are PRIVATE (not shown in the diagram above). That means they are

only invoked from within the module in which they reside and no other process

has any knowledege of their existence.

Additionally, a number of other software modules are modified slightly to

allow proper operation of the powertrain during all phases of the EGO

monitor. These additional modules and the interface flags used to control

execution flow within them during the EGO monitor is shown in the INTERFACE

REQUIREMENTS diagram shown above.

This module contains the public process, ego\_monitor\_controller, which is

invoked once each background pass. It monitors system parameters and signals

from the OBDII diagnostic executive and uses this information to initiate,

continue, or abort an EGO monitor test sequence.

Also contained within this module are two private processes. The first,

rev\_counting\_process, is a foreground process. It executes each PIP high

interrupt and is used to count engine revolutions. It is used to ensure

stabalized engine operation after initiating high frequency fuel modulation.

The second private process contained within this module,

disable\_fuel\_modulation, is used to place the EGO monitor in an initial

state. This can be invoked when the diagnostic executive disables the EGO

monitor, or when the local entry conditions to execute the upstream EGO

monitor are violated during a test of the upstream EGO sensors.

During normal operation of the vehicle, the EGO monitor will follow the

following execution sequence:

I. Test is enabled from the Diagnostic Executive.

II. Local entry conditions are satisified.

III. High frequency fuel modulation begins.

IV. After a number of engine revolutions, sampling of the upstream EGO

sensors starts occuring every 16 milliseconds. Upstream EGO sensor voltage

statistics are computed.

V. After a number of comanded LAMBSE cycles occur, high frequency fuel

modulation is disabled, and 16 millisecond sampling is disabled.

VI. EGO signal amplitude is calculated for each of the upstream sensors.

These statistics are compared to calibrated limits and a decision is made as

to the health of the upstream EGO sensors.

VII. The voltage envelope of the downstream EGO sensors is checked, and if

it not sufficently large because a minimum rich voltage on bank 1 or a

minimum lean voltage on bank 2 has not been observed, then the fuel control

is forced into open loop and a rich A/F ratio is commanded for bank 1.

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EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

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VIII. After the calibrated number of seconds times out or the required rich

voltage is seen the rich A/F excursion is discontinued. If a required

minimum lean EGO sensor voltage has not been seen up to this point then the

fuel control is forced into open loop operation and a lean and A/F ratio is

commanded for a calibrated number of seconds for the appropriate bank.

IX. After the calibrated number of seconds times out or the required lean

EGO sensor voltage is seen, the lean A/F excursion is discontinued.

X. A decision is made on the relative health of the downstream EGO sensors

based on the voltage envelope attained on the downstream EGO sensors.

Simultaneously to all of the above, whenever an overvoltage condition occurs

on any EGO sensor, a malfunction will be identified to the diagnostic

executive and no further testing of the malfunctioning sensor will take

place.

Also, the EGO heaters will be testes by rapidly turning them on and then off

and then back on again and recording the activity on the OSM (output state

monitor) input for each of the EGO heaters. Malfunctions will be identified

to the diagnostic executive when a faulty heater is found.

In order to ensure EGO tests can be included/excluded as required to match

the particular application a set of configuration switches are made available

to the calibrator. The table below shows the calibration in order to turn

all EGO monitor tests on:

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EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

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EGO MONITOR CALIBRATION ENABLEMENT

EGO TEST NAME APPLICABLE CALIBRATION SWITCH

-------------------------- ----------------------------------

UPSTREAM EGO MONITOR \*EGO\_TST\_SW = 1

DOWNSTREAM EGO MONITOR \*EGO\_TST\_SW = 1

EGO HEATER MONITOR (CONT) \*EGO\_HTR\_SW = 1 & [EGO\_TST\_SW = 1

OR CCM\_TST\_SW = 1]

EGO HEATER MONITOR (KOER) \*EGO\_HTR\_SW = 1

EGO HEATER CHECK (KOEO) EGO\_HTR\_SW = 1

EGO SWITCH TEST (CONT) \*V\_EGO\_ENA = 1

EGO U.S. SWITCH TEST (KOER) V\_EGO\_ENA = 1

EGO D.S. SWITCH TEST (KOER) V\_EGO\_ENA = 1 & DS\_KOER\_SW = 1

OVERVOLTAGE (CONT) \*EGO\_TST\_SW = 1 OR CCM\_TST\_SW = 1

OVERVOLTAGE (KOER) \*unconditional

OVERVOLTAGE (KOEO) \*unconditional

\* : Test can also be allowed to execute, but failure limits can be used to

calibrate out the test.

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EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled.

- DS\_DLY\_TMR = Timer used to measure the amount of time an A/F excursion

has been active to test the downstream EGO sensors. Timer, Free running

down counter, Units: SECONDS, Range: 0 - 60, Resolution: 0.25.

- DS\_HTR\_TMR = Elapsed time downstream EGO heaters have been on, seconds.

- DS\_STATE = State variable to be used during the

forced\_downstream\_excursion EGO monitor test.

- EGO\_REV\_CTR = Count of the number of revolutions of the engine that have

occured since starting the rev\_counting\_process in the

ego\_monitor\_controller. Register, Units: engine revs., Range: 0 - 100,

Resolution: 1.

- EXT\_FEU = Inferred unheated tip temperature at the front HEGO sensor

location, degrees.

- EXT\_FLANGE = Instantaneous inferred exhaust flange temperature.

- EXT\_REG = Inferred tip temperature for the downstream EGO sensor.

- KAM\_ERROR = Indicates Keep Alive RAM invalid.

- LAM\_CYCLES = Number of commanded LAM\_MOD cycles that have occured since

starting the upstream EGO monitor.

- LOAD = Universal load as a ratio of air charge over standard air charge.

- LOAD\_EGO = Filtered LOAD for use in the EGO monitor.

- N = Engine RPM.

- N\_EGO = Filtered engine speed for use in the EGO monitor.

- OL\_DESIRED = Open loop fuel desired flag.

- VS = Instantaneous vehicle speed, MPH.

- VS\_EGO = Filtered VS for use in the EGO monitor.

Bit Flags:

- ABORT\_DONE = Flag indicating the EGO monitor abort process is complete.

1 -> abort is complete.

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag; 1 -> test

enabled.

- CCM\_TST\_RDY = CCM test ready flag; 1 -> all local conditions have been

met; ready to run CCN test.

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EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- CURR\_TST\_ENA = Flag used to start the EGO heater current measurement.

- DS\_EGO\_LEAN1 = Flag used by the downstream EGO monitor to trigger a lean

A/F excursion for bank 1; 1 -> excursion is in progress.

- DS\_EGO\_LEAN2 = Flag used by the downstream EGO monitor to trigger a lean

A/F excursion for bank 2; 1 -> excursion is in progress.

- DS\_EGO\_OL = Flag used to force open loop fuel control during a forced A/F

excursion to test the downstream EGO sensors.

- DS\_EGO\_RICH1 = Flag used by the downstream EGO monitor to trigger a rich

A/F excursion for bank 1; 1 -> excursion is in progress.

- DS\_EGO\_RICH2 = Flag used by the downstream EGO monitor to trigger a rich

A/F excursion for bank 2; 1 -> excursion is in progress.

- EGO\_DS\_MON = Flag used to signal when the downstream EGO monitor has run

to completion.

- EGO\_HTR\_MON = Monitor flag for the EGO heaters; 1 -> all EGO faults have

been monitored at least once since power-up.

- EGO\_MON11 = EGO11 monitored flag; 1 -> sensor monitored.

- EGO\_MON21 = EGO21 monitored flag; 1 -> sensor monitored.

- EGO\_RETEST = Flag used to trigger a retest of the upstream EGO monitor; 1

-> Retest the upstream EGOs.

- EGO\_REV\_ENA = Flag used to enable the rev\_counting\_process in the

ego\_monitor\_controller; 1 -> enable the foreground rev\_counting\_process.

- EGO\_REV\_FLG = Flag used to trigger the capture of the SYNC\_CTR in the

foreground rev\_counting\_process; 1 -> capture SYNC\_CTR on next PIP high

interrupt.

- EGO\_STAT11 = Flag indicating the first EGO11 switch has been encountered,

start the area ratio calculation.

- EGO\_STAT21 = Flag indicating the first EGO21 switch has been encountered,

start the area ratio calculation.

- EGO\_TST\_ENA = OBD-II EGO test enable flag; 1 -> test enabled.

- EGO\_TST\_RDY = EGO test ready flag; 1 -> all local conditions have been

met; ready to run EGO test.

- EGO\_US\_MON = Flag used to signal when the upstream EGO monitor has run to

completion.

- EGO\_WIND\_SET = Flag indicating EGO monitor steady state window conditions

have been set; 1 -> window conditions set.

- LAM\_MOD\_FLG = Flag used to initiate high frequency fuel modulation for

the upstream EGO monitor; 1 -> fuel modulation active.

11-9

EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PxxxMALF = Malfunction flag for code Pxxx; 1 -> a malfunction currently

exists for fault Pxxx.

- SMPL\_EGO\_FLG = Flag used to enable the foreground EGO samling process

used on the upstream EGO sensors; 1 -> enable the sampling.

- STOP\_EXCURS = Flag used to signal when a forced downstream ego monitoring

excursion is not allowed.

Calibration Constants:

- DS\_HEAT\_TM = Amount of time into run mode when the downstream EGO sensors

heaters have been on long enough to allow testing of the downstream EGO

sensors. Calibration Constant, Units: SECONDS, Range: 0 - 255,

Resolution: 1. Base value: 60.

- DS\_OV\_ON = Minimum downstream EGO tip temperature to enable overvoltage

monitor to run.

- EGO\_HTR\_SW = Calibration switch to enable EGO heater controls and

monitoring.

- EGO\_TST\_SW = EGO test present calibration switch; 1 -> EGO test present.

- LAM\_CYC\_MAX = Number of commanded LAMBSE fuel modulation cycles to

perform for the EGO monitor w/FAOSC active.

- NUMEGO = Number of EGO sensors.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II scan tool

reset message.

- TCLOAD\_EGO = Time constant for filtered LOAD for use in the EGO monitor,

sec.

- TCN\_EGO = Time constant for filtered N for use in the EGO monitor, sec.

- TCVS\_EGO = Time constant for filtered VS for use in the EGO monitor, sec.

- US\_OV\_ON = Minimum upstream EGO tip temperature to enable overvoltage

monitor to run.

- US\_REV\_DLY = Number of engine revolutions to delay entry into the

upstream EGO monitor after starting high frequency fuel modulation.

Claibration Constant, Units: engine revolutions, Range: 0 - 100,

Resolution: 1.

OTHER

- ego\_codes = set of (upstream\_ego\_codes, downstream\_ego\_codes,

ego\_htr\_codes, ego\_on\_demand\_codes). The set of OBD-II fault codes that

relate to the ego monitor.

- P0132 = Heated oxygen sensor circuit voltage out of range, sensor 11.

- P0152 = Heated oxygen sensor circuit voltage out of range, sensor 12.

11-10

EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EGO\_MONITOR\_CONTROL\_COM10

BEGIN: ego\_monitor\_controller

;

;This procedure is executed once per background pass and controls the

;execution of the HEGO monitor, including the upstream and downstream

;functional checks, heater control and monitor logic, and the continuous

;switching test.

;

unconditionally -----------------------| Do: ego\_lambse\_clips

| ;set adaptive lambse clips

| ;to cal constants (if adaptive

| ;algorithm not installed).

EGO\_TST\_SW = 1 ------------------------| LOAD\_EGO = rolav(LOAD, TCLOAD\_EGO)

;filter inputs to define steady | VS\_EGO = rolav(VS, TCVS\_EGO)

;state and start continuous tests. | N\_EGO = rolav(N, TCN\_EGO)

| Do: update\_ego\_cl\_tmr

| ego\_window\_set := EGO\_WIND\_SET

| ;capture current value of window

| Do: check\_upstream\_entry\_conditions

| ;this updates value of window

| Do: determine\_flg\_ego\_idle

| Do: stop\_excursion\_check

| Do: ego\_tst\_rdy\_control

EGO\_HTR\_SW = 1 ------------------------| Do: ego\_heater\_control

EGO\_TST\_ENA = 1 -----------------|

|

CCM\_ER\_ENA = 1 ------------------|

|OR --| test\_enabled := 1

CCM\_TST\_ENA = 1 -----------------| |

| |

CCM\_EO\_ENA = 1 ------------------| |

| --- ELSE ---

|

| test\_enabled := 0

11-11

EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P0132MALF = 1 -------|

|

P0152MALF = 1 -------|AND -|

| |

NUMEGO = 2 ----------| |

|OR --|

P0132MALF = 1 -------| | |

|AND -| |

NUMEGO = 1 ----------| | |AND -| Do: upstream\_overvoltage\_check

| | | ;only test for overvoltage if

OL\_DESIRED = 0 ------------| | | ;closed loop is desired and the

| | ;sensor location is hot enough OR

test\_enabled = 1 ----------------| | ;overvoltage fault has forced

| | ;open loop.

EXT\_FEU > US\_OV\_ON --------------| |

| --- ELSE ---

|

| Do: reset\_overvoltage\_us

| ;freeze OV timers.

DS\_HTR\_TMR > DS\_OV\_TIME ---------|

|

test\_enabled = 1 ----------------|AND -| Do: downstream\_overvoltage\_check

| | ;only test for overvoltage if

EXT\_REG > DS\_OV\_ON --------------| | ;heaters have been on long enough

| ;and the sensor location is

| ;hot enough.

| --- ELSE ---

|

| Do: reset\_overvoltage\_ds

| ;freeze OV timers.

test\_enabled = 1 ----------------------| Do: downstream\_ego\_monitor

| ;perform functional check of

| ;downstream sensors.

| Do: check\_upstream\_static\_shift

| ;check the FAOSC R\_BIASn values.

test\_enabled = 1 ----------------|

|AND -| Do: csd\_detection\_process

CCM\_EO\_ENA = 0 ------------------| | ;check upstream EGO sensors for

| ;characteristic shift downward.

11-12

EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OBDII\_RESET = 1 -----------------|

;system reset. |OR --| Do: disable\_fuel\_modulation

| | Do: upstream\_initialization

KAM\_ERROR = 1 -------------------| | EGO\_TST\_RDY := 0

| ;interface requirement from

| ;the executive to hold this

| ;low for at least one BG pass.

| EGO\_MON11 := 0

| EGO\_MON21 := 0

| EGO\_US\_MON := 0

| EGO\_DS\_MON := 0

| EGO\_HTR\_MON := 0

| Do: abort\_ds\_ego\_mon

| ;take actions that occur only on

| ;disable from executive.

| CURR\_TST\_ENA := 0

| ABORT\_DONE := 1

| Do: csd\_detection\_init

KAM\_ERROR = 1 -------------------------| Do: reset\_ego\_heater

| Do: reset\_us\_ego\_monitor

| Do: csd\_detection\_kam\_reset

EGO\_TST\_ENA = 0 -----------------|

|AND -| EGO\_TST\_RDY := 0

ABORT\_DONE = 0 ------------------| | ;interface requirement from

;test is disabled from the | ;the executive to hold this

;executive. | ;low for at least one BG pass.

| Do: disable\_fuel\_modulation

| DS\_EGO\_OL := 0

| DS\_EGO\_RICH1 := 0

| DS\_EGO\_RICH2 := 0

| DS\_EGO\_LEAN1 := 0

| DS\_EGO\_LEAN2 := 0

| DS\_DLY\_TMR := 0

| CURR\_TST\_ENA := 0

| ABORT\_DONE := 1

NUMEGO = 1 ----------------------------| EGO\_MON21 := true

;single bank system.

11-13

EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO\_TST\_ENA = 1 -----------------|

;Test enabled from the executive|

|

EGO\_WIND\_SET = 1 ----------------|

;entry conditions not met |

;last pass. |

|AND -| LAM\_MOD\_FLG := 1

LAM\_MOD\_FLG = 0 -----------------| | ;initiate fuel modulation.

;test not currently running. | | EGO\_REV\_FLG := 1

| | ;trigger foreground process

EGO\_MON11 = 0 -------------| | | ;to capture sync\_ctr.

;upstream monitor not done| | | EGO\_REV\_CTR := 0

;for bank1. |OR --| | EGO\_REV\_ENA := 1

| | ;enable the rev\_counting\_process

EGO\_MON21 = 0 -------------| | ;in the foreground.

;upstream monitor not done | ABORT\_DONE := 0

;for bank2. | Do: upstream\_initialization

| ;get ready to perform testing

| Do: csd\_detection\_init

|

|

| --- ELSE ---

EGO\_TST\_ENA = 1 -----------------| |

;Test enabled from the executive| |

| |

EGO\_WIND\_SET = 0 ----------------| |

;local entry conditions not | |

;met. | |

|AND -| Do: disable\_fuel\_modulation

ego\_window\_set = 1 --------------| | ;aborted due to local entry

;window was set last pass and is| | ;conditions not being met.

;closed now. |

|

EGO\_MON11 = 0 -------------| |

;upstream monitor not done| |

;for bank1. |OR --|

|

EGO\_MON21 = 0 -------------|

;upstream monitor not done

;for bank2.

11-14

EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO\_TST\_ENA = 1 -----------------|

;Test enabled from the executive|

|

EGO\_WIND\_SET = 1 ----------------|

|AND -| ;delay complete, perform monitor.

EGO\_REV\_CTR >= US\_REV\_DLY -------| | EGO\_REV\_ENA := 0

| | ;disable the rev\_counting\_process

EGO\_MON11 = 0 -------------| | | ;in the foreground.

;upstream monitor not done| | | SMPL\_EGO\_FLG := 1

;for bank1. |OR --| | ;enable 16ms EGO sampling

| | Do: upstream\_ego\_monitor

EGO\_MON21 = 0 -------------|

;upstream monitor not done

;for bank2.

EGO\_TST\_ENA = 1 -----------------|

;Test enabled from the executive|

|

EGO\_WIND\_SET = 1 ----------------|

|AND -| ;upstream monitor complete.

EGO\_REV\_CTR >= US\_REV\_DLY -------| | Do: check\_upstream\_results

| | Do: disable\_fuel\_modulation

LAM\_CYCLES >= LAM\_CYC\_MAX -| |

|OR --|

EGO\_MON11 = 1 -------| |

|AND -|

EGO\_MON21 = 1 -------|

;overvoltage or RBIAS

;extreme.

EGO\_TST\_ENA = 1 -----------------|

;test is enabled from the |

;diagnostic executive. |

|

EGO\_MON11 = 1 -------------------|

;upstream monitor done |

;for bank1. |AND -| EGO\_US\_MON := 1

| | ;upstream monitor complete.

EGO\_MON21 = 1 -------------------|

;upstream monitor done |

;for bank2. |

|

EGO\_US\_MON = 0 ------------------|

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EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO\_TST\_ENA = 1 -----------------|

;test is enabled from the |

;diagnostic executive. |

|

EGO\_US\_MON = 1 ------------------|AND -| ;upstream monitor complete.

;upstream monitor complete. | | ;AND valid results were achived.

| | Do: forced\_downstream\_excursion

DS\_STATE <> final\_state ---------| | ;check downstream ego monitor

;final\_state is defined in | | ;and force rich and/or lean air

;the downstream ego monitor | | ;fuel excursion to check

| | ;downstream sensors.

DS\_HTR\_TMR > DS\_HEAT\_TM ---------|

;downstream heaters are warm.

EGO\_TST\_ENA = 1 -----------------|

;test is enabled from the |

;diagnostic executive. |

|AND -| ;downstream monitoring complete

EGO\_DS\_MON = 0 ------------------| | Do: detect\_ds\_ego\_malf

;downstream monitor is not done | | EGO\_DS\_MON := 1

|

DS\_STATE = final\_state ----------|

EGO\_US\_MON = 1 ------|

|AND ----|

EGO\_DS\_MON = 1 ------| |

|OR ---| CURR\_TST\_ENA := 1

CCM\_EO\_ENA = 1 ---------------| | ;once per drive.

| | ;perform current monitoring

CCM\_ER\_ENA = 1 ---------------|

EGO\_DS\_MON = 1 ------------------|

|

EGO\_US\_MON = 1 ------------------|AND -| EGO\_MON := 1

| | ;ego monitoring complete.

EGO\_HTR\_MON = 1 -----------------|

unconditionally -----------------------| Do: bg\_check\_entry\_conditions

| ;continuous lack of switching test

| Do: ego\_er\_switching\_test

| ;koer hego test

| Do: ego\_ffg\_control

| ;ffg\_ego fault flag checks

END: ego\_monitor\_controller

11-16

EGO MONITOR CONTROL STRATEGY, EGO MONITOR CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego\_tst\_rdy\_control

;This process, called from the ego\_monitor\_controller once per background

;pass is used to control the interface to the OBD-II Diagnostic Executive

;via the EGO\_TST\_RDY flag. The flag will be set during the upstream monitor

;while the speed/load window is open. After completion of the

;upstream monitor and during the execution of the downstream monitor and

;afterward until the ego heater monitor is complete.

EGO\_WIND\_SET = 1 ----------------------|

|

EGO\_US\_MON = 1 ------------------| |

|AND -|

STOP\_EXCURS = 0 -----------------| |OR --| EGO\_TST\_RDY := 1

| |

EGO\_DS\_MON = 1 ------------------| | |

| | |

EGO\_HTR\_MON = 0 -----------------|AND -| |

| |

EGO\_US\_MON = 1 ------------------| |

| --- ELSE ---

|

| EGO\_TST\_RDY := 0

END: ego\_tst\_rdy\_control

BEGIN: disable\_fuel\_modulation

;This process is used to abort the EGO monitor in the middle of execution

;due to local driving conditions falling outside the operating window or

;diagnostic executive intervention. This process is initiated from within

;the EGO monitor controller.

;It places the EGO monitor in a state ready to be run again when

;the entry conditions have been again met.

unconditionally -----------------------------| LAM\_MOD\_FLG := 0

| ;disable fuel modulation.

| SMPL\_EGO\_FLG := 0

| ;disable 16ms sampling.

| EGO\_REV\_ENA := 0

| EGO\_REV\_CTR := 0

| ;disable rev counting.

| EGO\_STAT11 := 0

| EGO\_STAT21 := 0

END: disable\_fuel\_modulation

11-17

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

11.1.2 UPSTREAM EGO MONITOR (CDAM0)

OVERVIEW

+----------------------------------+

| EGO\_US\_MONITOR |

+----------------------------------+

|PUBLIC PROCEDURES: |

|. check\_upstream\_entry\_conditions |

|. check\_upstream\_results |

|. upstream\_ego\_monitor |

|. upstream\_ego\_sampling |

|. upstream\_initialization |

|. upstream\_overvoltage\_check |

|. update\_ego\_cl\_tmr |

|. check\_upstream\_static\_shift |

|. reset\_us\_ego\_monitor |

|. reset\_overvoltage\_us |

+----------------------------------+

|PRIVATE PROCEDURES: |

|. calculate\_ego\_stats(n) |

|. detect\_us\_ego\_malf(n) |

|. ego\_voltage\_calculation |

|. slow\_ego\_malf(n) |

|. no\_slow\_ego\_malf(n) |

+----------------------------------+

This module is used to perform all the actions necessary to monitor the

upstream EGO sensors per OBD-II regulations. It is used for FAOSC

applications for single bank, dual bank,and Y-Pipe applications. It contains

a number of PUBLIC processes that act as seperate entry points into the

module. See the descriptions below and within the module at the site of each

of the procedures for a complete description of what the module does.

This module contains processes (upstream\_ego\_sampling,

ego\_voltage\_calculation) designed to sample the IEGOn\_NEW {n: 11, 21} analog

inputs and record the peak rich and lean values seen. Below is a crude graph

of one half cycle in a typical EGO sensor output signal. This shows the rich

half cycle, the lean half cycle is similar.

This module also contains a process (check\_upstream\_entry\_conditions) used to

enable the OBD-II EGO monitor. For each of the entry conditions to be met,

an acceptable window of operations is calibrated to be the range where the

EGO monitor could be run. Once initiated, a tighter window is chosen and if

the operating state falls out of this region, the test is aborted. This

gives the calibrator the flexibility to define the necessary steady state

conditions that must be maintained during the test. The test will attempt to

continually enable the monitor when the appropriate conditons are met. It is

the resonsibility of the OBD-II Operating System Executive to disable the

monitor when it is no longer required.

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EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

+--(VEGORH\_BARn - VEGO\_DLTA) VEGOn\_NEW ^

| |

| VEGO\_PK\_RHn ------>+ +------>

| \_\_\_\_\_\_\_\_\_\_\_\_\_\_- -\_\_\_\_\_\_\_\_\_\_ time

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1 +-----------------------------+

VEGO\_RHAVGn | |

0---------------+ +--------------------------

1 +----+

PK\_RH\_FLGn | |

0----------+ +--------------------------------------------------------

Each EGO sensor will be sampled once every 16 milliseconds in order to

accurately capture the peak voltage achieved during the rich or lean

excursion from stoichiometery. One of the upstream sensors will be sampled

at each 8 millisecond time interval as shown below:

time(ms) 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 ...

EGO sampled 11 21 11 21 ...

Additional processes are used to continuously monitor EGO sensor voltage for

an overvoltage condition. When one is encountered a malfunction is flagged

to the diagnostic executive and no further test of the upstream sensors is

allowed. The RBIAS statistic is aslo check once per background pass against

a pair of limits. If it is found to exceed these limits, all further testing

of the sensor is discontinued.

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EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- ECT = Coolant temperature, degrees farhenheit.

- EGO11\_FREQ = Calculated EGO11 average switching frequency during area

ratio calculation. Range = 0 - 15Hz, Resolution = 0.0625, Initially =

0.0

- EGO11\_TIME = Elapsed time to accumulate MAX\_CYCLES number of EGO11

cycles. Maximum value represents 1.5Hz switch frequency for 20 cycles.

Range = 0 - 14 seconds, Resolution = 0.0625 second, Initially = 0.0.

- EGO21\_FREQ = Calculated EGO21 average switching frequency during area

ratio calculation. Range = 0 - 15Hz, Resolution = 0.0625, Initially =

0.0

- EGO21\_TIME = Elapsed time to accumulate MAX\_CYCLES number of EGO21

cycles. Maximum value represents 1.5Hz switch frequency for 20 cycles.

Range = 0 - 14 seconds, Resolution = 0.0625 second, Initially = 0.0.

- EGO\_CL\_TMR = Elapsed time since entering closed loop while the EGO

monitor is enabled.

- EGO\_LOAD\_ST = LOAD upon entry to the EGO monitor.

- EGO\_MON\_TMR = Timer used to measure length of time EGO monitor is

enabled, seconds.

- EGO\_N\_ST = Engine speed upon entry to the EGO monitor.

- EGO\_VS\_ST = VS upon entry to the EGO monitor.

- FAILED\_BANK = Register indicating which bank is in lack of EGO switching,

unitless.

- FAO\_MON\_TMR1 = Total accumulated time in the integral learning window,

seconds.

- FAO\_MON\_TMR2 = Total accumulated time in the integral learning window,

seconds.

- IEGOn\_NEW = Value of A-to-D converter for the EGO channel, counts.

- LAMAVE1 = Average of LAMBSE1. Averages the value of LAMBSE1 at the

current EGO-1 switch and last EGO-1 switch.

- LAMAVE2 = Average of LAMBSE2. Averages the value of LAMBSE2 at the

current EGO-2 switch and last EGO-2 switch.

- LD\_EGO\_DLTA = Absolute change in LOAD since last background pass, used to

determine steady state for the EGO monitor.

- LEAN\_COUNT11 = Count of lean samples taken at 16 millisecond intervals

for the area ratio calculation. Range = 0 - 900, Resolution = 1,

Initially = 0.

11-20

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- LEAN\_COUNT21 = Count of lean samples taken at 16 millisecond intervals

for the area ratio calculation. Range = 0 - 900, Resolution = 1,

Initially = 0.

- LOAD\_EGO = Filtered LOAD for use in the EGO monitor.

- N\_EGO = Filtered engine speed for use in the EGO monitor.

- N\_EGO\_DLTA = Absolute change in engine speed since last background pass,

used to determine steady state for the EGO monitor.

- OV\_TMR\_11 = EGO11 overvoltage timer.

- OV\_TMR\_21 = EGO21 overvoltage timer.

- PxxxMALF = Obdii malfunction flag for fault xxx.

- R\_BIAS1 = Rear BIAS trim for bank one.

- R\_BIAS2 = Rear BIAS trim for bank two.

- R\_BIAS\_AVG1 = The average value of the integral value of R\_BIAS1.

- R\_BIAS\_AVG2 = The average value of the integral value of R\_BIAS2.

- RICH\_COUNT11 = Count of rich samples taken at 16 millisecond intervals

for the area ratio calculation. Range = 0 - 900, Resolution = 1,

Initially = 0.

- RICH\_COUNT21 = Count of rich samples taken at 16 millisecond intervals

for the area ratio calculation. Range = 0 - 900, Resolution = 1,

Initially = 0.

- SAMPLE\_CNT11 = Count of the number of samples taken on EGO11 during the

ego monitor.

- SAMPLE\_CNT21 = Count of the number of samples taken on EGO21 during the

ego monitor.

- SWITCH\_CNT11 = Count of the number of EGO11 switches during the ego

monitor.

- SWITCH\_CNT21 = Count of the number of EGO21 switches during the ego

monitor.

- S\_USVEGOn1 = Bank n upstream HEGO voltage, minus hardware voltage bias.

- SWTP\_BARn1 = The filtered adaptive switchpoint calculated for HEGO

upstream sensor bank n.

- VEGO\_AMP11 = Amplitude (volts) of difference between rich and lean for

bank 1, fore HEGO.

- VEGO\_AMP12 = Amplitude (volts) of difference between rich and lean for

bank 1, aft.

- VEGO\_AMP21 = Amplitude (volts) of difference between rich and lean for

bank 2, fore HEGO.

11-21

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- VEGO\_AMP22 = Amplitude (volts) of difference between rich and lean for

bank 2, aft HEGO.

- VEGO\_DLTA = Voltage delta from rich/lean average below/above which peak

value is recorded, volts.

- VEGO\_LSTn = Last calculated EGO voltage, volts.

- VEGOLN\_BARn = Average lean EGO voltage, volts.

- VEGOn\_NEW = Calculated EGO voltage, volts.

- VEGOPKLEANn = Average peak lean EGO voltage, volts.

- VEGO\_PK\_LNn = Instantaneous peak lean EGO voltage, volts.

- VEGO\_PK\_RH11 = Instantaneous peak rich EGO voltage, volts.

- VEGO\_PK\_RH21 = Instantaneous peak rich EGO voltage, volts.

- VEGOPKRICHn = Average peak rich EGO voltage, volts.

- VEGORH\_BARn = Average rich EGO voltage, volts.

- VS\_EGO = Filtered VS for use in the EGO monitor.

- VS\_EGO\_DLTA = Absolute change in VS since last background pass, used to

determine steady state for the EGO monitor.

Bit Flags:

- EGOMON\_ENTRY = Flag indicating EGO monitor has been entered; 1 -> monitor

entered.

- EGO\_MON\_RDY = Flag indicating EGO monitor is ready to look for entry

conditions; 1 -> monitor ready.

- EGO\_MON11 = EGO11 monitored flag; 1 -> sensor monitored.

- EGO\_MON21 = EGO21 monitored flag; 1 -> sensor monitored.

- EGO\_STAT11 = Flag indicating the first EGO11 switch has been encountered,

start the area ratio calculation.

- EGO\_STAT21 = Flag indicating the first EGO21 switch has been encountered,

start the area ratio calculation.

- EGO\_WIND\_SET = Flag indicating EGO monitor steady state window conditions

have been set; 1 -> window conditions set.

- FRSTSWITCH11 = Flag indicating if the first switch seen during area ratio

calculation was rich-to-lean (0) or lean-to-rich (1). Range = 0 - 1,

Resolution = 1, Initially = 0.

- FRSTSWITCH21 = Flag indicating if the first switch seen during area ratio

calculation was rich-to-lean (0) or lean-to-rich (1). Range = 0 - 1,

Resolution = 1, Initially = 0.

11-22

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- LST\_SWITCH11 = Flag indicating if the last switch seen during area ratio

calculation was rich-to-lean (0) or lean-to-rich (1). Range = 0 - 1,

Resolution = 1, Initially = 0.

- LST\_SWITCH21 = Flag indicating if the last switch seen during area ratio

calculation was rich-to-lean (0) or lean-to-rich (1). Range = 0 - 1,

Resolution = 1, Initially = 0.

- OLFLG = Open loop fuel flag. 1 -> Open Loop fuel; 0 -> Closed loop fuel

- OV\_DOWN\_11 = Flag, when set triggers OV\_TMR\_11 to decrement.

- OV\_DOWN\_21 = Flag, when set triggers OV\_TMR\_21 to decrement.

- OV\_UP\_11 = Flag, when set, triggers OV\_TMR\_11 to increment.

- OV\_UP\_21 = Flag, when set triggers OV\_TMR\_21 toi increment.

- OV\_FMEM\_n1 = Flag which is set when the overvoltage timer triggers a

fault condition. This flag gets cleared when the overvoltage timer

starts counting down after fault condition clears.

- PK\_LN\_FLGn = Flag indicating the lean peak cannot be updated yet; 1 -> do

not update the peak lean value.

- PK\_RH\_FLGn = Flag indicating the rich peak cannot be updates yet; 1 -> do

not update the peak rich value.

- SMPL\_EGO\_FLG = Flag used to enable the foreground EGO samling process

used on the upstream EGO sensors. 1 -> enable the sampling.

- SWTP\_STABLn1 = Flag indicating that the adaptive switchpoint is

stabalized at either normal or csd voltage levels.

- VEGO\_LNAVGn = Flag indicating when lean EGO voltage averaging/peak update

is allowed; 1 -> allow update.

- VEGO\_RHAVGn = Flag indicating when rich EGO voltage averaging/peak update

is allowed; 1 -> allow update.

Calibration Constants:

- ACT\_CATEGOMX = Maximum ACT to allow the CAT and EGO monitors to begin.

Units: Degress F, Range: 120 - 254, Resolution: 2, Base value: 254.

- DSRD\_FREQ = Desired frequency of LAMBSE fuel modulation, Hertz.

- EGO\_CL\_TM = Elapsed time in closed loop with EGO monitor enabled before

running the upstream EGO monitor.

- ECT\_EGO\_MIN = Minimum engine coolant temperature to allow upstream EGO

sensor monitoring. Calibration Constant, Units: Degrees F, Range: 0 -

254, Resoultion: 2.0. Base value: 0.

- ECT\_EGO\_MAX = Maximum engine coolant temperature to allow upstream EGO

sensor monitoring. Calibration Constant, Units: Degrees F, Range: 0 -

254, Resoultion: 2.0. Base value: 0.

11-23

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FAOS\_MON\_TM = Accumulated time in the FAOS integral learning window

before a malfunction can be signalled, seconds.

- FREQERR\_BAND = Error from DSRD\_FREQ allowable to accept the results from

the upstream EGO monitor. Calibration Constant, Units: HERTZ, Range: 0

- 15, Resolution: 0.0625. Base value: 15.

- HEGO\_FC\_AVG = EGO filter constant.

- HEGO\_FC\_PEAK = EGO filter constant for peak voltages. Range = 0 - 1.0,

Resolution = 0.03125, Base value = 0.875.

- LAMAVE\_MAX = Maximum LAMAVE to enter the EGO monitor.

- LAMAVE\_MIN = Minimum LAMAVE to enter the EGO monitor.

- LDEGO\_DLTMX = Maximum absolute change in LOAD since entering EGO monitor

to keep the test enabled.

- LEAN\_AMP\_M = Upstream EGO voltage amplitude to signal a failure when the

area ratio is not shifted rich or lean (median). Calibration Constant,

Units: VOLTS, Range: 0 - 1, Resolution: 0.001. Base value: 0.

- LOAD\_EGO\_MAX = Maximum LOAD to enter the EGO monitor.

- LOAD\_EGO\_MIN = Minimum LOAD to enter the EGO monitor.

- MAX\_CYCLES = The number of cycles over which the area ratio is to be

calculated. Range = 0 - 40, Resolution = 1, Base value = 10.

- MAX\_EGO\_VOLT = EGO voltage at which an overvoltage condition is

signalled. Calibration Constant, Units: VOLTS, Range: 0 - 2,

Resolution: 0.001. Base value: 2.

- NEGO\_DLTMX = Maximum absolute change in engine speed since entering EGO

monitor to keep the test enabled.

- N\_EGO\_MAX = Maximum engine speed to enter the EGO monitor.

- N\_EGO\_MIN = Minimum engine speed to enter the EGO monitor.

- NUMEGO = Number of EGO sensors.

- OV\_CLEAR\_TM = Reset overvoltage timer to this value after fault condition

clears, seconds.

- OV\_TIME = Time at overvoltage on the EGO sensor to signal a malfunction.

- RBIAS\_EGO\_MX = Maximum allowable value of R\_BIAS.

- RBIAS\_EGO\_MN = Minimum allowable value of R\_BIAS.

- RICH\_AR = AREA\_RATIO threshold to use the rich voltage thresholds for the

upstream EGO monitor fault detection. Calibration Constant, Units:

NONE, Range: 0 - 5, Resolution: 0.03125. Base value: 0.

- VSEGO\_DLTMX = Maximum absolute change in VS since entering EGO monitor to

keep the test enabled.

11-24

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- VS\_EGO\_MAX = Maximum VS to enter the EGO monitor.

- VS\_EGO\_MIN = Minimum VS to enter the EGO monitor.

- US\_SWTPOINT = Upstream EGO input switch point, volts.

OTHER

- upstream\_ego\_codes = set of (P0132, P0133, P1130, P1131, P1132, P1133,

P1134, P0152, P0153, P1150, P1151, P1152, P1153, P1154). The set of

OBD-II fault codes that relate to the ego monitor.

- malfunction(ego, Pxxx) = Public procedure updating the MIL control status

provided by the MIL control module.

- P0131 = EGO sensor circuit out of range low (bank 1, sensor 1).

- P0132 = Oxygen sensor circuit high voltage (bank 1 upstream).

- P0133 = Oxygen sensor circuit slow response (bank 1 upstream).

- P0135 = Fault code for EGO11 sensor heater circuit malfunction.

- P0151 = EGO sensor circuit out of range low (bank 2, sensor 1).

- P0152 = Oxygen sensor circuit high voltage (bank 2 upstream).

- P0153 = Oxygen sensor circuit slow response (bank 2 upstream).

- P0155 = Fault code for EGO21 sensor heater circuit malfunction.

11-25

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EGO\_US\_MONITOR\_COM10

BEGIN: upstream\_initialization

;To be performed during RAM initialization or when called from within the

;EGO monitor control process (during an abort\_ego\_mon sequence).

For n = 11, 21:

unconditionally -------------------------| VEGORH\_BARn := US\_SWTPOINT

| VEGOLN\_BARn := US\_SWTPOINT

| VEGOPKRICHn := US\_SWTPOINT

| VEGOPKLEANn := US\_SWTPOINT

| VEGOn\_NEW := US\_SWTPOINT

| VEGO\_LSTn := US\_SWTPOINT

END: upstream\_initialization

BEGIN: reset\_overvoltage\_us

;The following process is called from the EGO montior control process

;and is used to freeze the overvoltage timers when the test is not

;is not currently enabled. This will prevent the timers from being

;started while enabled and then become dissabled, but keep running.

unconditionally -------------------------| OV\_UP\_11 := 0

| OV\_UP\_21 := 0

| OV\_DOWN\_11 := 0

| OV\_DOWN\_21 := 0

| ;freeze both timers.

END: reset\_overvoltage\_us

11-26

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: upstream\_overvoltage\_check

;This process, initiated from the EGO monitor control process is used to

;detect an overvoltage condition on the EGO sensor. once detected, the

;upstream EGO monitor is disabled.

P0135MALF = 0 ---------------------|

|AND -| OV\_UP\_11 := 1

VEGO11 > MAX\_EGO\_VOLT -------------| | OV\_DOWN\_11 := 0

;Check for overvoltage when heater | ;count up OV\_TMR\_11

;is functional only. |

|

| --- ELSE ---

|

| OV\_UP\_11 := 0

| OV\_DOWN\_11 := 1

| ;count down OV\_TMR\_11

NUMEGO = 2 ------------------------|

|

P0155MALF = 0 ---------------------|AND -| OV\_UP\_21 := 1

| | OV\_DOWN\_21 := 0

VEGO21 > MAX\_EGO\_VOLT -------------| | ;count up OV\_TMR\_21

;Check for overvoltage. |

| --- ELSE ---

|

| OV\_UP\_21 := 0

| OV\_DOWN\_21 := 1

| ;count down OV\_TMR\_21

OV\_DOWN\_11 = 1 --------------------|

|AND -| OV\_TMR\_11 := OV\_CLEAR\_TM

OV\_FMEM\_11 = 1 --------------------| | ;begin OV timer countdown

| OV\_FMEM\_11 := 0

| ;clear OV countdown flag

OV\_TMR\_11 > OV\_TIME ---------------------| Do: malfunction(ego, P0132)

| ;high voltage on ego11.

| EGO\_MON11 := 1

| ;lock out the U.S. ego

| ;monitor for this bank.

| OV\_FMEM\_11 := 1

| ;arm OV countdown flag

|

| --- ELSE ---

|

OV\_TMR\_11 = 0 ---------------------------| Do: clear\_malf(P0132)

OV\_DOWN\_21 = 1 --------------------|

|AND -| OV\_TMR\_21 := OV\_CLEAR\_TM

OV\_FMEM\_21 = 1 --------------------| | ;begin OV timer countdown

| OV\_FMEM\_21 := 0

| ;clear OV countdown flag

11-27

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OV\_TMR\_21 > OV\_TIME ---------------------| Do: malfunction(ego, P0152)

| ;high voltage on ego21.

| EGO\_MON21 := 1

| ;lock out the U.S. ego

| ;monitor for this bank.

| OV\_FMEM\_21 := 1

| ;arm OV fault flag

|

| --- ELSE ---

|

OV\_TMR\_21 = 0 ---------------------------| Do: clear\_malf(P0152)

END: upstream\_overvoltage\_check

11-28

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: upstream\_ego\_sampling

;This process is executed once every 16 milliseconds for each of the

;upstream EGO sensors. That implies that the process is executed once evey

;8 milliseconds, alternating between bank 1 EGO sensor and bank 2 EGO

;sensor sampling (if NUMEGO = 2).

;The results are stored in a RAM buffer. Each background loop the buffer is

;emptied and the upstream\_ego\_monitor process is performed for each value

;that was stored in the buffer. The register IEGOn\_NEW will be updated at

;an 16ms rate and available via the RCON or similar device.

SMPL\_EGO\_FLG = 1 ------------------|

|AND -| Sample EGO11 and place in

16ms elapsed since | | buffer and in IEGO11\_NEW.

IEGO11\_NEW was sampled --------| | ;the entry is also tagged with

| ;sensor number 11.

NUMEGO = 2 ------------------------|

|

SMPL\_EGO\_FLG = 1 ------------------|AND -| Sample EGO21 and place in

| | buffer and in IEGO21\_NEW.

16ms elapsed since | | ;the entry is also tagged with

IEGO21\_NEW was sampled --------| | ;sensor number 21.

END: upstream\_ego\_sampling

BEGIN: upstream\_ego\_monitor

;The following process is performed once for each entry in the buffer. 'n'

;is determined from the entry in the buffer.

;

;Convert the HEGO sensor A/D counts to voltage using the same process

;as described in the ego input processing module (please refer to the

;ego\_input\_com10 module). For the CSD compensation voltage (csd\_bias)

;which normalizes VEGOxy\_NEW, an averaged value is used for the adaptive

;switchpoint parameter.

;

unconditionally --------------------| VEGO\_LSTn = VEGOn\_NEW

| S\_USVEGOn = ego\_hw\_xfer\_fn(IEGOn\_NEW)

| ;convert A/D counts to volts

| csd\_bias = US\_SWTPOINT - SWTP\_BARn

| VEGOn\_NEW = max(S\_USVEGOn + csd\_bias,0)

| Do: ego\_voltage\_calculation(n)

| Do: frequency\_calculation(n)

END: upstream\_ego\_monitor

11-29

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: frequency\_calculation(n)

;This process is used to calculate the parameters necessary to calculate the

;EGO\_FREQn statistic. This statistic is used to reject the results of a

;very slow EGO sensor. This process is initiated from within the

;upstream\_ego\_monitor process.

EGO\_MONn = 1 ---------------------------| EXIT this process.

EGO\_STATn = 0 --------------------------| EGO\_STATn := 1

| SAMPLE\_CNTn := 0

| SWITCH\_CNTn := 0

| VEGO\_LSTn := VEGOn\_NEW

| EGOn\_FREQ := 0

| ;if this bank has not completed,

| ;re-initalize the statistics and

| ;set VEGO\_LST = VEGO\_NEW to

| ;prevent SWITCH\_CNT to increment

| ;on a dead sensor.

VEGOn\_NEW >= US\_SWTPOINT ---|

|AND -|

VEGO\_LSTn < US\_SWTPOINT ----| |

|OR --| SWITCH\_CNTn := SWITCH\_CNTn + 1

VEGOn\_NEW < US\_SWTPOINT ----| |

|AND -|

VEGO\_LSTn >= US\_SWTPOINT ---|

unconditionally ------------------------| SAMPLE\_CNTn := SAMPLE\_CNTn + 1

END: frequency\_calculation(n)

11-30

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego\_voltage\_calculation(n)

;This process is used to calculate EGO voltage statistics used to determine

;the EGO signal amplitude. EGO signal amplitude is a measure of the

;response rate of the sensor and has been correlated to emmision levels.

;This process is initiated from within the upstream\_ego\_monitor process.

;NOTE: n = sensor number (11, 21).

VEGOn\_NEW > (VEGORH\_BARn - VEGO\_DLTA) ---| VEGO\_RHAVGn = 1

(rich - allow updating of rich | (rich updates allowed)

average) |

| PK\_RH\_FLGn = 0

| (rich peak will be updated)

|

| --- ELSE ---

|

| VEGO\_RHAVGn = 0

| (rich updates not allowed)

VEGOn\_NEW < (VEGOLN\_BARn + VEGO\_DLTA) ---| VEGO\_LNAVGn = 1

(lean - allow updating of lean peak | (lean updates allowed)

and lean average) |

| PK\_LN\_FLGn = 0

| (peak lean will be updated)

|

| --- ELSE ---

|

| VEGO\_LNAVGn = 0

| (lean updates not allowed)

VEGOn\_NEW >= US\_SWTPOINT ----------|

(rich updates allowed) |

|

VEGO\_LSTn < US\_SWTPOINT -----------|AND -| VEGOPKLEANn =

(rich updates were not allowed | | rolav(VEGO\_PK\_LNn, HEGO\_FC\_PEAK)

last sample) | | (filter the last peak lean

| | voltage seen)

PK\_LN\_FLGn = 0 --------------------|

(average lean + delta attained)

VEGOn\_NEW >= US\_SWTPOINT ----------|

(rich updates allowed) |AND -| VEGO\_PK\_RHn = US\_SWTPOINT

| | (reset peak rich value)

VEGO\_LSTn < US\_SWTPOINT -----------| |

(rich updates were not allowed | PK\_LN\_FLGn = 0

last sample) | (stop looking for peak lean

| value)

|

| PK\_RH\_FLGn = 1

| (look for new peak rich value)

VEGO\_RHAVGn = 1 -------------------|

(rich updates allowed) |AND -| VEGO\_PK\_RHn = VEGOn\_NEW

| | (update peak rich voltage seen

VEGOn\_NEW > VEGO\_PK\_RHn -----------| | this cycle)

(new rich peak voltage observed)

11-31

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

VEGO\_RHAVGn = 1 -------------------------| VEGORH\_BARn =

(rich updates allowed) | rolav(VEGOn\_NEW, HEGO\_FC\_AVG)

| (average in last rich value)

VEGOn\_NEW < US\_SWTPOINT -----------|

(lean updates allowed) |

|

VEGO\_LSTn >= US\_SWTPOINT ----------|AND -| VEGOPKRICHn =

(lean updates were not allowed | | rolav(VEGO\_PK\_RHn, HEGO\_FC\_PEAK)

last sample) | | (filter the last peak rich

| | voltage seen)

PK\_RH\_FLGn = 0 --------------------|

(average rich + delta attained)

VEGOn\_NEW < US\_SWTPOINT -----------|

(lean updates allowed) |AND -| VEGO\_PK\_LNn = US\_SWTPOINT

| | (reset peak lean value)

VEGO\_LSTn >= US\_SWTPOINT ----------| |

(lean updates were not allowed | PK\_RH\_FLGn = 0

last sample) | (stop looking for peak rich

| value)

|

| PK\_LN\_FLGn = 1

| (look for new peak lean value)

VEGO\_LNAVGn = 1 -------------------|

(lean updates allowed) |AND -| VEGO\_PK\_LNn = VEGOn\_NEW

| | (update peak lean voltage seen

VEGOn\_NEW < VEGO\_PK\_LNn -----------| | this cycle)

(new lean peak voltage observed)

VEGO\_LNAVGn = 1 -------------------------| VEGOLN\_BARn =

(lean updates allowed) | rolav(VEGOn\_NEW, HEGO\_FC\_AVG)

| (average in last lean value)

END: ego\_voltage\_calculation

11-32

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: check\_upstream\_entry\_conditions

;Once per background loop, when EGO\_TST\_SW=1 perform the following:

; Check switchpoint stability as part of the Upstream monitor entry

; conditions. The switchpoint stable flags are set in the adaptive

; switchpoint algorithm and indicate that the switchpoint has

; stabalized at either normal or csd voltage levels.

;

SWTP\_STABL11 = 1 -----------------|

|AND -| swtpoint\_rdy := true

SWTP\_STABL21 = 1 ----------------| |

| --- ELSE ---

|

| swtpoint\_rdy := false

swtpoint\_rdy = true ---------------|

|

EGO\_TEST\_MON = 1 ------------------|

|

EGO\_CL\_TMR > EGO\_CL\_TM ------------|

|

LAMAVE1 < LAMAVE\_MAX --------------|

|

LAMAVE1 > LAMAVE\_MIN --------------|

|

LAMAVE2 < LAMAVE\_MAX --------| |

|OR --|

NUMEGO = 1 ------------------| |

|

LAMAVE2 > LAMAVE\_MIN --------| |

|OR --|

NUMEGO = 1 ------------------| |

|

ECT < ECT\_EGO\_MAX -----------------|AND -| EGO\_MON\_RDY := 1

| | ;allow entry to or continuation

ECT > ECT\_EGO\_MIN -----------------| | ;of EGO monitor

| |

OLFLG = 0 -------------------------| |

(Closed Loop Fuel) | |

| |

ACT < ACT\_CATEGOMX ----------------| |

| --- ELSE ---

|

| EGO\_MON\_RDY := 0

| ;abort monitor

11-33

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO\_MON\_RDY = 1 -------------------|

|

LOAD\_EGO < LOAD\_EGO\_MAX -----------|

|

LOAD\_EGO > LOAD\_EGO\_MIN -----------|

|

VS\_EGO < VS\_EGO\_MAX ---------------|AND -| ego\_mon\_entry := 1

| | ;entry conditions met,

VS\_EGO > VS\_EGO\_MIN ---------------| | ;start monitoring

| |

N\_EGO < N\_EGO\_MAX -----------------| |

| |

N\_EGO > N\_EGO\_MIN -----------------| |

| --- ELSE ---

|

| ego\_mon\_entry := 0

| ;don't start monitoring yet

11-34

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;Once the entry conditions have been met, a tighter window defining steady

;state for the EGO monitor is used to determine if the EGO monitor can

;continue to execute. Capture the starting point:

EGOMON\_ENTRY = 0 ------------------|

|

ego\_mon\_entry = 1 -----------------|AND -| EGO\_WIND\_SET := 1

| | EGO\_VS\_ST := VS\_EGO

EGO\_WIND\_SET = 0 ------------------| | EGO\_LOAD\_ST := LOAD\_EGO

| EGO\_N\_ST := N\_EGO

unconditionally -------------------------| EGOMON\_ENTRY := ego\_mon\_entry

Compute the absolute variation from the entry condition:

EGO\_WIND\_SET = 1 ------------| VS\_EGO\_DLTA := abs(EGO\_VS\_ST - VS\_EGO)

| LD\_EGO\_DLTA := abs(EGO\_LOAD\_ST - LOAD\_EGO)

| N\_EGO\_DLTA := abs(EGO\_N\_ST - N\_EGO)

:Exit the EGO monitor if steady state is breached and record the elapsed time

:since entering steady state:

EGO\_WIND\_SET = 1 ------------------|

|

VS\_EGO\_DLTA > VSEGO\_DLTMX ---| |

| |AND -| EGO\_WIND\_SET := 0

LD\_EGO\_DLTA > LDEGO\_DLTMX ---| | | EGOMON\_ENTRY := 0

| | | ;abort monitor

N\_EGO\_DLTA > NEGO\_DLTMX -----| |

|OR --|

LOAD\_EGO >= LOAD\_EGO\_MAX ----|

|

LOAD\_EGO <= LOAD\_EGO\_MIN ----|

|

EGO\_MON\_RDY = 0 -------------|

END: check\_upstream\_entry\_conditions

11-35

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: check\_upstream\_results

;This process is called from the ego\_monitor\_controller to compute

;amplitude and check it against calibrated limits.

EGO\_MON11 = 0 ---------------------------| Do: calculate\_ego\_stats(11)

;this sensor not monitored yet.

;this implies not overvoltaged.

NUMEGO = 1 ------------------------------| VEGO\_AMP21 := 0xffffh

;single bank applications | ;set to all '1's

|

| --- ELSE ---

NUMEGO = 2 ------------------------| |

|AND -| Do: calculate\_ego\_stats(21)

EGO\_MON21 = 0 ---------------------|

;this sensor not monitored yet.

;this implies not overvoltaged.

END: check\_upstream\_results

BEGIN: calculate\_ego\_stats(n)

;This procedure calculates voltage envelope of the selected

;ego sensor. 'n' represents the sensor for which the voltage

;envelope is to be calculated. This procedure is called after the upstream

;test is complete with valid results.

unconditionally ------------------------| ego\_sampling\_period = 0.016 sec.

| EGOn\_FREQ := (SWITCH\_CNTn/

| (SAMPLE\_CNTn\*ego\_sample\_period\*2))

| EGO\_STATn := 0

abs(EGOn\_FREQ - DSRD\_FREQ)

<= FREQERR\_BAND --------------| VEGO\_AMPn := (VEGOPKRICHn -

;good test, within tolerance band. | VEGOPKLEANn)

| EGO\_MONn := 1

| Do: detect\_us\_ego\_malf(n)

|

| --- ELSE ---

|

EGOn\_FREQ < EGO\_FREQ\_MIN ---------------| VEGO\_AMPn := 0

;extremely slow sensor or shifted | EGO\_MONn := 1

;fuel system. Signal a fault. | Do: detect\_us\_ego\_malf(n)

|

| --- ELSE ---

|

| ;re-run the test.

| EGO\_MONn := 0

END: calculate\_ego\_stats(n)

11-36

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: detect\_us\_ego\_malf(n)

;This procedure determines if an upstream ego sensor has malfunctioned to a

;point where it is causing the vehicle exhaust emmisions to exceed the

;levels that require illumination of the malfunction indicator light. 'n'

;represents the sensor for which the determination is to be made. This

;procedure is called after the voltage envelope has been

;calculated.

VEGO\_AMPn < LEAN\_AMP\_M ----------------------| Do: slow\_ego\_malf(n)

|

| --- ELSE ---

|

| Do: no\_slow\_ego\_malf(n)

END: detect\_us\_ego\_malf(n)

11-37

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: slow\_ego\_malf(n)

;This procedure will set the appropriate malfunction code when a fault is

;detected and signal the OBD-II Diagnostic Executive that a malfunction

;has occured.

n = 11 ----------------------------------| Do: malfunction(ego,P0133)

|

| --- ELSE ---

|

n = 21 ----------------------------------| Do: malfunction(ego,P0153)

END: slow\_ego\_malf(n)

BEGIN: no\_slow\_ego\_malf(n)

;This procedure will clear the appropriate malfunction code when a fault is

;not detected.

n = 11 ----------------------------------| Do: clear\_malf(P0133)

|

| --- ELSE ---

|

n = 21 ----------------------------------| Do: clear\_malf(P0153)

END: no\_slow\_ego\_malf(n)

BEGIN: update\_ego\_cl\_tmr

;PUBLIC process executed on demand from the ego\_monitor\_controller process

;and done once per background pass to determine the elapsed

;time since entering closed loop fuel control while the EGO monitor has

;been enabled. EGO\_CL\_TMR is a free running upcounting timer.

OLFLG = 1 -------------------------------| EGO\_CL\_TMR := 0

END: update\_ego\_cl\_tmr

BEGIN: reset\_us\_ego\_monitor

;The following logic process is used to reset the KAM parameters VEGO\_AMP

;on KAM reset. It is called from the EGO monitor control module.

unconditionally ------------------------| VEGO\_AMP11 := 1

| VEGO\_AMP21 := 1

| EGO11\_FREQ := 0

| EGO21\_FREQ := 0

END: reset\_us\_ego\_monitor

11-38

EGO MONITOR CONTROL STRATEGY, UPSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: check\_upstream\_static\_shift

;This PUBLIC logic process is called on demand from the

;ego\_monitor\_controller process once per background pass when the

;appropriate conditions have been met.

FAO\_MON\_TMR1 >= FAOS\_MON\_TM -------|

|

FAILED\_BANK <> 1 ------------------|AND -| malfunction(ego,P1134)

| | EGO\_MON11 := 1

R\_BIAS\_AVG1 > RBIAS\_EGO\_MX --------| |

;rich shift on ego11 |

| --- ELSE ---

|

| Do: clear\_malf(P1134)

FAO\_MON\_TMR1 >= FAOS\_MON\_TM -------|

|

FAILED\_BANK <> 1 ------------------|AND -| malfunction(ego,P1133)

| | EGO\_MON11 := 1

R\_BIAS\_AVG1 < RBIAS\_EGO\_MN --------| |

;lean shift on ego11 |

| --- ELSE ---

|

| Do: clear\_malf(P1133)

FAO\_MON\_TMR2 >= FAOS\_MON\_TM -------|

|

FAILED\_BANK <> 2 ------------------|AND -| malfunction(ego,P1154)

| | EGO\_MON21 := 1

R\_BIAS\_AVG2 > RBIAS\_EGO\_MX --------| |

;rich shift on ego21 |

| --- ELSE ---

|

| Do: clear\_malf(P1154)

FAO\_MON\_TMR2 >= FAOS\_MON\_TM -------|

|

FAILED\_BANK <> 2 ------------------|AND -| malfunction(ego,P1153)

| | EGO\_MON21 := 1

R\_BIAS\_AVG2 < RBIAS\_EGO\_MN --------| |

;lean shift on ego21 |

| --- ELSE ---

|

| Do: clear\_malf(P1153)

END: check\_upstream\_static\_shift

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EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

11.1.3 DOWNSTREAM EGO MONITOR (CDAM0)

OVERVIEW

+----------------------------------+

| EGO\_DS\_MONITOR |

+----------------------------------+

|PUBLIC PROCEDURES: |

|. detect\_ds\_ego\_malf |

|. downstream\_ego\_monitor |

|. downstream\_initialization |

|. downstream\_overvoltage\_check |

|. forced\_downstream\_excursion |

|. determine\_flg\_ego\_idle |

|. abort\_ds\_ego\_monitor |

|. stop\_excursion\_check |

+----------------------------------+

This module is designed to monitor the downstream EGO sensors. It will work

for single bank, dual bank, or Y-Pipe configurations. The downstream EGO

sensor voltage envelope is monitored. The envelope is compared to threshold.

If the voltage envelope is larger than the threshold envelope, the downstream

EGO sensors are assumed to be functional.

This module contains a process to gather the peak rich and lean voltages seen

on each of the downstream EGO sensors (downstream\_ego\_monitor).

Another process (forced\_downstream\_excursion) is excersied when faulty EGO

sensors are present or when a very green catalyst is installed. This process

will force an A/F excursion in the direction(s) in which the EGO signal has

not met some minimum value for a calibratable amount of time (or until the

required minimum voltage has been seen).

There is also a process to determine if one of the sensors is malfunctioning

and signal the malfunction to the diagnostic executive.

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EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

A finite state machine representation of the forced\_downstream\_excursion is

shown below. The transitions cannot be labeled in detail in the diagram and

still have it readable, so only a brief statement of what event is occuring

is put on the diagram.

+-------------------+

| initial\_state |----------------------------+

+-----------------------| |------------------------+ |

| +----->| |<-----+ | |

| abort| +------A----+-------+ |abort | |

|start | abort| |start | start| |

| | | | | | |

+-V----------------++ +-------+----V------+ ++-----------------V+ |

| rich\_bank1 |<---| rich\_bank1/ |----->| lean\_bank2 | |

| | | lean\_bank2 | | | |

+-+---------------+-+ +------+----+-------+ +-+---------------+-+ |

| | time out| |completed | | |

|time out | | | |time out | |

| completed| +-----V----V--------+ | completed| |

| +------>|part2\_initial\_state|<------+ | |

+---------------------->| |<----------------------+ |

| |<---------------------------+

+-+-A--A----+-A-+-+-+ no excursion necessary

| | | | | | |

| | | | | | +------------------------------+

+-------------------------+ | | | | +----------------------------+ |

| +----------+ | | +------------+ | |

| abort| abort| |start |abort | |

|start | | | | start| |

+-V----------------++ +------+----V-------+ ++-----------------V+ |

| lean\_bank1 | | rich\_bank2/ | | rich\_bank2 | |

| | | lean\_bank1 | | | |

+--------+----A-----+ +-+---+------------++ +------A---+--------+ |

time out| |rich complete| |time out |lean complete| |time out |

OR | +-------------+ | OR +-------------+ | OR |

complete| |complete |complete |

| +-----V-------------+ | |

+--------------->| final\_state |<---------------+ |

| |<---------------------------+

+-------------------+ no excursion necessary

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EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- DS\_DLY\_TMR = Timer used to measure the amount of time an A/F excursion

has been active to test the downstream EGO sensors. Timer, Free running

down counter, Units: SECONDS, Range: 0 - 60, Resolution: 0.25.

- DS\_STATE = State variable to be used during the

forced\_downstream\_excursion EGO monitor test.

- EXT\_CMD = Signed inferred catalyst midbed gas temperatures, degrees.

- FUEL\_SOURCE1 = Value to indicate the source of the final open loop LAMBSE

caluculation for bank 1.

- FUEL\_SOURCE2 = Value to indicate the source of the final open loop LAMBSE

caluculation for bank 2.

- OV\_TMR\_12 = Ego12 overvoltage timer.

- OV\_TMR\_22 = Ego22 overvoltage timer.

- VEGO\_PK\_RH12 = Instantaneous peak rich EGO voltage, volts.

- VEGO\_PK\_RH22 = Instantaneous peak rich EGO voltage, volts.

- VEGO\_RH\_FF12 = Fault filter for downstream bank 1 EGO sensor for

overvoltage fault detection. Register, Units: NONE, Range: 0 - 1,

Resolution: 0.001.

- VEGO\_RH\_FF22 = Fault filter for downstream bank 2 EGO sensor for

overvoltage fault detection. Register, Units: NONE, Range: 0 - 1,

Resolution: 0.001.

Bit Flags:

- DS\_EGO\_LEAN1 = Flag used by the downstream EGO monitor to trigger a lean

A/F excursion for bank 1; 1 -> excursion is in progress.

- DS\_EGO\_LEAN2 = Flag used by the downstream EGO monitor to trigger a lean

A/F excursion for bank 2; 1 -> excursion is in progress.

- DS\_EGO\_OL = Flag used to force open loop fuel control during a forced A/F

excursion to test the downstream EGO sensors.

- DS\_EGO\_RICH1 = Flag used by the downstream EGO monitor to trigger a rich

A/F excursion for bank 1; 1 -> excursion is in progress. excursion to

test the downstream EGO sensors.

- DS\_EGO\_RICH2 = Flag used by the downstream EGO monitor to trigger a rich

A/F excursion for bank 2; 1 -> excursion is in progress.

- DS\_LEAN1 = Flag used by the downstream EGO monitor used to signal when a

lean A/F excursion is required for bank 1; 1 -> excursion is complete or

not required.

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EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- DS\_LEAN2 = Flag used by the downstream EGO monitor used to signal when a

lean A/F excursion is required for bank 2; 1 -> excursion is complete or

not required.

- DS\_RICH1 = Flag used by the downstream EGO monitor used to signal when a

rich A/F excursion is required for bank 1; 1 -> excursion is complete or

not required.

- DS\_RICH2 = Flag used by the downstream EGO monitor used to signal when a

rich A/F excursion is required for bank 2; 1 -> excursion is complete or

not required.

- FLG\_EGO\_IDLE = Flag used to prevent A/F excursion to test the downstream

ego sensors during idle.

- OV\_DOWN\_12 = Flag, when set triggers OV\_TMR\_12 to decrement.

- OV\_DOWN\_22 = Flag, when set triggers OV\_TMR\_22 to decrement.

- OV\_UP\_12 = Flag, when set triggers OV\_TMR\_12 to increment.

- OV\_UP\_22 = Flag, when set triggers OV\_TMR\_22 to increment.

- OV\_FMEM\_n2 = Flag which is set when the overvoltage timer triggers a

fault condition. This flag gets cleared when the overvoltage timer

starts counting down after fault condition clears.

- STOP\_EXCURS = Flag used to signal when a forced downstream ego monitoring

excursion is not allowed.

- UNDSP = Run/Underspeed Flag; 1 -> Underspeed (or CRANK), 0 -> Run.

Calibration Constants:

- CAT\_MX\_LEAN = Maximum catalyst midbed temperature to allow the downstream

monitor, degrees.

- DS\_DELAY = Maximum time which an A/F ratio excursion can be active in

order to test the downstream EGO sensors. Calibration Constant, Units:

SECONDS, Range: 0 - 60, Resolution: 0.25. Base value: 0.

- HEGO\_CONFIG = HEGO configuration register.

- LEAN\_THRESH = Downstream EGO voltage threshold to signal a healthy EGO

sensor. Calibration Constant, Units: VOLTS, Range: 0 - 1, Resolution:

0.001. Base value: 0.

- MAX\_EGO\_VOLT = EGO voltage at which an overvoltage condition is

signalled. Calibration Constant, Units: VOLTS, Range: 0 - 2,

Resolution: 0.001. Base value: 2.

- N\_IDLE\_CH = Engine RPM above which downstream EGO A/F excursion is

allowed.

- N\_IDLE\_SL = Engine RPM below which downstream EGO monitoring A/F

excursion is disabled.

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EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- OV\_CLEAR\_TM = Reset overvoltage timer to this value after fault condition

clears, seconds.

- OV\_TIME = Time at overvoltage on the EGO sensor to signal a malfunction.

- RICH\_THRESH = Downstream EGO voltage threshold to signal a healthy EGO

sensor. Calibration Constant, Units: VOLTS, Range: 0 - 1, Resolution:

0.001. Base value: 0.

- VEGO\_FK = EGO sensor overvoltage fault filter constant. Calibration

Constant, Units: NONE, Range: 0 - 1, Resolution: 0.001. Base value:

1.

OTHER

- downstream\_ego\_codes = set of (P0138, P0136, P0158, P0156). The set of

OBD-II fault codes that relate to the downstream ego monitor.

- malfunction(ego, Pxxx) = Public procedure updating the MIL control status

provided by the MIL control module.

- P0138 = Oxygen sensor circuit high voltage (bank 1 downstream).

- P0136 = Oxygen sensor circuit malfunction (bank 1 downstream).

- P0156 = Oxygen sensor circuit malfunction (bank 2 downstream).

- P0158 = Oxygen sensor circuit high voltage (bank 2 downstream).

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EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EGO\_DS\_MONITOR\_COM10

BEGIN: definitions

;the following logic chart is not to be specifically executed. It

;merely exists to make documentation more readable.

unconditionally --------------------------| initial\_state := 0

| rich\_bank1 := 1

| rich\_bank1\_lean\_bank2 := 2

| lean\_bank2 := 3

| part2\_initial\_state := 4

| lean\_bank1 := 5

| rich\_bank2\_lean\_bank1 := 6

| rich\_bank2 := 7

| final\_state := 8

| no\_aft\_hego := 0

| single\_bank := 1

| dual\_bank := 2

| y\_pipe := 3

END: definitions

BEGIN: downstream\_initialization

;executed on powerup.

unconditionally --------------------------| VEGO\_PK\_RH12 := 0

| VEGO\_PK\_RH22 := 0

| VEGO\_PK\_LN12 := 1

| VEGO\_PK\_LN22 := 1

END: downstream\_initialization

11-45

EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: reset\_overvoltage\_ds

;The following process is called from the EGO montior control process

;and is used to freeze the overvoltage timers when the test is not

;is not currently enabled. This will prevent the timers from being

;started while enabled and then become dissabled, but keep running.

unconditionally -------------------------| OV\_UP\_12 := 0

| OV\_UP\_22 := 0

| OV\_DOWN\_12 := 0

| OV\_DOWN\_22 := 0

| ;freeze both timers.

END: reset\_overvoltage\_ds

BEGIN: determine\_flg\_ego\_idle

;This process is called from within the EGO monitor controller

;and is used to control the flag FLG\_EGO\_IDLE, used by the forced

;downstream excursion.

N < N\_IDLE\_SL ----------------------|S Q -| FLG\_EGO\_IDLE

|

N > N\_IDLE\_CH ----------------------|C

END: determine\_flg\_ego\_idle

11-46

EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: downstream\_overvoltage\_check

;This process, initiated from the EGO monitor control process is used to

;detect an overvoltage condition on the EGO sensor.

HEGO\_CONFIG <> no\_aft\_hego --------|

|

P0141MALF = 0 ---------------------|AND -| OV\_UP\_12 := 1

| | OV\_DOWN\_12 := 0

VEGO12 > MAX\_EGO\_VOLT -------------| | ;count up OV\_TMR\_12

;Check for overvoltage when heater |

;is functional only. |

| --- ELSE ---

|

| OV\_UP\_12 := 0

| OV\_DOWN\_12 := 1

| ;count down OV\_TMR\_12

HEGO\_CONFIG = dual\_bank -----------|

|

P0161MALF = 0 ---------------------|AND -| OV\_UP\_22 := 1

| | OV\_DOWN\_22 := 0

VEGO22 > MAX\_EGO\_VOLT -------------| | ;count up OV\_TMR\_22

;Check for overvoltage. |

| --- ELSE ---

|

| OV\_UP\_22 := 0

| OV\_DOWN\_22 := 1

| ;count down OV\_TMR\_22

OV\_DOWN\_12 = 1 --------------------|

|AND -| OV\_TMR\_12 := OV\_CLEAR\_TM

OV\_FMEM\_12 = 1 --------------------| | ;begin OV timer countdown

| OV\_FMEM\_12 := 0

| ;clear OV countdown flag

OV\_TMR\_12 > OV\_TIME ---------------------| Do: malfunction(ego, P0138)

| ;high voltage on ego12.

| DS\_RICH1 := 1

| DS\_LEAN1 := 1

| ;lock out D.S. functional

| ;check on this bank.

| OV\_FMEM\_12 := 1

| ;arm OV countdown flag

|

| --- ELSE ---

|

OV\_TMR\_12 = 0 ---------------------------| Do: clear\_malf(P0138)

OV\_DOWN\_22 = 1 --------------------|

|AND -| OV\_TMR\_22 := OV\_CLEAR\_TM

OV\_FMEM\_22 = 1 --------------------| | ;begin OV timer countdown

| OV\_FMEM\_22 := 0

| ;clear OV countdown flag

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EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OV\_TMR\_22 > OV\_TIME ---------------------| Do: malfunction(ego, P0158)

| ;high voltage on ego22.

| DS\_RICH2 := 1

| DS\_LEAN2 := 1

| ;lock out D.S. functional

| ;check on this bank.

| OV\_FMEM\_22 := 1

| ;arm OV countdown flag

|

| --- ELSE ---

|

OV\_TMR\_22 = 0 ---------------------------| Do: clear\_malf(P0158)

END: downstream\_overvoltage\_check

11-48

EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: downstream\_ego\_monitor

;This procedure is called from within the EGO monitor controller and

;ratchets on the peak rich and lean voltages seen while monitoring the

;downstream EGO signals.

HEGO\_CONFIG <> no\_aft\_hego ---------|

|

VEGO12 > VEGO\_PK\_RH12 --------------|AND -| VEGO\_PK\_RH12 := VEGO12

|

UNDSP = 0 --------------------------|

;new rich peak voltage observed.

HEGO\_CONFIG = dual\_bank ------------|

|

VEGO22 > VEGO\_PK\_RH22 --------------|AND -| VEGO\_PK\_RH22 := VEGO22

|

UNDSP = 0 --------------------------|

;new rich peak voltage observed.

HEGO\_CONFIG <> no\_aft\_hego ---------|

|

VEGO12 < VEGO\_PK\_LN12 --------------|AND -| VEGO\_PK\_LN12 := VEGO12

|

UNDSP = 0 --------------------------|

;new lean peak voltage observed.

HEGO\_CONFIG = dual\_bank ------------|

|

VEGO22 < VEGO\_PK\_LN22 --------------|AND -| VEGO\_PK\_LN22 := VEGO22

|

UNDSP = 0 --------------------------|

;new lean peak voltage observed.

HEGO\_CONFIG = no\_aft\_hego ----------|

|OR --| DS\_LEAN1 := 1

VEGO\_PK\_LN12 <= LEAN\_THRESH --------|

HEGO\_CONFIG = no\_aft\_hego ----------|

|OR --| DS\_RICH1 := 1

VEGO\_PK\_RH12 >= RICH\_THRESH --------|

HEGO\_CONFIG <> dual\_bank -----------|

|OR --| DS\_LEAN2 := 1

VEGO\_PK\_LN22 <= LEAN\_THRESH --------|

HEGO\_CONFIG <> dual\_bank -----------|

|OR --| DS\_RICH2 := 1

VEGO\_PK\_RH22 >= RICH\_THRESH --------|

END: downstream\_ego\_monitor

11-49

EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: stop\_excursion\_check

;The following logic is used to determine if the forced downstream excursion

;should be stopped based on vehicle operational state. It is called from

;within the ego\_monitor\_control process.

APT = 1 --------------------------------------|

|

FLG\_EGO\_IDLE = 1 -----------------------------|

|

FUEL\_SOURCE1 = 1 -----------------------------|

|OR --| STOP\_EXCURS := 1

FUEL\_SOURCE2 = 1 -----------------------------| | ;downstream ego

| | ;monitor, not able

EXT\_CMD > CAT\_MX\_LEAN ------------------| | | ;to run at WOT,

| | | ;idle, cat overtemp

DS\_LEAN1 = 0 ---------------------| |AND -| |

|OR --| |

DS\_LEAN2 = 0 ---------------------| |

| --- ELSE ---

|

| STOP\_EXCURS := 0

END: stop\_excursion\_check

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EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: forced\_downstream\_excursion

;This process is used to determine if the downstream sensors have been

;active, i.e., a large variation in voltage has been seen on them. If

;this is not the case the air fuel ratio is forced rich and/or lean

;in an open loop manner to some predetermined point to attempt to force

;the downstream sensor to switch. The air fuel ratio is held some

;calibratiable number of seconds at this open loop value.

;This process is called from within the EGO monitor controller.

HEGO\_CONFIG <> no\_aft\_hego -------|

|

DS\_STATE = initial\_state ---------|

|

DS\_LEAN2 = 1 ---------------------|AND -| DS\_STATE := rich\_bank1

| | DS\_EGO\_OL := 1

DS\_RICH1 = 0 ---------------------| | DS\_EGO\_RICH1 := 1

| | DS\_DLY\_TMR := DS\_DELAY

STOP\_EXCURS = 0 ------------------| |

| --- ELSE ---

HEGO\_CONFIG = dual\_bank ----------| |

| |

DS\_STATE = initial\_state ---------| |

| |

DS\_LEAN2 = 0 ---------------------|AND -| DS\_STATE := rich\_bank1\_lean\_bank2

| | DS\_EGO\_OL := 1

DS\_RICH1 = 0 ---------------------| | DS\_EGO\_RICH1 := 1

| | DS\_EGO\_LEAN2 := 1

STOP\_EXCURS = 0 ------------------| | DS\_DLY\_TMR := DS\_DELAY

|

| --- ELSE ---

HEGO\_CONFIG = dual\_bank ----------| |

| |

DS\_STATE = initial\_state ---------| |

| |

DS\_LEAN2 = 0 ---------------------|AND -| DS\_STATE := lean\_bank2

| | DS\_EGO\_OL := 1

DS\_RICH1 = 1 ---------------------| | DS\_EGO\_LEAN2 := 1

| | DS\_DLY\_TMR := DS\_DELAY

STOP\_EXCURS = 0 ------------------| |

| --- ELSE ---

DS\_STATE = initial\_state ---------| |

| |

DS\_LEAN2 = 1 ---------------------|AND -| DS\_STATE = part2\_initial\_state

|

DS\_RICH1 = 1 ---------------------|

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EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DS\_STATE = rich\_bank1 ------------|

|AND -| DS\_STATE := part2\_initial\_state

DS\_DLY\_TMR = 0 -------------------| | DS\_RICH1 := 1

| DS\_LEAN1 := 1

| DS\_EGO\_OL := 0

| DS\_EGO\_RICH1 := 0

|

| --- ELSE ---

DS\_STATE = rich\_bank1 ------------| |

|AND -| DS\_STATE := part2\_initial\_state

DS\_RICH1 = 1 ---------------------| | DS\_EGO\_OL := 0

| DS\_EGO\_RICH1 := 0

| DS\_DLY\_TMR := 0

|

| --- ELSE ---

DS\_STATE = rich\_bank1 ------------| |

|AND -| DS\_STATE := initial\_state

STOP\_EXCURS = 1 ------------------| | DS\_EGO\_OL := 0

| DS\_EGO\_RICH1 := 0

| DS\_DLY\_TMR := 0

DS\_STATE = lean\_bank2 ------------|

|AND -| DS\_STATE := part2\_initial\_state

DS\_DLY\_TMR = 0 -------------------| | DS\_RICH2 := 1

| DS\_LEAN2 := 1

| DS\_EGO\_OL := 0

| DS\_EGO\_LEAN2 := 0

|

| --- ELSE ---

DS\_STATE = lean\_bank2 ------------| |

|AND -| DS\_STATE := part2\_initial\_state

DS\_LEAN2 = 1 ---------------------| | DS\_EGO\_OL := 0

| DS\_EGO\_LEAN2 := 0

| DS\_DLY\_TMR := 0

|

| --- ELSE ---

DS\_STATE = lean\_bank2 ------------| |

|AND -| DS\_STATE := initial\_state

STOP\_EXCURS = 1 ------------------| | DS\_EGO\_OL := 0

| DS\_EGO\_LEAN2 := 0

| DS\_DLY\_TMR := 0

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EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DS\_STATE = rich\_bank1\_lean\_bank2 -|

|AND -| DS\_STATE := part2\_initial\_state

DS\_DLY\_TMR = 0 -------------------| | DS\_RICH1 := 1

| DS\_LEAN1 := 1

| DS\_RICH2 := 1

| DS\_LEAN2 := 1

| DS\_EGO\_OL := 0

| DS\_EGO\_RICH1 := 0

| DS\_EGO\_LEAN2 := 0

|

| --- ELSE ---

DS\_STATE = rich\_bank1\_lean\_bank2 -| |

| |

DS\_RICH1 = 1 ---------------------|AND -| DS\_STATE := part2\_initial\_state

| | DS\_EGO\_OL := 0

DS\_LEAN2 = 1 ---------------------| | DS\_EGO\_RICH1 := 0

| DS\_EGO\_LEAN2 := 0

| DS\_DLY\_TMR := 0

|

| --- ELSE ---

DS\_STATE = rich\_bank1\_lean\_bank2 -| |

|AND -| DS\_STATE := rich\_bank1

DS\_LEAN2 = 1 ---------------------| | DS\_EGO\_LEAN2 := 0

|

| --- ELSE ---

DS\_STATE = rich\_bank1\_lean\_bank2 -| |

|AND -| DS\_STATE := lean\_bank2

DS\_RICH1 = 1 ---------------------| | DS\_EGO\_RICH1 := 0

|

| --- ELSE ---

DS\_STATE = rich\_bank1\_lean\_bank2 -| |

|AND -| DS\_STATE := initial\_state

STOP\_EXCURS = 1 ------------------| | DS\_EGO\_OL := 0

| DS\_EGO\_LEAN2 := 0

| DS\_EGO\_RICH1 := 0

| DS\_DLY\_TMR := 0

11-53

EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HEGO\_CONFIG = dual\_bank ----------|

|

DS\_STATE = part2\_initial\_state ---|

|

DS\_LEAN1 = 1 ---------------------|AND -| DS\_STATE := rich\_bank2

| | DS\_EGO\_OL := 1

DS\_RICH2 = 0 ---------------------| | DS\_EGO\_RICH2 := 1

| | DS\_DLY\_TMR := DS\_DELAY

STOP\_EXCURS = 0 ------------------| |

| --- ELSE ---

HEGO\_CONFIG = dual\_bank ----------| |

| |

DS\_STATE = part2\_initial\_state ---| |

| |

DS\_LEAN1 = 0 ---------------------|AND -| DS\_STATE := rich\_bank2\_lean\_bank1

| | DS\_EGO\_OL := 1

DS\_RICH2 = 0 ---------------------| | DS\_EGO\_RICH2 := 1

| | DS\_EGO\_LEAN1 := 1

STOP\_EXCURS = 0 ------------------| | DS\_DLY\_TMR := DS\_DELAY

|

| --- ELSE ---

HEGO\_CONFIG <> no\_aft\_hego -------| |

| |

DS\_STATE = part2\_initial\_state ---| |

| |

DS\_LEAN1 = 0 ---------------------|AND -| DS\_STATE := lean\_bank1

| | DS\_EGO\_OL := 1

DS\_RICH2 = 1 ---------------------| | DS\_EGO\_LEAN1 := 1

| | DS\_DLY\_TMR := DS\_DELAY

STOP\_EXCURS = 0 ------------------| |

| --- ELSE ---

DS\_STATE = part2\_initial\_state ---| |

| |

DS\_LEAN1 = 1 ---------------------|AND -| DS\_STATE = final\_state

|

DS\_RICH2 = 1 ---------------------|

DS\_STATE = rich\_bank2 ------------|

|AND -| DS\_STATE := final\_state

DS\_DLY\_TMR = 0 -------------| | | DS\_RICH2 := 1

|OR --| | DS\_EGO\_OL := 0

DS\_RICH2 = 1 ---------------| | DS\_EGO\_RICH2 := 0

| DS\_DLY\_TMR := 0

|

| --- ELSE ---

DS\_STATE = rich\_bank2 ------------| |

|AND -| DS\_STATE := part2\_initial\_state

STOP\_EXCURS = 1 ------------------| | DS\_EGO\_OL := 0

| DS\_EGO\_RICH2 := 0

| DS\_DLY\_TMR := 0

11-54

EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DS\_STATE = lean\_bank1 ------------|

|AND -| DS\_STATE := final\_state

DS\_DLY\_TMR = 0 -------------| | | DS\_LEAN1 := 1

|OR --| | DS\_EGO\_OL := 0

DS\_LEAN1 = 1 ---------------| | DS\_EGO\_LEAN1 := 0

| DS\_DLY\_TMR := 0

|

| --- ELSE ---

DS\_STATE = lean\_bank1 ------------| |

|AND -| DS\_STATE := part2\_initial\_state

STOP\_EXCURS = 1 ------------------| | DS\_EGO\_OL := 0

| DS\_EGO\_LEAN1 := 0

| DS\_DLY\_TMR := 0

DS\_STATE = rich\_bank2\_lean\_bank1 -|

|

DS\_DLY\_TMR = 0 -------------------|AND -| DS\_STATE := final\_state

| | DS\_RICH2 := 1

DS\_RICH1 = 1 ---------------| | | DS\_LEAN1 := 1

|OR --| | DS\_EGO\_OL := 0

DS\_LEAN2 = 1 ---------------| | DS\_EGO\_RICH2 := 0

| DS\_EGO\_LEAN1 := 0

| DS\_DLY\_TMR := 0

|

| --- ELSE ---

DS\_STATE = rich\_bank2\_lean\_bank1 -| |

|AND -| DS\_STATE := rich\_bank2

DS\_LEAN1 = 1 ---------------------| | DS\_EGO\_LEAN1 := 0

|

| --- ELSE ---

DS\_STATE = rich\_bank2\_lean\_bank1 -| |

|AND -| DS\_STATE := lean\_bank1

DS\_RICH2 = 1 ---------------------| | DS\_EGO\_RICH2 := 0

|

| --- ELSE ---

DS\_STATE = rich\_bank2\_lean\_bank1 -| |

|AND -| DS\_STATE := part2\_initial\_state

STOP\_EXCURS = 1 ------------------| | DS\_EGO\_OL := 0

| DS\_EGO\_LEAN1 := 0

| DS\_EGO\_RICH2 := 0

| DS\_DLY\_TMR := 0

HEGO\_CONFIG = y\_pipe -------------------| DS\_EGO\_RICH2 := DS\_EGO\_RICH1

| DS\_EGO\_LEAN2 := DS\_EGO\_LEAN1

| ;if y-pipe application, ensure

| ;both banks go on open loop

| ;excursion together.

END: force\_downstream\_excursion

11-55

EGO MONITOR CONTROL STRATEGY, DOWNSTREAM EGO MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: detect\_ds\_ego\_malf

;This process is called from within the EGO monitor controller and is

;used to determine if the downstream sensors are malfunctioning.

HEGO\_CONFIG <> no\_aft\_hego ---------|

|AND -| Do: malfunction(ego, P0136)

VEGO\_PK\_LN12 > LEAN\_THRESH ---| | |

|OR --| |

VEGO\_PK\_RH12 < RICH\_THRESH ---| |

| --- ELSE ---

|

| Do: clear\_malf(P0136)

HEGO\_CONFIG = dual\_bank ------------|

|AND -| Do: malfunction(ego, P0156)

VEGO\_PK\_LN22 > LEAN\_THRESH ---| | |

|OR --| |

VEGO\_PK\_RH22 < RICH\_THRESH ---| |

| --- ELSE ---

|

| Do: clear\_malf(P0156)

END: detect\_ds\_ego\_malf

BEGIN: abort\_ds\_ego\_monitor

;this process will perform all reset actions necessary to put the

;downstream EGO monitor back in state prior to it being executed.

unconditionally --------------------------| Do: downstream\_initialization

| DS\_STATE := initial\_state

| DS\_EGO\_OL := 0

| DS\_EGO\_RICH1 := 0

| DS\_EGO\_RICH2 := 0

| DS\_EGO\_LEAN1 := 0

| DS\_EGO\_LEAN2 := 0

| DS\_RICH1 := 0

| DS\_RICH2 := 0

| DS\_LEAN1 := 0

| DS\_LEAN2 := 0

| DS\_DLY\_TMR := 0

END: abort\_ds\_ego\_monitor

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

11.1.4 EGO HEATER CONTROL (CDAN0)

This file contains the following processes used to perform EGO heater control

and monitoring.

+-------------------------------+

| EGO\_HEATER\_CONTROL |

+-------------------------------+

|PUBLIC PROCEDURES: |

|. ego\_heater\_control\_init |

|. ego\_heater\_control |

|. reset\_ego\_heater |

+-------------------------------+

|PRIVATE PROCEDURES: |

|. check\_us\_faults |

|. check\_ds\_faults |

|. current\_monitor\_state\_control|

|. current\_fault\_check |

|. ds\_fault\_filtering |

|. ego\_heater\_current\_monitor |

|. ego\_heater\_diag\_state\_control|

|. ego\_heater\_fault\_report |

|. ego\_heater\_mode\_select |

|. ego\_heater\_mon\_control |

|. ego\_heater\_state\_control |

|. ego\_heater\_timer\_control |

|. koeo\_test |

|. reset\_diag\_state |

|. us\_fault\_filtering |

|. update\_retry\_max |

+-------------------------------+

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The following calling structure exists within this module:

PROCESS NAME LOCATION

----------------------------------------- ---------------------------

background->ego\_heater\_control ego\_heater\_control\_com

ego\_heater\_fault\_status ego\_heater\_io\_com

ego\_heater\_state\_control ego\_heater\_control\_com

ego\_heater\_control\_init ego\_heater\_control\_com

ego\_heater\_io\_init ego\_heater\_io\_com

koeo\_test ego\_heater\_control\_com

malfunction obdii executive

clear\_malf obdii executive

ego\_heater\_mode\_select ego\_heater\_control\_com

ego\_heater\_diag\_state\_control ego\_heater\_control\_com

clear\_malf obdii executive

reset\_diag\_state ego\_heater\_control\_com

check\_us\_faults ego\_heater\_control\_com

check\_ds\_faults ego\_heater\_control\_com

us\_fault\_filtering ego\_heater\_control\_com

update\_retry\_max ego\_heater\_control\_com

clear\_malf obdii executive

ds\_fault\_filtering ego\_heater\_control\_com

update\_retry\_max ego\_heater\_control\_com

clear\_malf obdii executive

ego\_heater\_fault\_report ego\_heater\_control\_com

malfunction obdii executive

ego\_heater\_timer\_control ego\_heater\_control\_com

ego\_heater\_current\_monitor ego\_heater\_control\_com

current\_monitor\_state\_control ego\_heater\_control\_com

current\_fault\_check ego\_heater\_control\_com

ego\_heater\_mon\_control ego\_heater\_control\_com

ego\_heater\_output ego\_heater\_io\_com

substitute obdii executive

osc\_response scp control

KAM init->reset\_ego\_heater ego\_heater\_control\_com

RAM init->ego\_heater\_control\_init ego\_heater\_control\_com

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

This module is build around state machine logic which encodes the parameter

HEATER\_STATE with the following information: heater operation mode (normal,

voltage diagnositics, and current monitoring), upstream pair on/off status,

and downstream pair on/off status. The diagram below shows an overview of

HEGO heater control.

+-----------+ +-----------+

---------->| |-------------->| |

EXT\_FEU, | State | HEATER\_STATE | I/O |<----> IMP IC,

EXT\_REG | Machines | | Interface | heaters

| |<--------------| |

(temp +-----------+ HTR\_FAULTxy +-----------+

controls) (ego\_heater\_ (ego\_heater\_ (Hardware)

control\_com) io\_com)

Inferred tip temperatures at the front and rear HEGO sensors (EXT\_FEU,

EXT\_REG) control state machine operation. In normal operatoin, when tip

temperature increases above a low threshold, heaters are commanded on. This

low temperature threshold protects the heater ceramic element from cracking

due to large thermal gradients when cold. The heaters will be commanded off

if the tip temperature rises above an upper threshold. This protects the

heater element from damage due to overtemperature.

Fault flags are returned by the heater interface module if voltage faults are

detected. Once per trip, heaters will be turned on and off, and these fault

flags will be checked to report on heater status. If a fault flag is set,

the faulty heater will be commanded on/off in an attempt to clear the fault

condition. If the fault does not clear after repeated retries, a malfunction

code will be set. Also, if a fault flag is set at any time during normal

heater operation, the state machine will be placed back into diagnositics

mode and the retry process above will be repeated.

Once per trip, after all heaters have been commanded on and are warmed up, a

current measurement will be performed. The OBD-II regulations state: "For

heated oxygen sensors, the heater circuit shall be considered malfunctioning

when the current or voltage drop in the circuit is no longer within the

manufacturer's specified limits for proper operation."

See the circuit diagrams below for a description of the state machines for

heater and current monitoring operation.

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The upstream EGO heaters are electrically configured as shown in the diagram

below. The downstream pair is similarily configured. When an application

does not have either HEGO21, or HEGO22, the same control scheme is used. The

heater is missing from the diagram, but the control FETs must be turned on in

pairs to prevent burning out the sense resistor.

PWR

o

|

+-------+-------+

| |

| |

+-+ +-+

| | | |

| | |HTR11 | |HTR21 |

| | | | | |

heater11| +-+ +-+ |heater21

current | | +---------+ | |current

| +--| |--+ |

| | +---------+ | |

| | R | |

V | sense | V

|---| |---|

HEGOHTR11 o---| |---o HEGOHTR21

(normally ON) |---| |---| (normally ON)

| |

| |

--+-- --+--

--- ---

- -

In order to measure the current through the heater, the following steps are

taken.

1. The HEGOHTRxy output associated with the heater that the current will be

measured in is switched off.

2. The HEGO heater A/D input is selected via the AMUX by taking ACHMUX1 & 2

high.

3. The A/D channel is read and the result stored into HTRCMxy for the heater

being read.

4. The HEGOHTRxy output is switched back on.

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

When the HEGOHTRxy output is switched off, all the current from the heater

being measured is directed through the sense resistor and through the

opposite FET to ground. The sense resistor is 1 ohm, so the volotage read by

the A/D is the same, numerically, as the current through the heater. See the

diagram below showing current monitoring configuration for heater 21.

PWR

o

|

+-------+-------+

| |

| | |

+-+ heater21| +-+

| | | current| | |

| HTR11| | | | |HTR21

| | | | | |

heater11| +-+ <-----+ +-+

current | | +---------+ |

| B--| |--A V = (heater21 current)\*(1 ohm)

| | +---------+ | AB

| | R |

V | sense |

|---| |---|

HEGOHTR11 o---| |---o HEGOHTR21

(ON) |---| |---| (OFF)

| |

| |

--+-- --+--

--- ---

- -

Prior to commencement of current measurements, all EGO sensor heaters must be

on for enough time to allow the heater current to stabalize. Additionally,

all heaters must be operating normally, i.e., no faults detected. The

strategy enforces this by testing the HTR\_FAULTxy bits prior to current

monitoring. These bits are set in the heater I/O module (ego\_heater\_io) and

indicate heater hardware fault status.

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

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EGO HEATER CONTROLS

The following diagrams describe, using finite state automata, operation of

the EGO heaters during non-current monitoring modes. The decision to turn on

pairs of EGO sensor heaters is based on temperature in the exhaust gas

stream.

+---------+

| |

| ds\_on |

| |

+-+--A----+

not in run mode OR | |in run mode &

EXT\_REG >= DS\_HTR\_OFF | |EXT\_FEU >= US\_HTR\_OFF &

---------------------- | |EXT\_REG >= DS\_HTR\_ON &

all heaters off | |EXT\_REG < DS\_HTR\_OFF

| |-----------------------

+---------+ | |upstream heaters off

| |<-+ |downstream heaters on

| |-----+

--------------------------------->| all\_off |

power-up OR OSM\_EO\_OFF=1 | |-----+

--------------- | |<-+ |in run mode &

all heaters off +---------+ | |EXT\_FEU > US\_HTR\_ON &

| |EXT\_FEU < US\_HTR\_OFF

| |-----------------------

not in run mode OR | |upstream heaters on

EXT\_FEU >= US\_HTR\_OFF | |downstream heaters off

------------------------| |

all heaters off | |

+-+--V----+

| |

| us\_on |

| |

+---------+

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

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EGO HEATER CONTROLS, CONTINUED.

+---------+

| |

| us\_on |

| |

+--+--A---+

DS\_HTR\_ON <= EXT\_REG &| |

DS\_HTR\_OFF > EXT\_REG | |EXT\_REG >= DS\_HTR\_OFF

-----------------------| |----------------------

upstream heaters on | |upstream heaters on

downstream heaters on | |downstream heaters off

| | +---------+

| +---------| |

+----------->| |

| all\_on |

+----------->| |

| +---------| |

| | +---------+

EXT\_FLANGE < US\_HTR\_OFF| |EXT\_FEU >= US\_HTR\_OFF

-----------------------| |------------------------

upstream heaters on | |upstream heaters off

downstream heaters on | |downstream heaters on

+--+--V---+

| |

| ds\_on |

| |

+---------+

OBDII\_RESET=1 or

ER\_STATUS=ER\_DONE or

ER\_STATUS=ER\_INIT

---------------|

HTR\_RETRYxy=0 |

all heaters off|

|

+------V--+ +---------+

| | | |

| all\_off | | all\_on |

| |<----------------------------------| |

+---A-----+ not in run mode +----A----+

| --------------- |

|OSM\_EO\_OFF=1 all heaters off |OSM\_EO\_ON=1

|--------------- |--------------

|all heaters off |all heaters on

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO HEATER CURRENT MONITORING

The following finite state automata is used to conduct current monitoring on

all the EGO sensor heaters present in the given application.

+---------+

+---------------------------| |

|CURRENT\_CKD=1 | cm\_22 |

|HTR\_FAULTxy = 0 +--| |

|---------------- | +-A--A----+

|heater 22 on | | |

|EGO\_HTR\_MON=1 +----+ |CURRENT\_CKD=1

|CURRENT\_CKD=0 "a" |HTR\_FAULTxy = 0

| |HEATER\_HP22 = 1

| CURRENT\_CKD=1 |---------------

| HEATER\_HP22 = 0 |heater 12 on

| HTR\_FAULTxy=0 |heater 22 off

| --------------- |CURRENT\_CKD=0

| EGO\_HTR\_MON=1 |

| all heaters on +----+----+

| CURRENT\_CKD=0 | |

| +------------------------| cm\_12 |

| | +--| |<------------+

| | | +-A--A----+ |

| | | | |CURRENT\_CKD=1 |

+----V--V-+ +----+ |HTR\_FAULTxy = 0 |

| | "a" |HEATER\_HP12 = 1 |

| all\_on | |--------------- |

| | |heater 21 on |

+----+--A-+ |heater 12 off |

| | |CURRENT\_CKD=0 |

| +-------------- +----+----+ |CURRENT\_CKD=1

| from any state | | |HEATER\_HP21 = 0

| HTR\_FAULTxy = 1 | cm\_21 | |---------------

| or CURR\_TST\_ENA=0 +--| | |heater 11 on

| or not in run mode | +-A--A----+ |heater 21 off

| ------------------ | | |CURRENT\_CKD=1 |CURRENT\_CKD=0

| all heaters on +----+ |HTR\_FAULTxy = 0 |

| CURRENT\_CKD=1 "a" |HEATER\_HP21 = 1 |

| |--------------- |

|CURR\_TST\_ENA = 1 |heater 11 on |

|HTR\_FAULTxy = 0 |heater 21 off |

|---------------- |CURRENT\_CKD=0 |

|heater 11 off +----+----+ |

|CURRENT\_CKD=0 | |-------------+

+-------------------------->| cm\_11 |

+--| |

| +-A-------+

| |

+----+

"a"

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

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Where transition "a" is defined as shown below:

CURRENT\_CKD = 1

---------------------------------------------

transfer FN\_HTR\_XFER(HTRCM\_CNTS) into HTRCMxy

A seperate process reads the HTRCM ATOD channel and sets CURRENT\_CKD.

The following diagram describes what happens when a fault is detected on one

or more of the HEGO heaters. A special diagnostic sequence is entered where

the sensor is toggled off and then on. The fault status is checked in both

states and if a fault was detected, the retry counter is incremented. This

repeats until the retry counter reaches RETRY\_ALLOW or no fault is detected.

HTR\_MALF=0 &

HTR\_FAULTxy=0

-------------

HTR\_MONxy=1

HTR\_RETRYxy=0

+-----------+

| |

+--+-----------V-+

| |

HTR\_MALFxy=1 or+--->| xxx\_on\_diag\_on |---+

HTR\_FAULTxy=1 | +-+------A-------+ |

---------------| | | |

inc HTR\_RETRYxy+------+ | |

| |

| |

+--------+--------+ |

+--->| xxx\_on\_diag\_off | |

HTR\_FAULTxy=1| +-+------A--------+ |

-------------| | | |

HTR\_MALFxy=1 +------+ | |

| |

TEST\_ENABLED=1 &| |

[RETRY\_ALLOW> | |

HTR\_RETRYxy>0 or| |

xy\_FAULTED=1 or| |

NORMAL\_MODE=0] | |

----------------| |

HTR\_MALFxy=0 | |

+----+---+ |

| |<------+

| xxx\_on |

| |

+--------+

NOTE: xxx\_on can be any one of us\_on, ds\_on, or all\_on.

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- DS\_HTR\_TMR = Length of time the downstream EGO heaters have been on,

seconds.

- ER\_STATUS = State pointer that indicated current state of engine running

on demand test.

- EXT\_FEU = Inferred tip temperature of the upstream EGO sensor (without

heater effects), degrees.

- EXT\_REG = Inferred tip temperature of the downstream ego sensor (without

heater effects), degrees.

- HEATER\_STATE = State pointer for EGO heater controls.

- HTRCM11 = Current measured in EGO heater 11.

- HTRCM12 = Current measured in EGO heater 12.

- HTRCM21 = Current measured in EGO heater 21.

- HTRCM22 = Current measured in EGO heater 22.

- HTRCM\_CNTS = ATOD input for heater current measurement, counts.

- HTR\_EXE\_TMR = Timer used to pace execution of the heater controller.

- HTR\_RET\_MX11 = Highest number of retries seen on EGO heater 11.

- HTR\_RET\_MX12 = Highest number of retries seen on EGO heater 12.

- HTR\_RET\_MX21 = Highest number of retries seen on EGO heater 21.

- HTR\_RET\_MX22 = Highest number of retries seen on EGO heater 22.

- HTR\_RETRY11 = The number of retries executed for EGO heater 11.

- HTR\_RETRY12 = The number of retries executed for EGO heater 12.

- HTR\_RETRY21 = The number of retries executed for EGO heater 21.

- HTR\_RETRY22 = The number of retries executed for EGO heater 22.

- OSM\_EO\_OFF = Off state requested for OSM outputs during engine off

on-demand test.

- OSM\_EO\_ON = On state requested for OSM outputs during engine off

on-demand test.

- US\_HTR\_TMR = Timer activated after the upstream heaters turn on, so the

heaters can warm up prior to allowing the current monitor to run.

- VBAT = Battery voltage.

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- CCM\_ER\_ENA = Engine running ondemand test for CCM enabled.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag, (1 -> test

enabled).

- CURRENT\_CKD = Semaphore to signal when the HTRCM data is available.

- CURR\_TST\_ENA = Flag used to start the EGO heater current measurement.

- EGO\_CUR\_MON = Flag indicating current monitoring has been completed,

unitless.

- EGO\_TST\_ENA = OBD-II test enable flag, (1 -> test enable).

- EO\_INIT\_FLG = Catch the rising edge of EO\_ACTIVE.

- EXT\_FMM\_FLG = FMEM flag set by inferred temperature model due to ECT/ACT

failure, to indicate temperature data may be inaccurate.

- HTR\_FAULT11 = Fault status of EGO heater 11.

- HTR\_FAULT12 = Fault status of EGO heater 12.

- HTR\_FAULT21 = Fault status of EGO heater 21.

- HTR\_FAULT22 = Fault status of EGO heater 22.

- HTR\_MALF11 = Flag used to latch a heater malfunction during an off-on

cycle, unitless.

- HTR\_MALF12 = Flag used to latch a heater malfunction during an off-on

cycle, unitless.

- HTR\_MALF21 = Flag used to latch a heater malfunction during an off-on

cycle, unitless.

- HTR\_MALF22 = Flag used to latch a heater malfunction during an off-on

cycle, unitless.

- HTR\_MON11 = Flag indicating when the heater has been monitored, unitless.

- HTR\_MON12 = Flag indicating when the heater has been monitored, unitless.

- HTR\_MON21 = Flag indicating when the heater has been monitored, unitless.

- HTR\_MON22 = Flag indicating when the heater has been monitored, unitless.

- NORMAL\_MODE = Flag defining if the EGO heater strategy is in normal mode

or intrusive test mode.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II scan tool

reset message.

- OLDHTRFALT11 = Previous b.g. pass value of HTR\_FAULT11.

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

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- OLDHTRFALT12 = Previous b.g. pass value of HTR\_FAULT12

- OLDHTRFALT21 = Previous b.g. pass value of HTR\_FAULT21.

- OLDHTRFALT22 = Previous b.g. pass value of HTR\_FAULT22.

- TEST\_ENABLED = Flag indicating whether or not the EGO heater tests are

enabled.

- UNDSP = Underspeed Flag; 1 -> Underspeed or Crank Mode, 0 -> Run mode.

- US\_FAULTED = Flag indicating one of the upstream heaters is faulted.

Calibration Constants:

- CM\_HEAT\_TM = Amount of time the downstream EGO heaters must be on prior

to current monitoring, seconds.

- DS\_CM\_MAX = Maximum downstream EGO temperature to enable current

monitoring, degrees.

- DS\_CM\_MIN = Minimum downstream EGO temperature to enable EGO heater

current monitoring, degrees.

- DS\_CUR\_HI = Maximum allowed EGO heater current for the downstream

heaters, amps.

- DS\_CUR\_LOW = Minimum allowed EGO heater current for the downstream

heaters, amps.

- DS\_HTR\_OFF = Temperature at which to turn off the downstream ego heaters.

- DS\_HTR\_ON = Temperature at which to turn on the downstream ego heaters.

- FN\_HTR\_XFER(HTRCM\_CNTS) = Heater current ATOD input transfer function.

- ER\_INIT = Value for state of ER\_STATUS when engine running test first

inits.

- EXT\_REGON\_SF = Temperature offset to delay downstream heater turn on if

the inferred temperature model FMEM flag is set, degrees.

- HEATER\_HP11 = EGO heater 11 hardware present switch.

- HEATER\_HP12 = EGO heater 12 hardware present switch.

- HEATER\_HP21 = EGO heater 21 hardware present switch.

- HEATER\_HP22 = EGO heater 22 hardware present switch.

- HTRCM\_SW = Switch to enable current monitoring, unitless.

- HTR\_EXE\_TM = Minimum time between passes of the heater controller,

seconds (milli-second resolution).

- HTR\_VOLT\_NOM = Nominal battery voltage at which current monitor

thresholds have been established.

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

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- RETRY\_ALLOW = The total number of retries allowed when detecting a fault

of an EGO heater.

- US\_CM\_MAX = Maximum upstream EGO temperature to perform the EGO heater

current monitor, degrees.

- US\_CM\_MIN = Minimum upstream EGO temperature to perform the EGO heater

current monitor, degrees.

- US\_CUR\_HI = Maximum allowed EGO heater current for the upstream heaters,

amps.

- US\_CUR\_LOW = Minimum allowed EGO heater current for the upstream EGOs,

amps.

- US\_HTR\_ON = Temperature at which to turn on upstream EGO sensor heater,

degrees.

- US\_HTR\_OFF = Temperature at which to turn off upstream ego sensors.

- US\_HEAT\_TM = Amount of time the upstream EGO heaters must be on prior to

EGO heater current monitoring.

OTHER

- P0135 = Fault code for EGO11 sensor heater circuit malfunction, MIL\_CODE.

- P0141 = Fault code for EGO12 sensor heater circuit malfunction, MIL\_CODE.

- P0155 = Fault code for EGO21 sensor heater circuit malfunction, MIL\_CODE.

- P0161 = Fault code for EGO22 sensor heater circuit malfunction, MIL\_CODE.

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

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PROCESS

STRATEGY MODULE: EGO\_HEATER\_CONTROL\_COM10

BEGIN: definitions

;The following represent definitions used throughout this module. This

;is not to be explicitly executed. It exists only to make the documentation

;more readable.

unconditionally ------------------------| on := 1

| off := 0

| true := 1

| false := 0

| fault := 1

| no\_fault := 0

| all\_on := 1

| all\_on\_diag\_on := 2

| all\_on\_diag\_off := 3

| us\_on := 4

| us\_on\_diag\_on := 5

| us\_on\_diag\_off := 6

| ds\_on := 7

| ds\_on\_diag\_on := 8

| ds\_on\_diag\_off := 9

| all\_off := 10

| keyon\_init := 11

| us\_toggle := 12

| ds\_toggle := 13

| cm\_11 := 100

| cm\_12 := 101

| cm\_21 := 102

| cm\_22 := 103

| cm\_done := 104

END: definitions

BEGIN: reset\_ego\_heater

;The following logic, called on demand from the EGO monitor control

;process, is used to reset KAM parameters associated with the

;EGO heater control strategy.

unconditionally ------------------------| HTRCM11 := 1

| HTRCM21 := 1

| HTRCM12 := 1

| HTRCM22 := 1

| HTR\_RET\_MX11 := 0

| HTR\_RET\_MX12 := 0

| HTR\_RET\_MX21 := 0

| HTR\_RET\_MX22 := 0

END: reset\_ego\_heater

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

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BEGIN: ego\_heater\_control\_init

;The following process is used to initialize the EGO heaters. It is to be

;executed during a power-up iniitialization prior to exiting HLOS (hardware

;requirement) and when called at the start and end of KOER EGO test.

unconditionally -----------| HTR\_RETRY11 := 0

| HTR\_RETRY12 := 0

| HTR\_RETRY21 := 0

| HTR\_RETRY22 := 0

| HTR\_MALF11 := false

| HTR\_MALF12 := false

| HTR\_MALF21 := false

| HTR\_MALF22 := false

| HTR\_MON11 := false

| HTR\_MON12 := false

| HTR\_MON21 := false

| HTR\_MON22 := false

| TEST\_ENABLED := false

| CURRENT\_CKD := false

| HEATER\_STATE := keyon\_init

| CURR\_TST\_ENA := false

| HTR\_EXE\_TMR := 0

| EGO\_CUR\_MON := false

| EGO\_HTR\_MON := false

END: ego\_heater\_control\_init

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: update\_retry\_max(n)

;The following process, called from within the ego\_fault\_filter routine,

;is used to update HTR\_RET\_MXn for use by the scan tool.

unconditionally ------------------------| HTR\_RET\_MX(n) := max(HTR\_RET\_MX(n),

HTR\_RETRY(n))

END: update\_retry\_max

BEGIN: ego\_heater\_control

;The following process is called from the ego monitor control process.

;It acts as the 'main' program for EGO heater controls. The actual

;hardware interface is implemented in lower level software processes

;(external to this module) which interface directly to the IMP heater

;driver chip, and the heater voltage A/D channel. Ideally, the

;heater control strategy, IMP I/F, and the heater voltage A/D

;would be synchronous processes. However, they are not, as the

;following paragraphs will describe.

;

;The IMP I/F process, which sends the actual heater on/off commands

;and checks fault status, is timer driven and currently runs at about 26.5ms

;rates. The heater controller strategy runs in the background loop,

;asynchronous from the IMP HW I/F process. The heater controller

;requires the IMP I/F process to run at least twice between each

;strategy background loop for proper detection of heater fault flags.

;Since background loop times can approach 50ms, this condition may not

;always be met.

;

;The A/D process for the heater current monitor is implemented as part

;of the background loop. A/D action assumes the heaters are in the

;HEATER\_STATE as set by the strategy. However, because the background

;loop is asynchronous to the IMP servicer, the A/D could sample the

;the HEATER\_STATE prior to the IMP servicer issuing the new heater

;commands. This lack of synchronization could produce bad current

;measurements.

;

;Slowing down the heater control logic will aviod these problems.

;A milli-second resolution timer, HTR\_EXE\_TMR, is used to force

;synchronization between all these processes by allowing the heater

;controller strategy to execute in a background loop only if a calibratable

;period of time has ellapsed. This calibration constant should be set

;to a value of (at least) twice the IMP I/F service rate, as shown below.

;This guarantees fault flags will be detected, and accurate current

;measurements. Although not an ideal fix, it was implemented to meet

;Job #1 requirements for the heater current monitor.

;

11-72

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;

; IMP servicer (send heater on/off commands, read fault status)

; ------|----------|----------|----------|----------|----------|------>

; <- ~26ms ->

;

; Background loops (current monitor A/D action)

; ---------|------------------|------------------|------------------|->

; <-- ~50ms (min) -->

;

; Heater control strategy (set heater on/off states)

; ---------|-------------------------------------|-------------------->

; <------ HTR\_EXE\_TM ------->

;

HTR\_EXE\_TMR >= HTR\_EXE\_TM -| Do: ego\_heater\_fault\_status

| Do: ego\_heater\_state\_control

| Do: ego\_heater\_mode\_select

| Do: ego\_heater\_diag\_state\_control

| Do: ego\_heater\_timer\_control

| Do: ego\_heater\_current\_monitor

| Do: ego\_heater\_mon\_control

| Do: ego\_heater\_output

| HTR\_EXE\_TMR := 0

|

| --- ELSE ---

|

| ;allow the free running timer,

| ;HTR\_EXE\_TMR, to increment.

;

;Setting the cal constant HTR\_EXE\_TM = 0 will effectively

;calibrate out the timer so the heater controller runs in

;every background loop.

;

END: ego\_heater\_control

11-73

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego\_heater\_current\_monitor

;The following process is executed only when called and is used to

;perform current monitoring at the appropriate time. Current

;monitor entry conditions during nomral operation require that

;the US/DS heaters have been turned on and are warmed up to their

;steady state resistance values. Temperature conditions are

;inferred with the US/DS\_HTR\_TMRs.

;

;The downstream heaters must be on for CM\_HEAT\_TM seconds before

;steady state is assumed. Note that CM\_HEAT\_TM is different

;from the DS\_HEAT\_TM constant used in the Ego controller to

;initiate the DS monitor. This gives flexibility to adjust

;downstream heater readiness for each of these monitors.

;

;Normal time/temp entry conditions into the current monitor will

;be bypassed during KOEO. KOEO current monitoring is intended

;to detect disconnected heaters with a low current fault check,

;which does not require the heaters to be at steady state.

;

;The flag EGO\_CUR\_MON is set to true upon completion of the

;current monitor, and is used here to lock out the test from

;re-running after it completes.

;

CURR\_TST\_ENA = true -----------------|

|

HEATER\_STATE = all\_on ---------| |

| |

HEATER\_STATE = cm\_11 ----------| |

| |

HEATER\_STATE = cm\_12 ----------|OR --|

| |

HEATER\_STATE = cm\_21 ----------| |

| |

HEATER\_STATE = cm\_22 ----------| |

| |

HEATER\_STATE = cm\_done --------| |

|AND -| Do:current\_monitor\_state\_control

EGO\_CUR\_MON = false -----------------|

|

US\_HTR\_TMR > US\_HEAT\_TM -| |

| |

DS\_HTR\_TMR > CM\_HEAT\_TM -| |

| |

EXT\_REG < DS\_CM\_MAX -----| |

|AND -| |

EXT\_REG > DS\_CM\_MIN -----| | |

| | |

EXT\_FEU < US\_CM\_MAX -----| |OR --|

| |

EXT\_FEU > US\_CM\_MIN -----| |

| ;bypass time/temp entry conditions

OSM\_EO\_ON = true --------------| ;for KOEO test

END: ego\_heater\_current\_monitor

11-74

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego\_heater\_mon\_control

;The following process is executed only when called and is used to signal

;back to the ego monitor control process that EGO heater monitoring

;is complete.

HEATER\_HP11 = false --|

|OR --|

HTR\_MON11 = true -----| |

|

HEATER\_HP21 = false --| |

|OR --|

HTR\_MON21 = true -----| |

|AND -| heaters\_monitored := true

HEATER\_HP12 = false --| | |

|OR --| |

HTR\_MON12 = true -----| | |

| |

HEATER\_HP22 = false --| | |

|OR --| |

HTR\_MON22 = true -----| |

| --- ELSE ---

|

| heaters\_monitored := false

heaters\_monitored = true ---|

|AND -| EGO\_HTR\_MON := true

HTRCM\_SW = false -----| |

|OR --|

EGO\_CUR\_MON = true ---|

END: ego\_heater\_mon\_control

11-75

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: koeo\_test

;The following process is only executed when called and is used to perform

;heater fault monitoring during a KOEO on demand test.

HTR\_FAULT11 = true ---------|

|AND -| Do: malfunction(ego, P0135)

HEATER\_HP11 = true ---------| |

| --- ELSE ---

|

| Do: clear\_malf(P0135)

HTR\_FAULT21 = true ---------|

|AND -| Do: malfunction(ego, P0155)

HEATER\_HP21 = true ---------| |

| --- ELSE ---

|

| Do: clear\_malf(P0155)

HTR\_FAULT12 = true ---------|

|AND -| Do: malfunction(ego, P0141)

HEATER\_HP12 = true ---------| |

| --- ELSE ---

|

| Do: clear\_malf(P0141)

HTR\_FAULT22 = true ---------|

|AND -| Do: malfunction(ego, P0161)

HEATER\_HP22 = true ---------| |

| --- ELSE ---

|

| Do: clear\_malf(P0161)

END: koeo\_test

11-76

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: current\_fault\_check

;The following process is only executed when called and is used to report

;malfunctions to the OBD-II Diagnostic Executive after current monitoring.

;

;The high current fault check is bypassed during KOEO. KOEO current

;monitoring is intended to detect disconnected heaters with a low

;current fault check. The high current check will be inaccurate,

;since the heaters will not reach their steady state resistance

;values (which are based on temperature) with the engine off.

;

HTRCM11 < US\_CUR\_LOW ------|

|OR --|

HTRCM11 > US\_CUR\_HI -| | |

|AND -| |AND -| Do: malfunction(ego, P0135)

OSM\_EO\_ON = false ---| | |

| |

HEATER\_HP11 = true --------------| |

| --- ELSE ---

|

| Do: clear\_malf(P0135)

HTRCM12 < DS\_CUR\_LOW ------|

|OR --|

HTRCM12 > DS\_CUR\_HI -| | |

|AND -| |AND -| Do: malfunction(ego, P0141)

OSM\_EO\_ON = false ---| | |

| |

HEATER\_HP12 = true --------------| |

| --- ELSE ---

|

| Do: clear\_malf(P0141)

HTRCM21 < US\_CUR\_LOW ------|

|OR --|

HTRCM21 > US\_CUR\_HI -| | |

|AND -| |AND -| Do: malfunction(ego, P0155)

OSM\_EO\_ON = false ---| | |

| |

HEATER\_HP21 = true --------------| |

| --- ELSE ---

|

| Do: clear\_malf(P0155)

HTRCM22 < DS\_CUR\_LOW ------|

|OR --|

HTRCM22 > DS\_CUR\_HI -| | |

|AND -| |AND -| Do: malfunction(ego, P0161)

OSM\_EO\_ON = false ---| | |

| |

HEATER\_HP22 = true --------------| |

| --- ELSE ---

|

| Do: clear\_malf(P0161)

END: current\_fault\_check

11-77

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: current\_monitor\_state\_control

;The following process is only executed when called and is used to control

;state of the EGO heaters when current monitoring is in progress.

HTRCM\_SW = false --------------| HEATER\_STATE := all\_on

| EGO\_CUR\_MON := true

|

| --- ELSE ---

|

HEATER\_STATE = all\_on ---------| HEATER\_STATE := cm\_11

| CURRENT\_CKD := false

|

| --- ELSE ---

HEATER\_STATE = cm\_11 ----| |

| |

HEATER\_HP21 = true ------|AND -| htrcm11 := FN\_HTR\_XFER(HTRCM\_CNTS)

| | HTRCM11 := htrcm11 \* HTR\_VOLT\_NOM / VBAT

CURRENT\_CKD = true ------| | HEATER\_STATE := cm\_21

| CURRENT\_CKD := false

|

| --- ELSE ---

HEATER\_STATE = cm\_11 ----| |

|AND -| HTRCM11 := FN\_HTR\_XFER(HTRCM\_CNTS)

CURRENT\_CKD = true ------| | HTRCM11 := htrcm11 \* HTR\_VOLT\_NOM / VBAT

| HEATER\_STATE := cm\_12

| CURRENT\_CKD := false

|

| --- ELSE ---

HEATER\_STATE = cm\_21 ----| |

|AND -| htrcm21 := FN\_HTR\_XFER(HTRCM\_CNTS)

CURRENT\_CKD = true ------| | HTRCM21 := htrcm21 \* HTR\_VOLT\_NOM / VBAT

| HEATER\_STATE := cm\_12

| CURRENT\_CKD := false

|

| --- ELSE ---

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11-78

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

HEATER\_STATE = cm\_12 ----| |

| |

HEATER\_HP22 = true ------|AND -| htrcm12 := FN\_HTR\_XFER(HTRCM\_CNTS)

| | HTRCM12 := htrcm12 \* HTR\_VOLT\_NOM / VBAT

CURRENT\_CKD = true ------| | HEATER\_STATE := cm\_22

| CURRENT\_CKD := false

|

| --- ELSE ---

HEATER\_STATE = cm\_12 ----| |

|AND -| htrcm12 := FN\_HTR\_XFER(HTRCM\_CNTS)

CURRENT\_CKD = true ------| | HTRCM12 := htrcm12 \* HTR\_VOLT\_NOM / VBAT

| HEATER\_STATE := cm\_done

| CURRENT\_CKD := false

|

| --- ELSE ---

HEATER\_STATE = cm\_22 ----| |

|AND -| htrcm22 := FN\_HTR\_XFER(HTRCM\_CNTS)

CURRENT\_CKD = true ------| | HTRCM22 := htrcm22 \* HTR\_VOLT\_NOM / VBAT

| HEATER\_STATE := cm\_done

| CURRENT\_CKD := false

|

| --- ELSE ---

|

HEATER\_STATE = cm\_done --------| HEATER\_STATE := all\_on

| EGO\_CUR\_MON := true

| Do: current\_fault\_check

;Allow one background loop to execute to clear fault bits set during

;current monitoring.

END: current\_monitor\_state\_control

11-79

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego\_heater\_state\_control

;The following process is executed only when called and is used to control

;the state of the EGO heaters during all normal, non-diagnostic modes.

;

;Reset all heater control parameters at the start and end of the

;KOEO/KOER self tests. For KOEO, force current monitoring (bypass

;normal time/temp entry conditions) and the koeo heater on/off state

;voltage checks. For KOER, allow the heater monitor to run naturally,

;based on it's normal time and temp entry conditions.

;

HTR\_RETRY11 = 0 ---------------|

|OR --|

HTR\_RETRY11 = RETRY\_ALLOW -----| |

|

HTR\_RETRY12 = 0 ---------------| |

|OR --|

HTR\_RETRY12 = RETRY\_ALLOW -----| |

|AND -| ok\_to\_change\_state := true

HTR\_RETRY21 = 0 ---------------| | |

|OR --| |

HTR\_RETRY21 = RETRY\_ALLOW -----| | |

| |

HTR\_RETRY22 = 0 ---------------| | |

|OR --| |

HTR\_RETRY22 = RETRY\_ALLOW -----| |

| --- ELSE ---

|

| ok\_to\_change\_state := false

; Check inferred temperature model FMEM flag. If set, add temperature

; offset to downstream heater turn on temperature. This will delay

; heater turn on to avoid potential ceramic cracking during cold starts.

; Local parameter used so calculation is only done once.

ds\_htr\_on\_fmm = DS\_HTR\_ON + EXT\_FMM\_FLG\*EXT\_REGON\_SF

;

;Detect start of the KOEO self test, and initialize heater control

;parms. Look for the rising and falling edges of EO\_ACTIVE.

;For 96 applications, move KOEO init logic into the Self

;Test strategy modules with the rest of the KOEO controller.

;

EO\_ACTIVE = 1 --------------------|

|AND -| Do: ego\_heater\_control\_init

EO\_INIT\_FLG = 0 ------------------| | Do: ego\_heater\_io\_init

| EO\_INIT\_FLG := 1

| ;set koeo start flag

|

| --- ELSE ---

EO\_ACTIVE = 0 --------------------| |

|AND -| EO\_INIT\_FLG := 0

EO\_INIT\_FLG = 1 ------------------| | ;clear koeo start flag

11-80

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OBDII\_RESET = true ---------------------|

|

ER\_STATUS = ER\_INIT --------------------|

|OR --| Do: ego\_heater\_control\_init

ER\_STATUS = ER\_DONE --------------------| | Do: ego\_heater\_io\_init

| | ;clean up before and after

EO\_STATUS = EO\_DONE --------------------| | ;self tests.

|

| --- ELSE ---

|

HEATER\_STATE = keyon\_init --------------------| HEATER\_STATE := us\_toggle

| ;toggle upstream heaters

| ;on/off to reset IMP IC

| ;fault flags and heater

| ;state at powerup.

|

| --- ELSE ---

|

HEATER\_STATE = us\_toggle ---------------------| HEATER\_STATE := ds\_toggle

| ;Toggle upstream heater pair

| ;first. (Turning on one pair

| ;at a time avoids excessive

| ;surge currents.)

|

| --- ELSE ---

|

HEATER\_STATE = ds\_toggle ---------------------| HEATER\_STATE := all\_off

| ;Reset of the IMP IC fault

| ;flags and heater states

| ;complete.

|

| --- ELSE ---

OSM\_EO\_ON = true -----------------------| |

| |

EGO\_CUR\_MON = false --------------------|AND -| HEATER\_STATE := all\_on

| | ;trigger current monitor

HEATER\_STATE = all\_off -----------------| | ;for KOEO

|

| --- ELSE ---

OSM\_EO\_ON = true -----------------------| |

|AND -| HEATER\_STATE := all\_on

EGO\_CUR\_MON = true ---------------------| | Do: koeo\_test

| ;wait for current monitor

| ;to complete

|

| --- ELSE ---

|

OSM\_EO\_ON = true -----------------------------| Do nothing

| ;Prevent underspeed flag

| ;from shutting heaters off

| ;while in KOEO current mon.

|

| --- ELSE ---

|

(continued on next page)

11-81

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

OSM\_EO\_OFF = true ----------------------------| HEATER\_STATE := all\_off

| Do: koeo\_test

|

| --- ELSE ---

|

ok\_to\_change\_state = true --------------| |

| |

HEATER\_STATE = all\_off -----| | |

| | |

EXT\_FEU > US\_HTR\_ON --------| |AND -| HEATER\_STATE := us\_on

|AND -| | |

EXT\_FEU < US\_HTR\_OFF -------| | | |

| | | |

UNDSP = 0 ------------------| |OR --| |

| |

HEATER\_STATE = all\_on ------| | |

|AND -| |

EXT\_REG >= DS\_HTR\_OFF ------| |

| --- ELSE ---

ok\_to\_change\_state = true---------------| |

| |

HEATER\_STATE = all\_off -----| | |

| | |

EXT\_FEU >= US\_HTR\_OFF ------| | |

| |AND -| HEATER\_STATE := ds\_on

ds\_htr\_on\_fmm <= EXT\_REG ---|AND -| | |

| | | |

EXT\_REG < DS\_HTR\_OFF -------| | | |

| | | |

UNDSP = 0 ------------------| | | |

|OR --| |

HEATER\_STATE = all\_on ------| | |

|AND -| |

EXT\_FEU >= US\_HTR\_OFF ------| |

| --- ELSE ---

ok\_to\_change\_state = true---------------| |

| |

UNDSP = 1 ------------------------| | |

| | |

HEATER\_STATE = us\_on -------| | |AND -| HEATER\_STATE := all\_off

|AND -| | |

EXT\_FEU >= US\_HTR\_OFF ------| | | |

|OR --| |

HEATER\_STATE = ds\_on -------| | |

|AND -| |

EXT\_REG >= DS\_HTR\_OFF ------| |

| --- ELSE ---

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11-82

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

ok\_to\_change\_state = true --------------| |

| |

HEATER\_STATE = us\_on ----- | | |

| | |

ds\_htr\_on\_fmm <= EXT\_REG ---|AND -| | |

| | |AND -| HEATER\_STATE := all\_on

EXT\_REG < DS\_HTR\_OFF -------| | |

| |

HEATER\_STATE = ds\_on -------| | |

|AND -|OR --|

EXT\_FEU < US\_HTR\_OFF -------| |

|

CURR\_TST\_ENA = false -------| |

| |

HEATER\_STATE = cm\_11 -| |AND -|

| |

HEATER\_STATE = cm\_12 -| |

|OR --|

HEATER\_STATE = cm\_21 -|

|

HEATER\_STATE = cm\_22 -|

END: ego\_heater\_state\_control

11-83

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego\_heater\_mode\_select

;The following process is executed only when called and is used to

;determine if the state controls should be in a normal mode or a

;test mode.

TEST\_ENABLED = true ---------------------|

|

HEATER\_STATE = us\_on --------| |

|AND -| |

HTR\_MON11 = false -----| | | |AND -|

|OR --| | | |

HTR\_MON21 = false -----| | | |

| | |

HEATER\_STATE = ds\_on --------| | | |

|AND -|OR --| |

HTR\_MON12 = false -----| | | |

|OR --| | |

HTR\_MON22 = false -----| | |

| |

HEATER\_STATE = all\_on -------| | |

| | |

HTR\_MON11 = false -----| |AND -| |

| | |

HTR\_MON12 = false -----| | |

|OR --| |

HTR\_MON21 = false -----| |

| |

HTR\_MON22 = false -----| |OR --| NORMAL\_MODE := false

| |

HTR\_RETRY11 = RETRY\_ALLOW ---------------| | |

| | |

HTR\_FAULT11 = no\_fault ------------------| | |

|AND -| |

OLDHTRFALT11 = fault --------------------| | |

| | |

HEGOHTR11 = OLDHEGOHTR11 ----------------| | |

| |

HTR\_RETRY12 = RETRY\_ALLOW ---------------| | |

| | |

HTR\_FAULT12 = no\_fault ------------------| | |

|AND -| |

OLDHTRFALT12 = fault --------------------| | |

| | |

HEGOHTR12 = OLDHEGOHTR12 ----------------| | |

| |

HTR\_RETRY21 = RETRY\_ALLOW ---------------| | |

| | |

HTR\_FAULT21 = no\_fault ------------------| | |

|AND -| |

OLDHTRFALT21 = fault --------------------| | |

| | |

HEGOHTR21 = OLDHEGOHTR21 ----------------| | |

| |

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11-84

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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HTR\_RETRY22 = RETRY\_ALLOW ---------------| | |

| | |

HTR\_FAULT22 = no\_fault ------------------| | |

|AND -| |

OLDHTRFALT22 = fault --------------------| |

| |

HEGOHTR22 = OLDHEGOHTR22 ----------------| |

| --- ELSE ---

|

| NORMAL\_MODE := true

END: ego\_heater\_mode\_select

BEGIN: reset\_diag\_state

;The following process is only executed when called and is used to return

;to a non-diagnostic state when testing gets disabled.

HEATER\_STATE = us\_on\_diag\_on -----|

|OR --| HEATER\_STATE := us\_on

HEATER\_STATE = us\_on\_diag\_off ----| |

| --- ELSE ---

HEATER\_STATE = ds\_on\_diag\_on -----| |

|OR --| HEATER\_STATE := ds\_on

HEATER\_STATE = ds\_on\_diag\_off ----| |

| --- ELSE ---

HEATER\_STATE = all\_on\_diag\_on ----| |

|OR --| HEATER\_STATE := all\_on

HEATER\_STATE = all\_on\_diag\_off ---|

END: reset\_diag\_state

11-85

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: check\_us\_faults

;The following process is only executed when called and latches faults on

;the upstream EGO heaters.

HTR\_FAULT11 = fault ----------| HTR\_MALF11 := true

HTR\_FAULT21 = fault ----------| HTR\_MALF21 := true

END: check\_us\_faults

BEGIN: check\_ds\_faults

;The following process is only executed when called and latches faults on

;the downstream EGO heaters.

HTR\_FAULT12 = fault ----------| HTR\_MALF12 := true

HTR\_FAULT22 = fault ----------| HTR\_MALF22 := true

END: check\_ds\_faults

11-86

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: us\_fault\_filtering

;The following process is only executed when called and is used to perform

;fault filtering on the upstream EGO heaters.

HTR\_FAULT11 = fault ------|

|OR --| HTR\_RETRY11 := min((HTR\_RETRY11+1),

HTR\_MALF11 = true --------| | RETRY\_ALLOW)

| Do: update\_retry\_max(11)

|

| --- ELSE ---

| Do: clear\_malf(P0135)

| HTR\_MON11 := true

| HTR\_RETRY11 := 0

HTR\_FAULT21 = fault ------|

|OR --| HTR\_RETRY21 := min((HTR\_RETRY21+1),

HTR\_MALF21 = true --------| | RETRY\_ALLOW)

| Do: update\_retry\_max(21)

|

| --- ELSE ---

| Do: clear\_malf(P0155)

| HTR\_MON21 := true

| HTR\_RETRY21 := 0

END: us\_fault\_filtering

BEGIN: ds\_fault\_filtering

;The following process is only executed when called and is used to perform

;fault filtering on the downstream EGO heaters.

HTR\_FAULT12 = fault ------|

|OR --| HTR\_RETRY12 := min((HTR\_RETRY12+1),

HTR\_MALF12 = true --------| | RETRY\_ALLOW)

| Do: update\_retry\_max(12)

|

| --- ELSE ---

|

| Do: clear\_malf(P0141)

| HTR\_MON12 := true

| HTR\_RETRY12 := 0

HTR\_FAULT22 = fault ------|

|OR --| HTR\_RETRY22 := min((HTR\_RETRY22+1),

HTR\_MALF22 = true --------| | RETRY\_ALLOW)

| Do: update\_retry\_max(22)

|

| --- ELSE ---

|

| Do: clear\_malf(P0161)

| HTR\_MON22 := true

| HTR\_RETRY22 := 0

END: ds\_fault\_filtering

11-87

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego\_heater\_diag\_state\_control

;The following process is only executed when called and is used to control

;the state of the EGO heaters during non-current monitoring diagnostics.

unconditionally --------------------------| old\_test\_enabled := TEST\_ENABLED

EGO\_TST\_ENA = true -----------------|

|

CCM\_ER\_ENA = true ------------------|OR --| TEST\_ENABLED := true

| |

CCM\_TST\_ENA = true -----------------| |

| --- ELSE ---

|

| TEST\_ENABLED := false

old\_test\_enabled = true ------------|

|AND -| HTR\_RETRY11 := 0

TEST\_ENABLED = false ---------------| | HTR\_RETRY21 := 0

| HTR\_RETRY12 := 0

| HTR\_RETRY22 := 0

| HTR\_MON11 := false

| HTR\_MON21 := false

| HTR\_MON12 := false

| HTR\_MON22 := false

| HTR\_MALF11 := false

| HTR\_MALF21 := false

| HTR\_MALF12 := false

| HTR\_MALF22 := false

| EGO\_HTR\_MON := false

| Do: clear\_malf(P0135)

| Do: clear\_malf(P0155)

| Do: clear\_malf(P0141)

| Do: clear\_malf(P0161)

| Do: reset\_diag\_state

UNDSP = 1 --------------------------------| EXIT this process.

11-88

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HTR\_FAULT11 = fault ----------|

|AND -|

HTR\_RETRY11 < RETRY\_ALLOW ----| |

|OR --| US\_FAULTED := true

HTR\_FAULT21 = fault ----------| | |

|AND -| |

HTR\_RETRY21 < RETRY\_ALLOW ----| |

| --- ELSE ---

|

| US\_FAULTED := false

HTR\_FAULT12 = fault ----------|

|AND -|

HTR\_RETRY12 < RETRY\_ALLOW ----| |

|OR --| DS\_FAULTED := true

HTR\_FAULT22 = fault ----------| | |

|AND -| |

HTR\_RETRY22 < RETRY\_ALLOW ----| |

| --- ELSE ---

|

| DS\_FAULTED := false

11-89

EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HEATER\_STATE = us\_on\_diag\_off -------------------| Do: check\_us\_faults

| HEATER\_STATE :=

| us\_on\_diag\_on

|

| --- ELSE ---

|

HEATER\_STATE = ds\_on\_diag\_off -------------------| Do: check\_ds\_faults

| HEATER\_STATE :=

| ds\_on\_diag\_on

|

| --- ELSE ---

|

HEATER\_STATE = all\_on\_diag\_off ------------------| Do: check\_us\_faults

| Do: check\_ds\_faults

| HEATER\_STATE :=

| all\_on\_diag\_on

|

| --- ELSE ---

|

HEATER\_STATE = us\_on\_diag\_on --------------------| Do: us\_fault\_filtering

| HEATER\_STATE := us\_on

|

| --- ELSE ---

|

HEATER\_STATE = ds\_on\_diag\_on --------------------| Do: ds\_fault\_filtering

| HEATER\_STATE := ds\_on

|

| --- ELSE ---

|

HEATER\_STATE = all\_on\_diag\_on -------------------| Do: us\_fault\_filtering

| Do: ds\_fault\_filtering

| HEATER\_STATE := all\_o

|

| --- ELSE ---

TEST\_ENABLED = true -----------------------| |

| |

HEATER\_STATE = us\_on ----------------------| |

| |

HTR\_RETRY11 > 0 ---------------| |AND -| HEATER\_STATE :=

|AND -| | | us\_on\_diag\_off

HTR\_RETRY11 < RETRY\_ALLOW -----| | | | HTR\_MALF11 := false

| | | HTR\_MALF21 := false

HTR\_RETRY21 > 0 ---------------| | | |

|AND -| | |

HTR\_RETRY21 < RETRY\_ALLOW -----| |OR --| |

| |

US\_FAULTED = true -------------------| |

| |

NORMAL\_MODE = false -----------------| |

| --- ELSE ---

(continued on next page)

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

TEST\_ENABLED = true -----------------------| |

| |

HEATER\_STATE = ds\_on ----------------------| |

| |

HTR\_RETRY12 > 0 ---------------| |AND -| HEATER\_STATE :=

|AND -| | | ds\_on\_diag\_off

HTR\_RETRY12 < RETRY\_ALLOW -----| | | | HTR\_MALF12 := false

| | | HTR\_MALF22 := false

HTR\_RETRY22 > 0 ---------------| | | |

|AND -| | |

HTR\_RETRY22 < RETRY\_ALLOW -----| |OR --| |

| |

DS\_FAULTED = true -------------------| |

| |

NORMAL\_MODE = false -----------------| |

| --- ELSE ---

TEST\_ENABLED = true -----------------------| |

| |

HEATER\_STATE = all\_on ---------------------| |

| |

HTR\_RETRY11 > 0 ---------------| | |

|AND -| | |

HTR\_RETRY11 < RETRY\_ALLOW -----| | | |

| | |

HTR\_RETRY21 > 0 ---------------| | | |

|AND -| |AND -| HEATER\_STATE :=

HTR\_RETRY21 < RETRY\_ALLOW -----| | | | all\_on\_diag\_off

| | | HTR\_MALF11 := false

HTR\_RETRY12 > 0 ---------------| | | | HTR\_MALF21 := false

|AND -| | | HTR\_MALF12 := false

HTR\_RETRY12 < RETRY\_ALLOW -----| | | | HTR\_MALF22 := false

| |

HTR\_RETRY22 > 0 ---------------| | |

|AND -| |

HTR\_RETRY22 < RETRY\_ALLOW -----| |OR --|

|

US\_FAULTED = true -------------------|

|

DS\_FAULTED = true -------------------|

|

NORMAL\_MODE = false -----------------|

TEST\_ENABLED = true -----------------| Do: ego\_heater\_fault\_report

END: ego\_heater\_diag\_state\_control

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EGO MONITOR CONTROL STRATEGY, EGO HEATER CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego\_heater\_fault\_report

;The following process is only executed when called and is used to control

;the fault codes associated with non-current monitoring diagnostics.

HTR\_RETRY11 >= RETRY\_ALLOW ---------| Do: malfunction(ego, P0135)

| HTR\_MON11 := true

HTR\_RETRY12 >= RETRY\_ALLOW ---------| Do: malfunction(ego, P0141)

| HTR\_MON12 := true

HTR\_RETRY21 >= RETRY\_ALLOW ---------| Do: malfunction(ego, P0155)

| HTR\_MON21 := true

HTR\_RETRY22 >= RETRY\_ALLOW ---------| Do: malfunction(ego, P0161)

| HTR\_MON22 := true

END: ego\_heater\_fault\_report

BEGIN: ego\_heater\_timer\_control

;The following process is only executed when called and is used to control

;timers that indicates how long the EGO heaters have been on.

HEATER\_STATE = all\_off -------|

|OR --| DS\_HTR\_TMR := 0

HEATER\_STATE = us\_on ---------| |

| --- ELSE ---

|

| ;Allow the free running timer,

| ;DS\_HTR\_TMR, to increment.

HEATER\_STATE = all\_off -------|

|OR --| US\_HTR\_TMR := 0

HEATER\_STATE = ds\_on ---------| |

| --- ELSE ---

|

| ;Allow the free running timer,

| ;US\_HTR\_TMR, to increment.

END: ego\_heater\_timer\_control

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EGO MONITOR CONTROL STRATEGY, EGO HEATER IO - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

11.1.5 EGO HEATER IO (CDAN0)

This module interfaces the EGO heater control and monitoring logic to the

heater IMP IC for ML-II hardware. It contains the following processes.

+-------------------------------+

| EGO\_HEATER\_IO\_COM10 |

+-------------------------------+

|PUBLIC PROCEDURES: |

|. ego\_heater\_io\_init |

|. ego\_heater\_output |

|. ego\_heater\_fault\_status |

+-------------------------------+

Two parameters interface the heater control state machine logic with the

hardware: HEATER\_STATE and HTR\_FAULTxy. HEATER\_STATE is encoded by the

state machine with the following information: heater mode (normal,

diagnostics, current monitoring), upstream heater pair on/off, and downstream

heater pair on/off. The ego\_heater\_output process decodes this parameter and

sets the HEGOHTRxy flags on or off.

The HEGOHTRxy flags are placed by software into a command byte sent to the

IMP IC to control heater hardware. For each command byte sent, the IMP

returns a status byte for the previous command. Software reads this value

and places heater status into the HTR\_FAULTxy flags. These flags are used

back in the control module for heater diagnositics.

Refer to the IMP Device Description and Design Specification for a complete

description of the IMP IC operation.

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EGO MONITOR CONTROL STRATEGY, EGO HEATER IO - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- ER\_STATUS = During the engine running self test (KOER) this byte

indicates which part of the test is running. For example, it will be set

to state "ER\_INIT" at the beginning of the test .

- HEATER\_STATE = State machine set in the heater control module, and

decoded by this module to set the HEGOHTRxy flags on/off.

Bit Flags:

- HEGOHTRxy = EGO heater on/off flags. These flags are put into a command

byte by software, and sent to the IMP IC. 'xy' is array notation for

bank x, location y (upstream or downstream).

- HTR\_FAULTxy = Heater Fault flags. The IMP responds to each heater

command with a heater status byte, which software places into these

flags. Value of 1 indicates voltage fault for heater 'xy'.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II scan tool

reset message.

- OFF\_FAULTxy = Voltage fault detected for heater 'xy' when it was last

off.

- OLDHEGOHTRxy = Previous background pass value of HEGOHTRxy.

- OLDHTRFALTxy = Previous background value of HTR\_FAULTxy.

- ON\_FAULTxy = Voltage fault detected for heater 'xy' when it was last on.

- SUBST\_REQ25:28 = Output State Control commanded substitution requested

for heater channels 25-28.

Calibration Constants:

- ER\_DONE = Value for state of ER\_STATUS when engine running test

completes.

- ER\_INIT = Value for state of ER\_STATUS when engine running test first

inits.

- HEATER\_HPxy = EGO heater xy hardware present switch.

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EGO MONITOR CONTROL STRATEGY, EGO HEATER IO - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EGO\_HEATER\_IO\_COM2

BEGIN: definitions

;The following represent definitions used throughout this module. This

;is not to be explicitly executed. It exists only to make the documentation

;more readable.

unconditionally ------------------------| on := 1

| off := 0

| true := 1

| false := 0

| fault := 1

| no\_fault := 0

| all\_on := 1

| all\_on\_diag\_on := 2

| all\_on\_diag\_off := 3

| us\_on := 4

| us\_on\_diag\_on := 5

| us\_on\_diag\_off := 6

| ds\_on := 7

| ds\_on\_diag\_on := 8

| ds\_on\_diag\_off := 9

| all\_off := 10

| keyon\_init := 11

| us\_toggle := 12

| ds\_toggle := 13

| cm\_11 := 100

| cm\_12 := 101

| cm\_21 := 102

| cm\_22 := 103

| cm\_done := 104

END: definitions

11-95

EGO MONITOR CONTROL STRATEGY, EGO HEATER IO - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego\_heater\_io\_init

;The following process is used to initialize the EGO heater heater interface

;parameters. It is executed during a power-up iniitialization prior to

exiting

;HLOS (hardware requirement) and when called at the start and end of KOER

EGO

;test in the ego\_heater\_control module.

;

unconditionally -----------| HEGOHTR11 := off

| HEGOHTR21 := off

| HEGOHTR12 := off

| HEGOHTR22 := off

| OLDHEGOHTR11 := off

| OLDHEGOHTR21 := off

| OLDHEGOHTR12 := off

| OLDHEGOHTR22 := off

| HTR\_FAULT11 := no\_fault

| HTR\_FAULT12 := no\_fault

| HTR\_FAULT21 := no\_fault

| HTR\_FAULT22 := no\_fault

| OLDHTRFALT11 := no\_fault

| OLDHTRFALT12 := no\_fault

| OLDHTRFALT21 := no\_fault

| OLDHTRFALT22 := no\_fault

| ON\_FAULT11 := false

| ON\_FAULT12 := false

| ON\_FAULT21 := false

| ON\_FAULT22 := false

| OFF\_FAULT11 := false

| OFF\_FAULT12 := false

| OFF\_FAULT21 := false

| OFF\_FAULT22 := false

END: ego\_heater\_io\_init

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EGO MONITOR CONTROL STRATEGY, EGO HEATER IO - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego\_heater\_output

;The following process, executed only when called is used to write

;to the output parameters to turn on or off the heaters.

unconditionally -----------| OLDHEGOHTR11 := HEGOHTR11

| OLDHEGOHTR12 := HEGOHTR12

| OLDHEGOHTR21 := HEGOHTR21

| OLDHEGOHTR22 := HEGOHTR22

HEATER\_STATE = all\_off --------------|

|

HEATER\_STATE = all\_on\_diag\_off-| |

| |

ON\_FAULT11 = true -------| | |

| | |

OFF\_FAULT11 = true ------| | |

|OR --| |

ON\_FAULT21 = true -------| | |

| | |

OFF\_FAULT21 = true ------| | |

|AND -|OR --| hegohtr11 := off

ON\_FAULT12 = true -------| | | | hegohtr12 := off

| | | | hegohtr21 := off

OFF\_FAULT12 = true ------| | | | hegohtr22 := off

|OR --| | |

ON\_FAULT22 = true -------| | |

| | |

OFF\_FAULT22 = true ------| | |

| |

HEATER\_STATE = us\_on\_diag\_off -------| |

| |

HEATER\_STATE = ds\_on\_diag\_off -------| |

| --- ELSE ---

HEATER\_STATE = all\_on ---------------| |

|OR --| hegohtr11 := on

HEATER\_STATE = all\_on\_diag\_on -------| | hegohtr12 := on

| hegohtr21 := on

| hegohtr22 := on

|

| --- ELSE ---

HEATER\_STATE = us\_on ----------------| |

| |

HEATER\_STATE = us\_on\_diag\_on --------| |

|OR --| hegohtr11 := on

HEATER\_STATE = all\_on\_diag\_off-| | | hegohtr12 := off

| | | hegohtr21 := on

ON\_FAULT12 = true -------| |AND -| | hegohtr22 := off

| | |

OFF\_FAULT12 = true ------| | |

|OR --| |

ON\_FAULT22 = true -------| |

| |

OFF\_FAULT22 = true ------| |

| --- ELSE ---

(continued on next page)

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EGO MONITOR CONTROL STRATEGY, EGO HEATER IO - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

HEATER\_STATE = ds\_on ----------------| |

| |

HEATER\_STATE = ds\_on\_diag\_on --------| |

|OR --| hegohtr11 := off

HEATER\_STATE = all\_on\_diag\_off-| | | hegohtr12 := on

| | | hegohtr21 := off

ON\_FAULT11 = true -------| |AND -| | hegohtr22 := on

| | |

OFF\_FAULT11 = true ------| | |

|OR --| |

ON\_FAULT21 = true -------| |

| |

OFF\_FAULT21 = true ------| |

| --- ELSE ---

|

HEATER\_STATE = cm\_11 ----------------------| hegohtr11 := off

| hegohtr12 := on

| hegohtr21 := on

| hegohtr22 := on

|

| --- ELSE ---

|

HEATER\_STATE = cm\_21 ----------------------| hegohtr11 := on

| hegohtr12 := on

| hegohtr21 := off

| hegohtr22 := on

|

| --- ELSE ---

|

HEATER\_STATE = cm\_12 ----------------------| hegohtr11 := on

| hegohtr12 := off

| hegohtr21 := on

| hegohtr22 := on

|

| --- ELSE ---

|

HEATER\_STATE = cm\_22 ----------------------| hegohtr11 := on

| hegohtr12 := on

| hegohtr21 := on

| hegohtr22 := off

|

| --- ELSE ---

|

HEATER\_STATE = cm\_done --------------------| hegohtr11 := on

| hegohtr12 := on

| hegohtr21 := on

| hegohtr22 := on

|

| --- ELSE ---

|

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EGO MONITOR CONTROL STRATEGY, EGO HEATER IO - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

HEATER\_STATE = keyon\_init -----------------| hegohtr11 := off

| hegohtr12 := off

| hegohtr21 := off

| hegohtr22 := off

|

| --- ELSE ---

|

HEATER\_STATE = us\_toggle ------------------| hegohtr11 := on

| hegohtr12 := off

| hegohtr21 := on

| hegohtr22 := off

|

| --- ELSE ---

|

HEATER\_STATE = ds\_toggle ------------------| hegohtr11 := on

| hegohtr12 := on

| hegohtr21 := on

| hegohtr22 := on

;

;The state cm\_done is intended to allow fault flags, which get set during

;current monitoring, to clear prior to resuming operation of the normal

;heater controller. This prevents the heater controller from jumping

;into diagnostics mode to clear the fault bits, and the KOEO test from

;detecting inadvertant fault flags left over from the current monitor.

;

;The state keyon\_init begins the powerup reset sequence for the IMP IC

;to clear any erroneous IMP fault bits or heater states which may have

;latched on at powerup. The state us\_toggle turns on the upstream

;heaters first, followed by the state ds\_toggle to turn on the downstream

;pair. Upstream/downstream heater turn is staggered to avoid excessive

;surge currents during cold starts.

;

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EGO MONITOR CONTROL STRATEGY, EGO HEATER IO - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;Output State Control override logic:

; Notify user if requested channel is not present for this vehicle:

SUBST\_REQ25 = 1 -----|

|AND -| Do: osc\_response(25,10h)

HEATER\_HP11 = 0 -----|

SUBST\_REQ26 = 1 -----|

|AND -| Do: osc\_response(26,10h)

HEATER\_HP12 = 0 -----|

SUBST\_REQ27 = 1 -----|

|AND -| Do: osc\_response(27,10h)

HEATER\_HP21 = 0 -----|

SUBST\_REQ28 = 1 -----|

|AND -| Do: osc\_response(28,10h)

HEATER\_HP22 = 0 -----|

OBDII\_RESET <> 1 ----| |

| |

ER\_STATUS <> | |

ER\_INIT -----|AND -| Do: substitute(25,hegohtr11)

| | HEGOHTR11 := hegohtr11

ER\_STATUS <> | | Do: substitute(26,hegohtr12)

ER\_DONE ------| | HEGOHTR12 := hegohtr12

| Do: substitute(27,hegohtr21)

| HEGOHTR21 := hegohtr21

| Do: substitute(28,hegohtr22)

| HEGOHTR22 := hegohtr22

END: ego\_heater\_output

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EGO MONITOR CONTROL STRATEGY, EGO HEATER IO - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego\_heater\_fault\_status

;The following process is only executed when called and is used to control

;the reading of the fault status fromthe SPI inputs for each EGO heater.

unconditionally --------------| OLDHTRFALT11 := HTR\_FAULT11

| OLDHTRFALT12 := HTR\_FAULT12

| OLDHTRFALT21 := HTR\_FAULT21

| OLDHTRFALT22 := HTR\_FAULT22

HEATER\_HP11 = true -----------| HTR\_FAULT11 := Fault bit from driver.

|

| --- ELSE ---

|

| HTR\_FAULT11 := no\_fault

HEATER\_HP21 = true -----------| HTR\_FAULT21 := Fault bit from driver.

|

| --- ELSE ---

|

| HTR\_FAULT21 := no\_fault

HEATER\_HP12 = true -----------| HTR\_FAULT12 := Fault bit from driver.

|

| --- ELSE ---

|

| HTR\_FAULT12 := no\_fault

HEATER\_HP22 = true -----------| HTR\_FAULT22 := Fault bit from driver.

|

| --- ELSE ---

|

| HTR\_FAULT22 := no\_fault

HEGOHTR11 = on ---------------| ON\_FAULT11 := HTR\_FAULT11

|

| --- ELSE ---

|

| OFF\_FAULT11 := HTR\_FAULT11

HEGOHTR21 = on ---------------| ON\_FAULT21 := HTR\_FAULT21

|

| --- ELSE ---

|

| OFF\_FAULT21 := HTR\_FAULT21

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EGO MONITOR CONTROL STRATEGY, EGO HEATER IO - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HEGOHTR12 = on ---------------| ON\_FAULT12 := HTR\_FAULT12

|

| --- ELSE ---

|

| OFF\_FAULT12 := HTR\_FAULT12

HEGOHTR22 = on ---------------| ON\_FAULT22 := HTR\_FAULT22

|

| --- ELSE ---

|

| OFF\_FAULT22 := HTR\_FAULT22

END: ego\_heater\_fault\_status

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CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

11.1.6 EGO SWITCHING TEST (CDAN0)

OVERVIEW:

This test determines that the EGO sensor is switching properly when

conditions are present that will allow a functional fuel system to cause the

EGO sensor to switch.

The fundamental principles of the EGO/fuel system test are;

1 - that while the EGO test conditions are true a functioning fuel system

will not violate any EGO test criteria.

2 - while the EGO test conditions are false the EGO sensor cannot be expected

to switch, therefore all failure indicators are reset (LAMBSE and time since

last EGO switch criteria) or suspended (number of switches criterion).

Three separate failure criteria are used to determine if the EGO/fuel system

is malfunctioning;

1 - total number of EGO switches; if the EGO sensor/fuel system is in a

condition where the EGO sensor(s) do not switch at all then, after the test

has accumulated sufficient test time (to give the sensors the opportunity to

switch the required number of times) and a sufficient number of switches has

not occurred, then the test will indicate a malfunction.

2 - LAMBSE at clip; if LAMBSE is at a clip and remains there for V\_LESTM

seconds while the test conditions are true the test will indicate a

malfunction.

3 - Time since last EGO switch; if at any time the test conditions are true

and the time since the last EGO switch took place exceeds V\_LEGO\_MAX the test

will indicate a malfunction. When one or both sensors have failed while the

EGO test was inactive, special conditions are checked to allow testing for

time since last EGO switch while purging is taking place. See the procedure

"PURG\_NOT\_CAUSE\_FOR\_FAILURE".

DEFINITIONS

Registers:

- ATMR1 = Time since exiting crank mode.

- EGOSS11 = Number of EGO11 switches since start.

- EGOSS21 = Number of EGO21 switches since start.

- EXT\_FEU = Inferred tip temperature of the upstream EGO sensor (without

heater effects).

- INFAMB\_KAM = Inferred ambient air temperature, used to initialize the

cat. temp. model.

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CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- KAMRF1 = Total learned fuel system correction from EGO11.

- KAMRF2 = Total learned fuel system correction from EGO21.

- LAMBSE1 = Desired air/fuel ratio, EGO11.

- LAMBSE2 = Desired air/fuel ratio, EGO21.

- LEGONOTPURG = In EGO test, when equal to 1, testing while purging is

appropriate.

- LOAD = Nondimensional, generic engine load.

- LAMMAXn = Upper lambse clip calculated for bank n.

- LAMMINn = Lower lambse clip calculated for bank n.

- P1130FIL = Lack of EGO11 switch, adaptive fuel at limit fault filter.

- P1131FIL = Lack of EGO11 switch, EGO indicates lean fault filter.

- P1132FIL = Lack of EGO11 switch, EGO indicates rich fault filter.

- P1150FIL = Lack of EGO21 switch, adaptive fuel at limit fault filter.

- P1151FIL = Lack of EGO21 switch, EGO21 indicates lean fault filter.

- P1152FIL = Lack of EGO21 switch, EGO21 indicates rich fault filter.

- PUTMR = Time since powerup.

- TP\_REL = Relative Throttle Position, counts. TP - RATCH.

- V\_EGOTST\_TMR = Time since self test closed loop conditions have been met.

- V\_LEGOTMR1 = Self test time since last EGO11 switch while test conditions

are active.

- V\_LEGOTMR2 = Self test time since last EGO21 switch while test conditions

are active.

- V\_LESTMR1 = Self test lack of EGO11 switchng timer.

- V\_LESTMR2 = Self test lack of EGO21 switching timer.

Bit Flags:

- AFMFLG = Flag indicating that ACT sensor is in/out of range.

- CFMFLG = Flag indicating that ECT sensor is in/out of range.

- CRKFLG = Flag indicating crank mode.

- EGOFL11 = EGO11 state flag; 1 -> rich.

- EGOFL21 = EGO21 state flag; 1 -> rich.

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CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- EGOTSTCUMFLG = Flag used to start and halt EGOTSTCUMTMR; 0 -> halt.

- EGREN = Flag indicating EGR is enabled; 1 -> enabled.

- FFG\_CSD11 = Fault flag for CSD on sensor 11.

- FFG\_CSD21 = Fault flag for CSD on sensor 21.

- ISCFLG = Indication of Idle Air Flow; 1 = Idle Air Flow.

- LEGOFG11 = Lack of EGO11 switching.

- LEGOFG21 = Lack of EGO21 switching.

- MFMFLG = MAP failure flag set to 1 if MAP sensor fails.

- OL\_DESIRED = Open loop desired flag; 1 = open loop desired.

- OPEN\_EGOn1 = Flag indicating open circuit voltage condition found on

Upstream HEGO bank n sensor.

- PG\_DC = Purge enabled flag.

- SWTFL11 = EGO switch flag; 1 -> EGO11 switched this background loop.

- SWTFL21 = EGO switch flag; 1 -> EGO21 switched this background loop.

- TFMFLG = Flag indicating TP sensor is in/out of range.

- V\_LAMJMP1 = 1 -> base strategy caused a LAMBSE1 jump since last EGO11

switch.

- V\_LAMJMP2 = 2 -> base strategy caused a LAMBSE2 jump since last EGO21

switch.

- V\_EGO1\_BYPS = Prevents additional EGO11 service code.

- V\_EGO1L\_BYPS = Prevents additional EGO11 service code.

- V\_EGO2\_BYPS = Prevents additional EGO21 service code.

- V\_EGO2L\_BYPS = Prevents additional EGO21 service code.

- V\_EGR\_DLYFG = EGO test EGR transition indication flag; 1 -> EGR

transition has occurred.

- V\_EGR\_OLD = Previous background EGR state.

- V\_INJ\_ER\_FLG = In range injector error flag.

- V\_INRANG\_FLG = Continuous EGO test intermediate test flag used by

in-range sensor tests.

- V\_MAF\_ER\_FLG = In range MAF error flag.

- V\_TP\_ER\_FLG = In range TP error flag.

Calibration Constants:

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CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- CSD\_MIN\_AMB = Minimum ambient temperature to allow storage of CSD fault

codes.

- ETST\_SWCUMTM = Accumulated time EGO test active before failure is

indicated because of number of switches failure criteria.

- FN1351(N,LOAD)= Transport delay in REVS.

- MAXADP = Maximum adaptive correction.

- MINADP = Minimum adaptive correction.

- NUMEGO = Number of EGO sensors.

- PRG\_DEC = Purge DC decrement amount when purge overwhelms fuel control.

- PURGSW = When switch = 1, purging allowed during open loop fuel control.

- P1130LVL = Lack of EGO11 switch, adaptive fuel at limit fault filter

threshold.

- P1130UP = Lack of EGO11 switch, adaptive fuel at limit fault filter

increment.

- P1131LVL = Lack of EGO11 switch, EGO11 indicates lean fault filter

threshold.

- P1131UP = Lack of EGO11 switch, EGO11 indicates lean fault filter

increment.

- P1132LVL = Lack of EGO11 switch, EGO11 indicates rich fault filter

threshold.

- P1132UP = Lack of EGO11 switch, EGO11 indicates rich fault filter

increment.

- P1150LVL = Lack of EGO21 switch, adaptive fuel at limit fault filter

threshold.

- P1150UP = Lack of EGO21 switch, adaptive fuel at limit fault filter

increment.

- P1151LVL = Lack of EGO21 switch, EGO21 indicates lean fault filter

threshold.

- P1151UP = Lack of EGO21 switch, EGO21 indicates lean fault filter

increment.

- P1152LVL = Lack of EGO21 switch, EGO21 indicates rich fault filter

threshold.

- P1152UP = Lack of EGO21 switch, EGO21 indicates rich fault filter

increment.

- V\_EGO\_ENA = Continuous EGO test enable switch; 1 -> enable.

- V\_EGOIDL\_ENA = Switch to enable EGO sensor test at idle air flows; 1 ->

enable.

11-106

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- V\_EGOLD\_MAX = Maximum LOAD to perform EGO sensor test when not at idle.

- V\_EGOLD\_MIN = Minimum LOAD to perform EGO sensor test when not at idle.

- V\_EGOTEMP = Temperature at which to enable the continuous EGO switching

test, degrees.

- V\_EGOTST\_TM = Time since closed loop conditions minus EGO input have been

met.

- V\_LEGO\_MAX = Maximum time since last EGO-n switch before failure

indication.

- V\_LEGO\_MAX2 = Maximum time since last EGOn switch before failure

indication when failure took place while EGO testing was suspended.

- V\_LESTM1 = Time since last EGO11 switch limit to fail continuous EGO

switching test.

- V\_LESTM2 = Time since last EGO21 switch limit to fail continuous EGO

switching test.

11-107

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EGO\_CONTINUOUS\_TEST\_COM10

BEGIN: BG\_CHECK\_ENTRY\_CONDITIONS

;

; Execute this process only when called from the monitor control module.

;

; This process is the entry point for the continuous lack of switching tests.

; Check global entry conditions first, and then call the lack of switching

; test window is in-range.

;

DEMAND\_MODE = 0 --------|

(not in KOEO or KOER) |

|

V\_EGO\_ENA = 1 ----------|AND -| Do: EGR\_TRANSITION\_DELAY\_FLAG\_CONTROL

(test cal'd in) | | Do: EGO\_PURG\_CHK

| | Do: PURG\_NOT\_CAUSE\_OF\_FAILURE

CCM\_TST\_ENA = 1 --| | | Do: EGO\_SWITCHING\_FAILURE\_INDICATION\_CONTROL

|OR --| | Do: ACCUM\_TIMER\_CONTROL

EGO\_TST\_ENA = 1 --| | Do: IN\_RANGE\_ENTRY

| (test conditions checked)

|

| --- ELSE ---

|

V\_EGO\_ENA = 1 ----------------| EGOTSTCUMTMR := 0

(test cal'd in) | Do: EGO\_TEST\_TMR\_CLEAR

| (test is bypassed, clear timers

| until test is executed)

END: BG\_CHECK\_ENTRY\_CONDITIONS

11-108

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: IN\_RANGE\_ENTRY

The following test conditions plus the conditions in EGOTST\_TMR\_CONTROL

must be true for V\_EGOTST\_TM seconds before the fuel system can be tested.

The conditions in IN\_RANGE\_ENTRY are separated from the conditions in

EGOTST\_TMR\_CONTROL for use by the In-Range-Failure-Test via V\_INRANG\_FLG.

OL\_DESIRED = 0 ---------------|

(closed loop desired) |

|

EXT\_FEU >= V\_EGOWARM ---| |

|OR --|

ATMR1 >= V\_EGORNTM -----| |

|

AFMFLG = 0 -------------------|

|AND -| V\_INRANG\_FLG := 1

CFMFLG = 0 -------------------| | (for use by in-range-failure

| | test)

MFMFLG = 0 -------------------| | Do: EGOTST\_TMR\_CONTROL

| | Do: EGOTST\_TMR\_CHK

TFMFLG = 0 -------------------| |

(no failed sensors) | |

| |

V\_EGR\_DLYFG = 0 --------------| |

(no egr transitions) |

| --- ELSE ---

|

| V\_INRANG\_FLG := 0

| (for use by in-range-failure

| test)

| Do: EGOTST\_TMR\_CONTROL

END: IN\_RANGE\_ENTRY

11-109

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGOTST\_TMR\_CONTROL

The following test conditions logic must be true for V\_EGOTST\_TM

seconds before the fuel system can be tested.

V\_INRANG\_FLG = 1 -----------------|

(above conditions met) |

|

TP\_REL=> V\_EGOTP\_MIN -| |

(min TP\_REL to test) | |

| |AND -| increment V\_EGOTST\_TMR

ISCFLG <= 0 ----------| | | EGOTSTCUMFLG := 1

(not at idle) |AND -| | | (allow EGOTSTCUMTMR to run)

| | | |

LOAD > V\_EGOLD\_MIN ---| | | |

(load indicator) | | | |

| |OR --| |

LOAD < V\_EGOLD\_MAX ---| | |

| |

ISCFLG > 0 -----------| | |

(at idle) |AND -| |

| |

V\_EGOIDL\_ENA = 1 -----| |

(enable at idle) |

| --- ELSE ---

|

| Do: EGO\_TEST\_TMR\_CLEAR

| (test is bypassed, clear

| timers until test is executed)

| Do: VEGOFIL\_ZERO

| (control fault filter for

| MIL control)

| EGOTSTCUMFLG := 0

| (EGOTSTCUMTMR halted)

END: EGOTST\_TMR\_CONTROL

11-110

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGOTST\_TMR\_CHK

Control of how long the test conditions must be present before testing is to

take place is accomplished with the calibration parameter V\_EGOTST\_TM.

V\_EGOTST\_TMR > V\_EGOTST\_TM -----|

(test conditions present |

sufficiently long to test) |AND -| Do: EGO11\_TESTS

| | Do: EGO11\_MALF

NUMEGO = 2 ---------------------| | Do: EGO1FMFLG\_CONTROL

| Do: EGO21\_TESTS

| Do: EGO21\_MALF

| Do: EGO2FMFLG\_CONTROL

|

| --- ELSE ---

|

V\_EGOTST\_TMR > V\_EGOTST\_TM -----------| Do: EGO11\_TESTS

(test conditions present | Do: EGO11\_MALF

sufficiently long to test) | Do: EGO1FMFLG\_CONTROL

EGOTSTCUMTMR > ETST\_SWCUMTM ----------| EGO\_TEST\_MON := 1

(sufficient cumulative test time)

END: EGOTST\_TMR\_CHK

BEGIN: ACCUM\_TIMER\_CONTROL

The timer EGOTSTCUMTMR is a cumulative timer that documents total accumulated

time that the EGO test conditions are true while there are no purging

restrictions since the last time crank mode was exitted. If crank mode is

re-entered, this timer is cleared (see "Test Entry Conditions").

EGOTSTCUMFLG = 1 -----------------| allow EGOTSTCUMTMR to run

(test conditions true) |

|

| --- ELSE ---

|

| freeze EGOTSTCUMTMR

END: ACCUM\_TIMER\_CONTROL

11-111

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGO\_TEST\_TMR\_CLEAR

unconditionally ------------------------| V\_LESTMR1 := 0

| V\_LESTMR2 := 0

| V\_EGOTST\_TMR := 0

| V\_LEGOTMR1 := 0

| V\_LEGOTMR2 := 0

END: EGO\_TEST\_TMR\_CLEAR

BEGIN: EGO\_PURG\_CHK

PG\_DC = 0 ---------------------------|

(purge off) |

|

PRG\_DEC = 0 -------------------------|OR --| ego\_purg\_byps := 0

(purge does not effect | | (no purging restrictions

non pcomp fuel systems) | | on ego test)

| |

PCOMP\_SW = 1 ------------------------| |

(pcomp purge system) |

| --- ELSE ---

|

| ego\_purg\_byps := 1

| (purging restrictions

| on ego test in effect)

END: EGO\_PURG\_CHK

11-112

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: PURG\_NOT\_CAUSE\_OF\_FAILURE

This logic recognizes whether one or both EGO sensors has stop switching. In

the case where one sensor stopped switching, the control system causes both

banks to be controlled by the remaining sensor. In the case where both

sensors fail the system will go open loop. Normally a rich failure cannot be

recognized unless purging has been removed, eliminating purge as the cause of

the apparent failure. In the first case above, if the ego test was inactive

from the time the ego stopped switching to the time the LEGOFGn flag becomes

set a failure will have to be recognized while purging is taking place. If

one EGO is switching properly then the inference is that purging is not

overdriving the non switching sensor. In the second case (both sensors

failed) failure recognization can take place if purging is suspended during

open loop operation (PURGSW = 0).

The following logic recognizes the above conditions and indicates to the

failure assessment logic that one of the above situations exist. The flag

LEGONOTPURG indicates whether or not a test for ego failure may be performed

if one of the above situations has occurred.

;

;The lesflgn1 flags are used locally to this process.

;

LEGOFG11 = 0 ---------------------|

|AND -| lesflg11 := 0

FFG\_CSD11 = 0 --------------------| | ;switching OK

|

| --- ELSE ---

|

| lesflg11 := 1

| ;lack of switching

LEGOFG21 = 0 ---------------------|

|AND -| lesflg21 := 0

FFG\_CSD21 = 0 --------------------| |

| --- ELSE ---

|

| lesflg21 := 1

11-113

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PCOMP\_SW = 0 ------------------|

(non pcomp purge) |

|

LEGOFG11 = 1 ------| |

(byples timeout) | |

|AND -| |

lesflg21 = 0 ------| | |

| | |

NUMEGO > 1 --------| | |

(two forward egos) | |AND -| LEGONOTPURG := 1

| | | (conditions imply that purge

NUMEGO > 1 --------| | | | was not the cause of EGO11 or

| | | | EGO21 stuck rich)

lesflg11 = 0 ------|AND -| | |

| | | |

LEGOFG21 = 1 ------| | | |

(byples timeout) | | |

| | |

NUMEGO > 1 --------| |OR --| |

| | |

LEGOFG11 = 1 ------| | |

|AND -| |

LEGOFG21 = 1 ------| | |

| | |

PURGSW = 0 --------| | |

| |

NUMEGO = 1 --------| | |

| | |

LEGOFG11 = 1 ------|AND -| |

| |

PURGSW = 0 --------| |

(no purge while open loop) |

|

| --- ELSE ---

|

| LEGONOTPURG := 0

END: PURG\_NOT\_CAUSE\_OF\_FAILURE

11-114

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: VEGOFIL\_ZERO

Fault filters not currently above their level (PxxxFIL <= PxxxLVL)

get a fresh start each time the test conditions become true.

P1130FIL <= P1130LVL -----------------| P1130FIL := 0

P1131FIL <= P1131LVL -----------------| P1131FIL := 0

P1132FIL <= P1132LVL -----------------| P1132FIL := 0

P1150FIL <= P1150LVL -----------------| P1150FIL := 0

P1151FIL <= P1151LVL -----------------| P1151FIL := 0

P1152FIL <= P1152LVL -----------------| P1152FIL := 0

END: VEGOFIL\_ZERO

11-115

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO11/Fuel System Tests:

Base strategy will assign LAMBSE1 the value of LAMBSE2 after LESTMR11 >=

BYPLES. Failure codes P1130, P1131 or P1132 as appropriate will be stored

upon failure, with the MIL being illuminated. But as a result of the Base

Strategy action, the failure condition is overwritten. The fault filter will

down count. The service code will remain stored in KAM, but the MIL will be

turned off.

The following logic segment example below will maintain the fault filter

value after failure (PxxxFIL > PxxxLVL) until the sensor starts switching,

causing the malfunction to remain until the actual failure condition is not

present.

PxxxFIL > PxxxLVL ------------|

(failure has been indicated) |AND -|

| |

LEGOFG11 = 1 -----------------| |

(ego hasn't switched since |

failure)

(EXAMPLE LOGIC SEGMENT)

11-116

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGO11\_TESTS

;

;The lesflgn1 flags are used locally to this process.

;

LEGOFG11 = 1 ---------------------|

|OR --| lesflg11 := 1

FFG\_CSD11 = 1 --------------------| | ;lack of switching

|

| --- ELSE ---

|

| lesflg11 := 0

| ;switching OK

P1130FIL > P1130LVL ---------------------|

(failure has been indicated) |AND -| P1130FIL := P1130FIL +

| | P1130UP

lesflg11 = 1 ----------------------------| |

(ego hasn't switched since | P1131FIL := P1131FIL - 1

failure) | P1132FIL := P1132FIL - 1

|

| --- ELSE ---

P1131FIL > P1131LVL ---------------------| |

(failure has been indicated) |AND -| P1131FIL := P1131FIL +

| | P1131UP

lesflg11 = 1 ----------------------------| |

(ego hasn't switched since | P1130FIL := P1130FIL - 1

failure) | P1132FIL := P1132FIL - 1

|

| --- ELSE ---

P1132FIL > P1132LVL ---------------------| |

(failure has been indicated) |AND -| P1132FIL := P1132FIL +

| | P1132UP

lesflg11 = 1 ----------------------------| |

(ego hasn't switched since | P1130FIL := P1130FIL - 1

failure) | P1131FIL := P1131FIL - 1

|

| --- ELSE ---

(continued on next page)

11-117

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

V\_LESTMR1 > |

max(V\_LESMUL\*BYPLES\_TM1,V\_LESTM1) -| |

(failure indicated) | |

| |

EGOSS11 < V\_EGOSWNUM --------| | |

(fail from start) |AND -|OR --| |

| | | |

EGOTSTCUMTMR > ETST\_SWCUMTM -| | | |

(sufficient cumulated test time) | |AND -| P1130FIL := P1130FIL +

| | | P1130UP

V\_LEGOTMR1 > V\_LEGO\_MAX -----------| | |

| | P1131FIL := P1131FIL - 1

KAMRF1 = 0.5 + MINADP -------------| | | P1132FIL := P1132FIL - 1

(adaptive clip) |OR --| | (fuel system failure)

| |

KAMRF1 = 0.5 + MAXADP -------------| |

| --- ELSE ---

V\_LESTMR1 > |

max(V\_LESMUL\*BYPLES\_TM1,V\_LESTM1) -| |

(failure indicated) | |

| |

V\_EGO1L\_BYPS = 0 ------------| | |

| | |

EGOSS11 < V\_EGOSWNUM --------|AND -|OR --| |

(fail from start) | | | |

| | | |

EGOTSTCUMTMR > ETST\_SWCUMTM -| | | |

(sufficient cumulated test time) | |AND -| P1131FIL := P1131FIL +

| | | P1131UP

V\_LEGOTMR1 > V\_LEGO\_MAX -----------| | |

| | P1130FIL := P1130FIL - 1

EGOFL11 = 0 -----------------------------| | P1132FIL := P1132FIL - 1

(lean) | (ego circuit failure)

| V\_EGO1\_BYPS := 1

|

| --- ELSE ---

(continued on next page)

11-118

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

LEGONOTPURG = 1 -------------| |

(purge not implicated as | |

cause of failure) |AND -| |

| | |

V\_LEGOTMR1 > V\_LEGO\_MAX2 ----| | |

(failure indicated) | |

| |

V\_LESTMR1 > | |

max(V\_LESMUL\*BYPLES\_TM1,V\_LESTM1) -| |

(failure indicated) | |

| |

EGOSS11 < V\_EGOSWNUM --------| |OR --| |

(fail from start) | | | |

| | | |

V\_EGO1\_BYPS = 0 -------------|AND -| | |

| | |AND -| P1132FIL := P1132FIL +

EGOTSTCUMTMR > ETST\_SWCUMTM -| | | | P1132UP

(sufficient cumulated test time) | | |

| | | P1130FIL := P1130FIL - 1

V\_LEGOTMR1 > V\_LEGO\_MAX -----------| | | P1131FIL := P1131FIL - 1

(gross lack of ego switch) | | (ego circuit failure)

| | V\_EGO1L\_BYPS := 1

EGOFL11 = 1 -----------------------------| |

(rich) |

| --- ELSE ---

|

| P1130FIL := P1130FIL - 1

| P1131FIL := P1131FIL - 1

| P1132FIL := P1132FIL - 1

| (no failures present)

END: EGO11\_TESTS

11-119

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO21/Fuel System Tests:

Base strategy will assign LAMBSE2 the value of LAMBSE1 after LESTMR2 >=

BYPLES. Failure codes 1151, 1152 or 1153 as appropriate will be stored upon

failure, with the MIL being illuminated. But as a result of the Base

Strategy action, the failure condition is overwritten. The fault filter will

down count. The service code will remain stored in KAM, but the MIL will be

turned off.

The following logic segment example below will maintain the fault filter

value after failure (PxxxFIL > PxxxLVL) until the sensor starts switching,

causing the malfunction to remain until the actual failure condition is not

present.

PxxxFIL > PxxxLVL ------------|

(failure has been indicated) |AND -|

| |

LEGOFG21 = 1 -----------------| |

(ego hasn't switched since |

failure)

(EXAMPLE LOGIC SEGMENT)

11-120

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGO21\_TESTS

;

;The lesflg21 flag is used locally to this process.

;

LEGOFG21 = 1 ---------------------|

|OR --| lesflg21 := 1

FFG\_CSD21 = 1 --------------------| | ;lack of switching

|

| --- ELSE ---

|

| lesflg21 := 0

| ;switching OK

P1150FIL > P1150LVL ---------------------|

(failure has been indicated) |AND -| P1150FIL := P1150FIL +

| | P1150UP

lesflg21 = 1 ----------------------------| |

(ego hasn't switched since | P1151FIL := P1151FIL - 1

failure) | P1152FIL := P1152FIL - 1

|

| --- ELSE ---

P1151FIL > P1151LVL ---------------------| |

(failure has been indicated) |AND -| P1151FIL := P1151FIL +

| | P1151UP

lesflg21 = 1 ----------------------------| |

(ego hasn't switched since | P1150FIL := P1150FIL - 1

failure) | P1152FIL := P1152FIL - 1

|

| --- ELSE ---

P1152FIL > P1152LVL ---------------------| |

(failure has been indicated) |AND -| P1152FIL := P1152FIL +

| | P1152UP

lesflg21 = 1 ----------------------------| |

(ego hasn't switched since | P1150FIL := P1150FIL - 1

failure) | P1151FIL := P1151FIL - 1

|

| --- ELSE ---

(continued on next page)

11-121

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

V\_LESTMR2 > |

max(V\_LESMUL\*BYPLES\_TM2,V\_LESTM2) -| |

(failure indicated) | |

| |

EGOSS21 < V\_EGOSWNUM --------| | |

(fail from start) |AND -|OR --| |

| | | |

EGOTSTCUMTMR > ETST\_SWCUMTM -| | | |

(sufficient cumulated test time) | | |

| |AND -| P1150FIL := P1150FIL +

V\_LEGOTMR2 > V\_LEGO\_MAX -----------| | | P1150UP

| |

KAMRF2 = 0.5 + MINADP -------------| | | P1151FIL := P1151FIL - 1

(adaptive clip) |OR --| | P1152FIL := P1152FIL - 1

| | (fuel system failure)

KAMRF2 = 0.5 + MAXADP -------------| |

| --- ELSE ---

V\_LESTMR2 > |

max(V\_LESMUL\*BYPLES\_TM2,V\_LESTM2) -| |

(failure indicated) | |

| |

V\_EGO2L\_BYPS = 0 ------------| | |

| |OR --| |

EGOSS21 < V\_EGOSWNUM --------|AND -| | |

(fail from start) | | | |

| | | |

EGOTSTCUMTMR > ETST\_SWCUMTM -| | |AND -| P1151FIL := P1151FIL +

(sufficient cumulated test time) | | | P1151UP

| | |

V\_LEGOTMR2 > V\_LEGO\_MAX -----------| | | P1150FIL := P1150FIL - 1

| | P1152FIL := P1152FIL - 1

EGOFL21 = 0 -----------------------------| | (ego circuit failure)

(lean) | V\_EGO2\_BYPS := 1

|

| --- ELSE ---

(continued on next page)

11-122

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

LEGONOTPURG = 1 -------------| |

(purge not implicated | |

as cause of failure) |AND -| |

| | |

V\_LEGOTMR2 > V\_LEGO\_MAX2 ----| | |

(failure indicated) | |

| |

V\_LESTMR2 > | |

max(V\_LESMUL\*BYPLES\_TM2,V\_LESTM2) -| |

(lambse at clip) | |

| |

EGOSS21 < V\_EGOSWNUM --------| | |

(fail from start) | | |

|AND -|OR --| |

V\_EGO2\_BYPS = 0 -------------| | | |

| | | |

EGOTSTCUMTMR > ETST\_SWCUMTM -| | | |

(sufficient cumulated test time) | |AND -| P1152FIL := P1152FIL +

| | | P1152UP

V\_LEGOTMR2 > V\_LEGO\_MAX -----------| | |

(gross lack of ego switch) | | P1150FIL := P1150FIL - 1

| | P1151FIL := P1151FIL - 1

EGOFL21 = 1 -----------------------------| | (ego circuit failure)

(rich) | V\_EGO2L\_BYPS := 1

|

| --- ELSE ---

|

| P1150FIL := P1150FIL - 1

| P1151FIL := P1151FIL - 1

| P1152FIL := P1152FIL - 1

| (no failures present)

END: EGO21\_TESTS

11-123

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGR\_TRANSITION\_DELAY\_FLAG\_CONTROL

The EGR transition flag V\_EGR\_DLYFG when set indicates that an EGR transition

has taken place. To allow the EGO test to disregard EGR transitions,

calibrate V\_EGO\_EGR\_SW = 0. Otherwise any EGR transition (on/off, off/on)

will reset the EGO test timer and associated EGO fuel system failure

indicators.

EGRDC = 0 ------------------------------| temp := 1

(egr off) |

| --- ELSE ---

|

| temp := 0

V\_EGR\_OLD <> temp ----------------|

(egr transition) |AND -| V\_EGR\_DLYFG := 1

| | (ego test reset due to

V\_EGO\_EGR\_SW = 1 -----------------| | egr transition)

(egr considered to | V\_EGR\_OLD := temp

affect ego) |

| --- ELSE ---

|

| V\_EGR\_DLYFG := 0

(egr not affecting ego test)

END: EGR\_TRANSITION\_DELAY\_FLAG\_CONTROL

11-124

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGO\_SWITCHING\_FAILURE\_INDICATION\_CONTROL

This procedure serves two functions: 1) allows timers (V\_LESTMR1,

V\_LESTMR2) to run indicating the time LAMBSE1 or LAMBSE2 has

been at its clip. 2) maintain rolling averages of transport

delay times and EGO switching times.

VIP Lack of EGO11 Switching Timer:

LAMBSE1 <= LAMMIN1 -------------|

(rich clip, lean system) |

|OR --| (V\_LESTMR1 runs indicating

LAMBSE1 >= LAMMAX1 -------| | | potential lambse/ego based

(lean clip, rich system) |AND -| | failure)

| |

ego\_purg\_byps = 0 --------| |

(no purging restrictions) |

| --- ELSE ---

|

| V\_LESTMR1 := 0

| (no lambse/ego based

| errors indicated)

Vip Lack of EGO21 Switching Timer:

NUMEGO = 2 ---------------------------|

|

LAMBSE2 <= LAMMIN2 -------------| |AND -| (V\_LESTMR2 runs indicating

(rich clip, lean system) | | | potential lambse/ego based

|OR --| | failure)

LAMBSE2 >= LAMMAX2 -------| | |

(lean clip, rich system) |AND -| |

| |

ego\_purg\_byps = 0 --------| |

(no purging restrictins) |

| --- ELSE ---

|

| V\_LESTMR2 := 0

| (no lambse/ego based

| errors indicated)

11-125

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Time Since Last EGO11 Switch Logic:

SWTFL11 = 1 ------------------------| V\_LEGOTMR1 := 0

(ego11 switched this BG) |

| --- ELSE ---

V\_LAMJMP1 = 1 ----------------| |

(LAMBSE1 jump occurred) | |

|OR --| V\_LEGOTMR1 := 0

ego\_purg\_byps = 1 ------| | | V\_LAMJMP1 := 0

(purging is affecting | | | (reinitialization due to

ego performance) | | | LAMBSE1 jump)

|AND -|

EGOFL11 = 1 ------------|

(rich) |

|

LEGONOTPURG = 0 --------|

(purge implicated as a

cause of failure)

Time Since Last EGO21 Switch Logic:

NUMEGO = 2 -------------------------|

|AND -| V\_LEGOTMR2 := 0

SWTFL21 = 1 ------------------------| |

(ego21 switched this BG) |

| --- ELSE ---

NUMEGO = 2 -------------------------| |

| |

V\_LAMJMP2 = 1 ----------------| |AND -| V\_LEGOTMR2 := 0

(LAMBSE2 jump occurred) | | | V\_LAMJMP2 := 0

|OR --| | (reinitialization due to

ego\_purg\_byps = 1 ------| | | LAMBSE2 jump)

(purging is affecting | |

ego performance) | |

|AND -|

EGOFL21 = 1 ------------|

(rich) |

|

LEGONOTPURG = 0 --------|

(purge implicated as a

cause of failure)

END: EGO\_SWITCHING\_FAILURE\_INDICATION\_CONTROL

11-126

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGO11\_MALF

(process to interface to the diagnostic executive)

OPEN\_EGO11 = 1 ---------------|

|AND -| Do: malfunction(ego, P0130)

P1130FIL > P1130LVL ----------| | ;open circuit fault.

|

| --- ELSE ---

FFG\_CSD11 = 1 ----------------| |

| |

INFAMB\_KAM > CSD\_MIN\_AMB -----|AND -| Do: malfunction(ego, P0131)

| | ;CSD fault identified.

P1130FIL > P1130LVL ----------| |

|

| --- ELSE ---

INFAMB\_KAM > LES\_MIN\_AMB -----| |

| |

P1130FIL > P1130LVL ----------|AND -| Do: malfunction(cl, P1130)

| |

FFG\_CSD11 = 0 ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1130)

OPEN\_EGO11 = 1 ---------------|

|AND -| Do: malfunction(ego, P0130)

P1131FIL > P1131LVL ----------| | ;open circuit fault.

|

| --- ELSE ---

FFG\_CSD11 = 1 ----------------| |

| |

INFAMB\_KAM > CSD\_MIN\_AMB -----|AND -| Do: malfunction(ego, P0131)

| | ;CSD fault identified.

P1131FIL > P1131LVL ----------| |

|

| --- ELSE ---

INFAMB\_KAM > LES\_MIN\_AMB -----| |

| |

P1131FIL > P1131LVL ----------|AND -| Do: malfunction(cl, P1131)

| |

FFG\_CSD11 = 0 ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1131)

11-127

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OPEN\_EGO11 = 1 ---------------|

|AND -| Do: malfunction(ego, P0130)

P1132FIL > P1132LVL ----------| | ;open circuit fault.

|

| --- ELSE ---

FFG\_CSD11 = 1 ----------------| |

| |

INFAMB\_KAM > CSD\_MIN\_AMB -----|AND -| Do: malfunction(ego, P0131)

| | ;CSD fault identified.

P1132FIL > P1132LVL ----------| |

|

| --- ELSE ---

INFAMB\_KAM > LES\_MIN\_AMB -----| |

| |

P1132FIL > P1132LVL ----------|AND -| Do: malfunction(cl, P1132)

| |

FFG\_CSD11 = 0 ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1132)

OPEN\_EGO11 = 0 ---------------------| Do: clear\_malf(P0130)

FFG\_CSD11 = 0 ----------------------| Do: clear\_malf(P0131)

END: EGO11\_MALF

11-128

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGO21\_MALF

(process to interface to the diagnostic executive)

OPEN\_EGO21 = 1 ---------------|

|AND -| Do: malfunction(ego, P0150)

P1150FIL > P1150LVL ----------| | ;open circuit fault.

|

| --- ELSE ---

FFG\_CSD21 = 1 ----------------| |

| |

INFAMB\_KAM > CSD\_MIN\_AMB -----|AND -| Do: malfunction(ego, P0151)

| | ;CSD fault identified.

P1150FIL > P1150LVL ----------| |

|

| --- ELSE ---

INFAMB\_KAM > LES\_MIN\_AMB -----| |

| |

P1150FIL > P1150LVL ----------|AND -| Do: malfunction(cl, P1150)

| |

FFG\_CSD21 = 0 ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1150)

OPEN\_EGO21 = 1 ---------------|

|AND -| Do: malfunction(ego, P0150)

P1151FIL > P1151LVL ----------| | ;open circuit fault.

|

| --- ELSE ---

FFG\_CSD21 = 1 ----------------| |

| |

INFAMB\_KAM > CSD\_MIN\_AMB -----|AND -| Do: malfunction(ego, P0151)

| | ;CSD fault identified.

P1151FIL > P1151LVL ----------| |

|

| --- ELSE ---

INFAMB\_KAM > LES\_MIN\_AMB -----| |

| |

P1151FIL > P1151LVL ----------|AND -| Do: malfunction(cl, P1151)

| |

FFG\_CSD21 = 0 ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1151)

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CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OPEN\_EGO21 = 1 ---------------|

|AND -| Do: malfunction(ego, P0150)

P1152FIL > P1152LVL ----------| | ;open circuit fault.

|

| --- ELSE ---

FFG\_CSD21 = 1 ----------------| |

| |

INFAMB\_KAM > CSD\_MIN\_AMB -----|AND -| Do: malfunction(ego, P0151)

| | ;CSD fault identified.

P1152FIL > P1152LVL ----------| |

|

| --- ELSE ---

INFAMB\_KAM > LES\_MIN\_AMB -----| |

| |

P1152FIL > P1152LVL ----------|AND -| Do: malfunction(cl, P1152)

| |

FFG\_CSD21 = 0 ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1152)

OPEN\_EGO21 = 0 ---------------------| Do: clear\_malf(P0150)

FFG\_CSD21 = 0 ----------------------| Do: clear\_malf(P0151)

END: EGO21\_MALF

11-130

CONTINUOUS SELF TEST, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGO1FMFLG\_CONTROL

(The following process determines the state of the EGO1FMFLG flag.)

P1130FIL > P1130LVL ---------------|

(lack of HEGO11 sw,adapt at clip) |

|

P1131FIL > P1131LVL ---------------|OR --| EGO1FMFLG := 1

(lack of HEGO11 sw, lean) | | EGO\_MON11 := 1

| |

P1132FIL > P1132LVL ---------------| |

(lack of HEGO11 sw, rich) |

| --- ELSE ---

P1130FIL < P1130LVL - FILHYS ------| |

| |

P1131FIL < P1131LVL - FILHYS ------|AND -| EGO1FMFLG := 0

|

P1132FIL < P1132LVL - FILHYS ------|

END: EGO1FMFLG\_CONTROL

BEGIN: EGO2FMFLG\_CONTROL

(The following process determines the state of the EGO2FMFLG flag.)

P1150FIL > P1150LVL ---------------|

(lack of HEGO21 sw, |

adapt at clip) |

|

P1151FIL > P1151LVL ---------------|OR --| EGO2FMFLG := 1

(lack of HEGO21 sw, lean) | | EGO\_MON21 := 1

| |

P1152FIL > P1152LVL ---------------| |

(lack of HEGO21 sw, rich) |

| --- ELSE ---

P1150FIL < P1150LVL - FILHYS ------| |

| |

P1151FIL < P1151LVL - FILHYS ------|AND -| EGO2FMFLG := 0

|

P1152FIL < P1152LVL - FILHYS ------|

END: EGO2FMFLG\_CONTROL

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

11.1.7 EGO SWITCHING TEST (CDAM0)

OVERVIEW

+----------------------------------+

| EGO\_ER |

+----------------------------------+

|PUBLIC PROCEDURES: |

|. definitions |

|. ego\_er\_switching\_test |

+----------------------------------+

|PRIVATE PROCEDURES: |

|. abort\_ego\_er |

|. filter\_ego\_voltages |

|. bank1\_lean\_bank2\_rich |

|. bank1\_rich\_bank2\_lean |

|. bank1\_rich\_bank2\_rich |

|. bank1\_lean\_bank2\_lean |

|. report\_codes |

+----------------------------------+

This module is used in an On-Demand mode (engine running) to test the

upstream and downstream EGO sensors for a single bank, dual bank or y-PIPE

system. The test will ramp fuel lean in one bank and rich in the other and

monitor the response of the EGO sensors. The banks are then reversed and

ramped in the opposite direction and again the response of the EGOs are

recorded.

At the end of the test, the recorded EGO responses are compared and fault

codes are stored that can identify crossed upstream sensors, crossed

downstream sensors or faulty sensors.

During KOER self test, exhaust temperature is used to turn on the downstream

EGO heaters and ER\_HEAT\_TIME seconds from entry to the EGO switching test is

used to allow testing of all the sensors. When EXT\_REG > DS\_HTR\_ON, the

downstream heaters will be turned on and the heater monitor voltage check

will be performed on the heater pair. The EGO\_MONx2 flags will be set upon

completion of the voltage check, and the DS\_HTR\_TMR timer will begin counting

up. The time delay ER\_HEAT\_TIME is used to allow the downstream Hego sensors

time to warm up after heater turn on.

For systems with the current monitor installed, this time delay can also be

calibrated to allow time for the current monitor to run. The current monitor

will wait CM\_HEAT\_TM seconds before starting. Calibrating ER\_HEAT\_TM greater

than this value will allow the current monitor to complete.

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

If the downstream heaters fail, ER\_HEAT\_TIME is not used and the downstream

EGO sensors will not be tested. The powertrain will be too cold in this

situation to reliably test the downstream EGO sensors.

|<-EXT\_REG > DS\_HTR\_ON ->|<- ER\_HEAT\_TIME ->|

+---+-------------------------+------------------+---------------->time

| | | |

| | | +-- Allow Test

| | | of sensors.

| | |

| | +-- Turn on downstream heaters.

| +-- Entry to run mode.

+-- Power-up.

11-133

EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- BG\_TMR = Background loop timer.

- DEMAND\_STATE = Utility state register used during on-demand sequenced

tests.

- DEMAND\_TIMER = Utility timer for sequenced on-demand tests.

- DS\_HTR\_TMR = Elapsed time downstream EGO heaters have been on.

- ER\_FUL\_REQ = Utility flag udes during on-demand sequenced tests to

require LAMBSE override.

- ER\_LAM\_DSD = Utility register used during on-demand sequenced tests to

provide LAMBSE override value.

- ER\_STATUS = State pointer that incicated current state of engine running

on demand test.

- LAMBSE1 = LAMBDA equivalence ratio (EGO-1).

- VEGO11 = Bank1 upstream HEGO voltage.

- VEGO12 = Bank1 downstream HEGO voltage.

- VEGO21 = Bank2 upstream HEGO voltage.

- VEGO22 = Bank2 downstream HEGO voltage.

- VEGOBAR11 = Filtered EGO11 voltage.

- VEGOBAR12 = Filtered EGO12 voltage.

- VEGOBAR21 = Filtered EGO21 voltage.

- VEGOBAR22 = Filtered EGO22 voltage.

Bit Flags:

- DEMAND\_ABORT = Flag indicating that an on demand test is in the progress

of a abort.

- DS\_SWAPPED\_1 = Flag indicating potential for swapped downstream EGO

sensors exists.

- DS\_SWAPPED\_2 = Flag indicating potential for swapped downstream EGO

sensors exists.

- DS\_TST\_OK = Flag indicating it is o.k. to perform KOER test of

downstream EGO sensors.

- FLG\_11\_LN = Flag that indicates when the EGO11 has been lean; 1 -> EGO11

has been lean.

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_11\_RH = Flag that indicates when the EGO11 has been rich; 1 -> EGO11

has been rich.

- FLG\_12\_LN = Flag that indicates when the EGO12 has been lean; 1 -> EGO12

has been lean.

- FLG\_12\_RH = Flag that indicates when the EGO12 has been rich; 1 -> EGO12

has been rich.

- FLG\_21\_LN = Flag that indicates when the EGO21 has been lean; 1 -> EGO21

has been lean.

- FLG\_21\_RH = Flag that indicates when the EGO21 has been rich; 1 -> EGO21

has been rich.

- FLG\_22\_LN = Flag that indicates when the EGO22 has been lean; 1 -> EGO22

has been lean.

- FLG\_22\_RH = Flag that indicates when the EGO22 has been rich; 1 -> EGO22

has been rich.

- FLG\_EGO\_ER = Flag that indicates when the engine running EGO switching

test is running; 1 -> test running.

- HTR\_MON11 = Flag indicating when the heater has been monitored, unitless.

- HTR\_MON12 = Flag indicating when the heater has been monitored, unitless.

- HTR\_MON21 = Flag indicating when the heater has been monitored, unitless.

- HTR\_MON22 = Flag indicating when the heater has been monitored, unitless.

- PxxxMALF = Malfunction flag for code Pxxx; 1 -> a malfunction currently

exists for fault Pxxx.

- US\_SWAPPED\_1 = Flag indicating potential for swapped upstream EGO sensors

exists.

- US\_SWAPPED\_2 = Flag indicating potential for swapped upstream EGO sensors

exists.

- US\_TST\_OK = Flag indicating it is ok to perform KOER test of upstream EGO

sensors.

Calibration Constants:

- DS\_HTR\_ON = Temperature at which to turn on downstream ego heaters,

degrees F.

- DS\_SWTPOINT = Downstream HEGO switch point.

- EGO\_ER\_DONE = Value for state pointer when engine running EGO test is

complete.

- EGO\_ER\_INIT = Value for state of ER\_STATUS to indicate engine running EGO

test is to be run.

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- EGO\_KOER\_SW = Switch to enable/disable KOER EGO test.

- EGO\_KOER\_TM1 = Time to ramp bank lean and bank2 rich during KOER EGO

test.

- EGO\_KOER\_TM2 = Time to ramp bank2 lean during the KOER EGO switch test.

- EGO\_KOER\_TM3 = Time to ramp bank1 rich and bank2 rich during KOER EGO

tset of y-pipe vehicle.

- EGO\_KOER\_TM4 = Time to ramp bank1 lean and bank2 lean during KOER EGO

test of y-pipe vehicles.

- ER\_HEAT\_TIME = Time downstream EGO heaters must be on prior to KOER EGO

switch test.

- HEGO\_CONFIG = HEGO configuration register.

- LEQV = Lean limit for LAMBDA.

- NUMEGO = Number of EGO sensors.

- REQV = Rich limit for LAMBDA.

- US\_SWTPOINT = Upstream HEGO switch point.

- V\_EGO\_ENA = Alternate Continuous VIP EGO test enable switch; 1 -> enable.

- VIPLR1 = Rate to ramp lean, LAMBDAS/sec.

- VTCEGO = EGOBAR time constant.

OTHER

- ego\_on\_demand\_codes = set of {P0141, P0161, P1131, P1132, P1137, P1138,

P1151, P1152, P1157, P1158}. The set of OBD-II fault codes that relate

to the ego switching test.

- P0141 = Fault code for EGO12 sensor heater circuit malfunction.

- P0161 = Fault code for EGO22 sensor heater circuit malfunction.

- P1127 = Exhaust system not warm, downstream EGO sesnors not tested during

KOER.

- P1131 = Lack of HO2S switch, HO2S11 indicates lean.

- P1132 = Lack of HO2S switch, HO2S11 indicates rich.

- P1137 = Lack of HO2S switch, HO2S12 indicates lean.

- P1138 = Lack of HO2S switch, HO2S12 indicates rich.

- P1151 = Lack of HO2S switch, HO2S21 indicates lean

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- P1152 = Lack of HO2S switch, HO2S21 indicates rich.

- P1157 = Lack of HO2S switch, HO2S22 indicates lean.

- P1158 = Lack of HO2S switch, HO2S22 indicates rich.

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EGO\_ER\_COM10

BEGIN: definitions

;The following block is used to define locally used symbols. The logic is

;not intended to be specifically executed, it only exists to make the

;documentation more readable.

unconditionally -----------------------| true := 1

| false := 0

| init\_ego\_er := 1

| us\_test\_config := 2

| ds\_test\_config := 3

| begin\_test := 4

| b1\_lean\_b2\_rich := 5

| b1\_rich\_b2\_lean := 6

| b1\_rich\_b2\_rich := 7

| b1\_lean\_b2\_lean := 8

| test\_complete := 0

| no\_aft\_hego := 0

| single\_bank := 1

| dual\_bank := 2

| y\_pipe := 3

END: definitions

BEGIN: ego\_er\_switching\_test

;The following logic controls entry to and exit from the engine running

;on-demand ego switching test. It is executed once per background pass.

ER\_STATUS = EGO\_ER\_INIT ---------|

|AND -| ER\_STATUS := EGO\_ER\_DONE

EGO\_KOER\_SW = false -------------| | ;test cal'd out

| Exit this process.

|

| --- ELSE ---

ER\_STATUS = EGO\_ER\_INIT ---------| |

;Time to perform test. | |

|AND -| DEMAND\_STATE := init\_ego\_er

DEMAND\_ABORT = false ------------| | FLG\_EGO\_ER := true

| | ;prepare to start the test.

FLG\_EGO\_ER = false --------------| |

| --- ELSE ---

FLG\_EGO\_ER = true ---------------| |

;Test aborted. |AND -| Do: abort\_ego\_er

| | Exit this process.

DEMAND\_ABORT = true -------------| |

| --- ELSE ---

FLG\_EGO\_ER = false --------------| |

|OR --| Exit this process.

ER\_STATUS <> EGO\_ER\_INIT --------|

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;the following logic is used on entry to the KOER test

;in order to perform specific initialization actions

;necessary to perfrom the KOER EGO switching test.

DEMAND\_STATE = init\_ego\_er ------------| ER\_LAM\_DSD1 := LAMBSE1

;Test needs to be initialized | ER\_LAM\_DSD2 := LAMBSE2

| ER\_FUL\_REQ := true

| FLG\_11\_RH := false

| FLG\_12\_RH := false

| FLG\_21\_RH := false

| FLG\_22\_RH := false

| FLG\_11\_LN := false

| FLG\_12\_LN := false

| FLG\_21\_LN := false

| FLG\_22\_LN := false

| US\_SWAPPED\_1 := false

| US\_SWAPPED\_2 := false

| DS\_SWAPPED\_1 := false

| DS\_SWAPPED\_2 := false

| US\_TST\_OK := false

| DS\_TST\_OK := false

| DEMAND\_STATE := us\_test\_config

;First determine if it is o.k. to perform both the upstream and

;downstream tests. It is only o.k. if the heaters have been

;monitored and there are no heater malfunctions. For the downstream

;sensors, the heaters also have to be on in order to perform the

;tests.

DEMAND\_STATE = us\_test\_config ----|

|

HTR\_MON11 = true -----------------|

|

HTR\_MON21 = true -----------------|AND -| US\_TST\_OK := true

| | DEMAND\_STATE := ds\_test\_config

P0135MALF = false ----------------| |

| |

P0155MALF = false ----------------| |

| --- ELSE ---

|

DEMAND\_STATE = us\_test\_config ----------| US\_TST\_OK := false

| DEMAND\_STATE := ds\_test\_config

11-139

EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DS\_KOER\_SW = true ----------------|

|

DEMAND\_STATE = ds\_test\_config ----|

|

HTR\_MON12 = true -----------------|

|AND -| DS\_TST\_OK := true

HTR\_MON22 = true -----------------| |

| |

P0141MALF = false ----------------| |

| |

P0161MALF = false ----------------| |

| --- ELSE ---

|

DEMAND\_STATE = ds\_test\_config ----------| DS\_TST\_OK := false

;If any of the EGO sensors heaters won't be coming on during this

;test, store a code indicating the exhaust was too cold to test

;at least one sensor.

DEMAND\_STATE = ds\_test\_config ----|

|AND -| Do: store\_code(P1127)

US\_TST\_OK = false ----------| | | DEMAND\_STATE := begin\_test

|OR --| |

DS\_TST\_OK = false ----------| |

| --- ELSE ---

|

DEMAND\_STATE = ds\_test\_config ----------| DEMAND\_STATE := begin\_test

11-140

EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;The following if-then-else block is used as the main controller

;for the KOER procedure to test the EGO sensors. After an

;initial warm-up fuel is ramped lean/rich then rich/lean, then if

;the vehicle is a y-pipe configuration, rich/rich and lean/lean.

;Following this, the data recorded during the fuel ramps will

;be analyzed and fault codes reported to the diagnostic executive.

DEMAND\_STATE = begin\_test --------|

|

DS\_HTR\_TMR < ER\_HEAT\_TIME --------|AND -| DEMAND\_STATE := begin\_test

| | ;wait for warm-up.

DS\_TST\_OK = true -----------------| |

| --- ELSE ---

DEMAND\_STATE = begin\_test --------| |

|AND -| DEMAND\_STATE := b1\_lean\_b2\_rich

US\_TST\_OK = true -----------| | | DEMAND\_TIMER := 0

|OR --| | VEGOBAR11 := VEGO11

DS\_TST\_OK = true -----------| | VEGOBAR12 := VEGO12

| VEGOBAR21 := VEGO21

| VEGOBAR22 := VEGO22

| Do: filter\_ego\_voltages

| Do: bank1\_lean\_bank2\_rich

|

| --- ELSE ---

|

DEMAND\_STATE = b1\_lean\_b2\_rich ---------| Do: filter\_ego\_voltages

| Do: bank1\_lean\_bank2\_rich

|

| --- ELSE ---

|

DEMAND\_STATE = b1\_rich\_b2\_lean ---------| Do: filter\_ego\_voltages

| Do: bank1\_rich\_bank2\_lean

|

| --- ELSE ---

HEGO\_CONFIG = y\_pipe -------------| |

|AND -| Do: filter\_ego\_voltages

DEMAND\_STATE = b1\_rich\_b2\_rich ---| | Do: bank1\_rich\_bank2\_rich

|

| --- ELSE ---

|

DEMAND\_STATE = b1\_rich\_b2\_rich ---------| DEMAND\_STATE := test\_complete

|

| --- ELSE ---

|

DEMAND\_STATE = b1\_lean\_b2\_lean ---------| Do: filter\_ego\_voltages

| Do: bank1\_lean\_bank2\_lean

|

| --- ELSE ---

|

DEMAND\_STATE = test\_complete -----------| Do: report\_codes

| Do: abort\_ego\_er

|

| --- ELSE ---

|

| Do: abort\_ego\_er

END: ego\_er\_switching\_test

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: abort\_ego\_er

;This process, called on-demand from other EGO switching test processes,

;is used to put the control system back in the state it was found in.

;It will signal back to the diagnostic sequencer that the EGO engine

;running test is done.

unconditionally -----------------------| DEMAND\_STATE := test\_complete

| DEMAND\_TIMER := 0

| ER\_FUL\_REQ := false

| FLG\_EGO\_ER := false

| ER\_STATUS := EGO\_ER\_DONE

END: abort\_ego\_er

BEGIN: filter\_ego\_voltages

;This process is used to compute filtered EGO voltages. It is executed

;on-demand from the ego\_er\_switching\_test process.

unconditionally -----------------------| VEGOBAR11 := rolav(VEGO11, VTCEGO)

HEGO\_CONFIG <> no\_aft\_hego ------------| VEGOBAR12 := rolav(VEGO12, VTCEGO)

NUMEGO = 2 ----------------------------| VEGOBAR21 := rolav(VEGO21, VTCEGO)

HEGO\_CONFIG = dual\_bank ---------------| VEGOBAR22 := rolav(VEGO22, VTCEGO)

END: filter\_ego\_voltages

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: bank1\_lean\_bank2\_rich

;The following process, executed on-demand form the ego\_er\_switching\_test

;is used to ramp fuel in bank 1 lean and the fuel in bank 2 rich.

;Seperate bank control is necessary to detect crossed sensors.

unconditionally ------------------------| ER\_LAM\_DSD1 := min(ER\_LAM\_DSD1 +

| (VIPLR1 \* BG\_TMR), LEQV)

| ER\_LAM\_DSD2 := max(ER\_LAM\_DSD2 -

| (VIPRR1 \* BG\_TMR), REQV)

| ER\_FUL\_REQ := true

;Compare the voltage upstream of the catalyst on the EGO sensors

;to the switchpoint. If bank 1 comes lean and bank 2 comes

;rich, everything is o.k. If bank 1 goes/stays rich AND

;bank 2 goes/stays lean at the end of this phase of the test

;then the potential exists for swapped sensors and a flag

;will be set indicating such.

;Wait until the time limit for this phase (as set by EGO\_KOER\_TM1)

;has expired before sampling voltages. This enables HEGO

;voltages to settle from pre-existing levels.

:

;Set the phase I "test o.k." flags if any of the following

;conditions are satisfied:

; 1) Not testing

; 2) Hardware not present

; 3) DEMAND\_TIMER >= EGO\_KOER\_TM1, and VEGO at expected

; lean/rich levels, respectively.

DEMAND\_TIMER >= EGO\_KOER\_TM1 -----|

|AND -|

VEGOBAR11 < US\_SWTPOINT ----------| |OR --| FLG\_11\_LN := true

|

US\_TST\_OK = false ----------------------|

DEMAND\_TIMER >= EGO\_KOER\_TM1 -----|

|AND -|

VEGOBAR21 > US\_SWTPOINT ----------| |

|OR --| FLG\_21\_RH := true

NUMEGO = 1 -----------------------------|

|

US\_TST\_OK = false ----------------------|

NUMEGO = 2 -----------------------|

|

VEGOBAR11 > US\_SWTPOINT ----------|

|AND -| US\_SWAPPED\_1 := true

VEGOBAR21 < US\_SWTPOINT ----------| |

| |

US\_TST\_OK = true -----------------| |

| --- ELSE ---

|

| US\_SWAPPED\_1 := false

11-143

EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;Compare the voltage downstream of the catalyst on the EGO sensors

;to the switchpoint. If bank 1 comes lean and bank 2 comes

;rich, everything is o.k. If bank 1 goes/stays rich AND

;bank 2 goes/stays lean at the end of this phase of the test

;then the potential exists for swapped sensors and a flag

;will be set indicating such. The option exists to disable

;the downstream test by clearing the DS\_KOER\_SW.

DEMAND\_TIMER >= EGO\_KOER\_TM1 -----|

|AND -|

VEGOBAR12 < DS\_SWTPOINT ----------| |

|

DS\_TST\_OK = false ----------------------|OR --| FLG\_12\_LN := true

|

HEGO\_CONFIG = no\_aft\_hego --------------|

|

HEGO\_CONFIG = y\_pipe -------------------|

DEMAND\_TIMER >= EGO\_KOER\_TM1 -----|

|AND -|

VEGOBAR22 > DS\_SWTPOINT ----------| |

|OR --| FLG\_22\_RH := true

DS\_TST\_OK = false ----------------------|

|

HEGO\_CONFIG <> dual\_bank ---------------|

HEGO\_CONFIG = dual\_bank ----------|

|

VEGOBAR12 > DS\_SWTPOINT ----------|

|AND -| DS\_SWAPPED\_1 := true

VEGOBAR22 < DS\_SWTPOINT ----------| |

| |

DS\_TST\_OK = true -----------------| |

| --- ELSE ---

|

| DS\_SWAPPED\_1 := false

FLG\_11\_LN = true -----------|

|

FLG\_12\_LN = true -----------|

|AND -|

FLG\_21\_RH = true -----------| |

| |OR --| DEMAND\_STATE := b1\_rich\_b2\_lean

FLG\_22\_RH = true -----------| | | DEMAND\_TIMER := 0

|

DEMAND\_TIMER >= EGO\_KOER\_TM1 -----|

END: bank1\_lean\_bank2\_rich

11-144

EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: bank1\_rich\_bank2\_lean

;The following process, executed on-demand form the ego\_er\_switching\_test

;is used to ramp fuel in bank 2 lean and the fuel in bank 1 rich.

;Seperate bank control is necessary to detect crossed sensors.

unconditionally ------------------------| ER\_LAM\_DSD2 := min(ER\_LAM\_DSD2 +

| (VIPLR1 \* BG\_TMR), LEQV)

| ER\_LAM\_DSD1 := max(ER\_LAM\_DSD1 -

| (VIPRR1 \* BG\_TMR), REQV

| ER\_FUL\_REQ := true

;Compare the voltage upstream of the catalyst onthe EGO sensors

;to the switchpoint. If bank 2 comes lean and bank 1 comes

;rich, everything is o.k. If bank 2 goes/stays rich AND

;bank 1 goes/stays lean at the end of this phase of the test

;then the potential exists for swapped sensors and a flag

;will be set indicating such.

;If phase 1 detected swapped HEGO's, wait until the time limit

;for this phase (as set by EGO\_KOER\_TM2) has expired before

;sampling voltages. This enables HEGO voltages to settle from

;levels of the previous phase.

;

;Set the phase II "test o.k." flags if any of the following

;conditions are satisfied:

; 1) Not testing

; 2) Hardware not present

; 3) Phase I swapped, DEMAND\_TIMER >= EGO\_KOER\_TM2, and VEGO at

; expected lean/rich levels

; 4) Phase I not swapped, and VEGO switches to expected

; lean/rich levels

US\_SWAPPED\_1 = true --------------|

|

DEMAND\_TIMER >= EGO\_KOER\_TM2 -----|AND -|

| |

VEGOBAR11 > US\_SWTPOINT ----------| |

|

US\_SWAPPED\_1 = false -------------| |OR --| FLG\_11\_RH := true

|AND -|

VEGOBAR11 > US\_SWTPOINT ----------| |

|

US\_TST\_OK = false ----------------------|

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

US\_SWAPPED\_1 = true --------------|

|

DEMAND\_TIMER >= EGO\_KOER\_TM2 -----|AND -|

| |

VEGOBAR21 < US\_SWTPOINT ----------| |

|

US\_SWAPPED\_1 = false -------------| |

|AND -|OR --| FLG\_21\_LN := true

VEGOBAR21 < US\_SWTPOINT ----------| |

|

NUMEGO = 1 -----------------------------|

|

US\_TST\_OK = false ----------------------|

NUMEGO = 2 -----------------------|

|

VEGOBAR21 > US\_SWTPOINT ----------|

|AND -| US\_SWAPPED\_2 := true

VEGOBAR11 < US\_SWTPOINT ----------| |

| |

US\_TST\_OK = true -----------------| |

| --- ELSE ---

|

| US\_SWAPPED\_2 := false

11-146

EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;Compare the voltage downstream of the catalyst on the EGO sensors

;to the switchpoint. If bank 2 comes lean and bank 1 comes

;rich, everything is o.k. If bank 2 goes/stays rich AND

;bank 1 goes/stays lean at the end of this phase of the test

;then the potential exists for swapped sensors and a flag

;will be set indicating such. The option exists to disable

;the downstream test by clearing the DS\_KOER\_SW.

DS\_SWAPPED\_1 = true --------------|

|

DEMAND\_TIMER >= EGO\_KOER\_TM2 -----|AND -|

| |

VEGOBAR22 < DS\_SWTPOINT ----------| |

|

DS\_SWAPPED\_1 = false -------------| |

|AND -|OR --| FLG\_22\_LN := true

VEGOBAR22 < DS\_SWTPOINT ----------| |

|

DS\_TST\_OK = false ----------------------|

|

HEGO\_CONFIG <> dual\_bank ---------------|

DS\_SWAPPED\_1 = true --------------|

|

DEMAND\_TIMER >= EGO\_KOER\_TM2 -----|AND -|

| |

VEGOBAR12 > DS\_SWTPOINT ----------| |

|

DS\_SWAPPED\_1 = false -------------| |

|AND -|OR --| FLG\_12\_RH := true

VEGOBAR12 > DS\_SWTPOINT ----------| |

|

DS\_TST\_OK = false ----------------------|

|

HEGO\_CONFIG = no\_aft\_hego --------------|

|

HEGO\_CONFIG = y\_pipe -------------------|

HEGO\_CONFIG = dual\_bank ----------|

|

VEGOBAR22 > DS\_SWTPOINT ----------|

|AND -| DS\_SWAPPED\_2 := true

VEGOBAR12 < DS\_SWTPOINT ----------| |

| |

DS\_TST\_OK = true -----------------| |

| --- ELSE ---

|

| DS\_SWAPPED\_2 := false

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_11\_RH = true -----------|

|

FLG\_12\_RH = true -----------|

|AND -|

FLG\_21\_LN = true -----------| |

| |OR --| DEMAND\_STATE := b1\_rich\_b2\_rich

FLG\_22\_LN = true -----------| | | DEMAND\_TIMER := 0

|

DEMAND\_TIMER >= EGO\_KOER\_TM2 -----|

HEGO\_CONFIG = y\_pipe -------------------| FLG\_12\_RH := false

| FLG\_12\_LN := false

END: bank1\_rich\_bank2\_lean

BEGIN: bank1\_rich\_bank2\_rich

;The following process, executed on-demand form the ego\_er\_switching\_test

;is used to ramp fuel in bank 1 & 2 rich to test the single downstream

;EGO sensor in the y-pipe configuration.

unconditionally ------------------------| ER\_LAM\_DSD1 := max(ER\_LAM\_DSD1 -

| (VIPRR1 \* BG\_TMR), REQV)

| ER\_LAM\_DSD2 := ER\_LAM\_DSD1

| ER\_FUL\_REQ := true

;Compare the voltage downstream of the catalyst on the EGO sensors

;to the switchpoint. If bank 2 comes rich and bank 1 comes

;rich, everything is o.k. The option exists to disable

;the downstream test by clearing the DS\_KOER\_SW.

DS\_TST\_OK = false ----------------|

|OR --| FLG\_12\_RH := true

VEGOBAR12 >= DS\_SWTPOINT ---------|

FLG\_12\_RH = true -----------------|

|OR --| DEMAND\_STATE := b1\_lean\_b2\_lean

DEMAND\_TIMER >= EGO\_KOER\_TM3 -----| | DEMAND\_TIMER := 0

END: bank1\_rich\_bank2\_rich

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: bank1\_lean\_bank2\_lean

;The following process, executed on-demand form the ego\_er\_switching\_test

;is used to ramp fuel in bank 1 & 2 lean to test the single downstream

;EGO sensor in the y-pipe configuration.

unconditionally ------------------------| ER\_LAM\_DSD1 := min(ER\_LAM\_DSD1 +

| (VIPLR1 \* BG\_TMR), LEQV)

| ER\_LAM\_DSD2 := ER\_LAM\_DSD1

| ER\_FUL\_REQ := true

;Compare the voltage downstream of the catalyst on the EGO sensors

;to the switchpoint. If bank 2 comes lean and bank 1 comes

;lean, everything is o.k. The option exists to disable

;the downstream test by clearing the DS\_KOER\_SW.

DS\_TST\_OK = false ----------------|

|OR --| FLG\_12\_LN := true

VEGOBAR12 <= DS\_SWTPOINT ---------|

FLG\_12\_LN = true -----------------|

|OR --| DEMAND\_STATE := test\_complete

DEMAND\_TIMER >= EGO\_KOER\_TM4 -----|

END: bank1\_lean\_bank2\_lean

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: report\_codes

;The following process is executed when the KOER test is over and reports

;fault codes to the diagnostic executive.

US\_SWAPPED\_1 = true --------------|

|AND -| Do: store\_code(P1128)

US\_SWAPPED\_2 = true --------------| | ;upstream EGO sensors

| ;swapped, probably.

DS\_SWAPPED\_1 = true --------------|

|AND -| Do: store\_code(P1129)

DS\_SWAPPED\_2 = true --------------| | ;downstream EGO sensors

| ;swapped, probably.

P1128MALF = false ----------------|

|AND -| Do: store\_code(P1132)

FLG\_11\_LN = false ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1132)

P1128MALF = false ----------------|

|AND -| Do: store\_code(P1131)

FLG\_11\_RH = false ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1131)

P1129MALF = false ----------------|

|AND -| Do: store\_code(P1138)

FLG\_12\_LN = false ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1138)

P1129MALF = false ----------------|

|AND -| Do: store\_code(P1137)

FLG\_12\_RH = false ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1137)

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EGO MONITOR CONTROL STRATEGY, EGO SWITCHING TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P1128MALF = false ----------------|

|AND -| Do: store\_code(P1152)

FLG\_21\_LN = false ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1152)

P1128MALF = false ----------------|

|AND -| Do: store\_code(P1151)

FLG\_21\_RH = false ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1151)

P1129MALF = false ----------------|

|AND -| Do: store\_code(P1158)

FLG\_22\_LN = false ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1158)

P1129MALF = false ----------------|

|AND -| Do: store\_code(P1157)

FLG\_22\_RH = false ----------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1157)

END: report\_codes

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EGO MONITOR CONTROL STRATEGY, EGO FAULT FLAG CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

11.1.8 EGO FAULT FLAG CONTROL (CDAM0)

OVERVIEW

+----------------------------------+

| EGO\_FFG\_CONTROL |

+----------------------------------+

|PUBLIC PROCEDURES: |

|. definitions |

|. ego11\_ffg\_control |

|. ego21\_ffg\_control |

|. ego12\_ffg\_control |

|. ego22\_ffg\_control |

+----------------------------------+

This module is used to control the EGO system FMEM flags as required by the

Diagnostic Executive interface requirements. These flags will be used to

disable other OBDII system monitors when relevant EGO sensor failures are

present or suspected to be present.

For the upstream EGO sensors, the appropriate flag will set when a single

overvoltage sample is received, when aged EGOs are detected by the EGO

monitor, when a heater malfunction is detected or when the continuous

switching test detects a lack of EGO sensor switching.

For the downstream EGO sensors, the appropriate flag will be set when a

single overvoltage sample is received, when a dead EGO signal is detected,

when insufficient activity is detected on the sensor,or when a heater

malfunction is detected.

DEFINITIONS

Registers:

- OV\_TMR\_11 = EGO11 overvoltage timer.

- OV\_TMR\_12 = EGO12 overvoltage timer.

- OV\_TMR\_21 = EGO21 overvoltage timer.

- OV\_TMR\_22 = EGO22 overvoltage timer.

Bit Flags:

- EGO1FMFLG = EGO1 FMEM flag; 1 -> EGO1 sensor failure.

- EGO2FMFLG = EGO2 FMEM flag; 1 -> EGO2 sensor failure.

- FFG\_CSD11 = Fault flag for CSD on sensor 11.

- FFG\_CSD21 = Fault flag for CSD on sensor 21.

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EGO MONITOR CONTROL STRATEGY, EGO FAULT FLAG CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FFG\_EGO11 = OBDII system FMEM flag for EGO11; 1 -> EGO11 is not currently

switching reliably.

- FFG\_EGO12 = OBDII system FMEM flag for EGO12; 1 -> EGO12 is not currently

switching reliably.

- FFG\_EGO21 = OBDII system FMEM flag for EGO21; 1 -> EGO21 is not currently

switching reliably.

- FFG\_EGO22 = OBDII system FMEM flag for EGO22; 1 -> EGO22 is not currently

switching reliably.

- PxxxMALF = Malfunction flag for code Pxxx; 1 -> a malfunction currently

exists for fault Pxxx.

Calibration Constants:

- HEGO\_CONFIG = HEGO configuration register.

- NUMEGO = Number of EGR sensors.

OTHER

- P0133 = Oxygen sensor circuit slow response (bank 1 upstream).

- P0135 = Fault code for EGO11 sensor heater circuit malfunction.

- P0136 = Oxygen sensor circuit malfunction (bank 1 downstream).

- P0141 = Fault code for EGO12 sensor heater circuit malfunction.

- P0153 = Oxygen sensor circuit slow response (bank 2 upstream).

- P0155 = Fault code for EGO21 sensor heater circuit malfunction.

- P0156 = Oxygen sensor circuit malfunction (bank 2 downstream).

- P0161 = Fault code for EGO22 sensor heater circuit malfunction.

- P1133 = Oxygen sensor switchpoint indicates lean (EGO11).

- P1134 = Oxygen sensor switchpoint indicates rich (EGO11).

- P1153 = Oxygen sensor switchpoint indicates lean (EGO21).

- P1154 = Oxygen sensor switchpoint indicates rich (EGO21).

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EGO MONITOR CONTROL STRATEGY, EGO FAULT FLAG CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EGO\_FFG\_CONTROL\_COM10

BEGIN: definitions

;This section defines symbols used to make the strategy more readable.

;It is not to be explicitly executed.

unconditionally ------------------------| no\_aft\_hego := 0

| single\_bank := 1

| dual\_bank := 2

| y\_pipe := 3

END: definitions

BEGIN: ego11\_ffg\_control

;PUBLIC process to control FFG\_EGO11. This is to be executed once per

;background loop.

FFG\_CSD11 = 1 --------------------|

;CSD detected. |

|

OV\_TMR\_11 > 0 --------------------|

;overvoltage. |

|

P0133MALF = 1 --------------------|

;slow response. |

|

P0135MALF = 1 --------------------|

;heater fault. |OR --| FFG\_EGO11 := 1

| |

EGO1FMFLG = 1 --------------------| |

;lack of switching. | |

| |

P1133MALF = 1 --------------------| |

;static shift | |

| |

P1134MALF = 1 --------------------| |

;static shift |

| --- ELSE ---

|

| FFG\_EGO11 := 0

END: ego11\_ffg\_control

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EGO MONITOR CONTROL STRATEGY, EGO FAULT FLAG CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego21\_ffg\_control

;PUBLIC process to control FFG\_EGO21. This is to be executed once per

;background loop.

NUMEGO = 2 -----------------------|

|

FFG\_CSD21 = 1 --------------| |

;CSD detected. | |

| |

OV\_TMR\_21 > 0 --------------| |

;overvoltage. | |

| |AND -| FFG\_EGO21 := 1

P0153MALF = 1 --------------| | |

;slow response. | | |

| | |

P0155MALF = 1 --------------| | |

;heater fault. |OR --| |

| |

EGO2FMFLG = 1 --------------| |

;lack of switching. | |

| |

P1153MALF = 1 --------------| |

;static shift | |

| |

P1154MALF = 1 --------------| |

;static shift |

| --- ELSE ---

|

| FFG\_EGO21 := 0

END: ego21\_ffg\_control

BEGIN: ego12\_ffg\_control

;PUBLIC process to control FFG\_EGO12. This is to be executed once per

;background loop.

HEGO\_CONFIG <> no\_aft\_hego -------|

|

OV\_TMR\_12 > 0 --------------| |AND -| FFG\_EGO12 := 1

;overvoltage. | | |

| | |

P0136MALF = 1 --------------|OR --| |

;insufficient activity. | |

| |

P0141MALF = 1 --------------| |

;heater fault. |

| --- ELSE ---

|

| FFG\_EGO12 := 0

END: ego12\_ffg\_control

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EGO MONITOR CONTROL STRATEGY, EGO FAULT FLAG CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ego22\_ffg\_control

;PUBLIC process to control FFG\_EGO22. This is to be executed once per

;background loop.

HEGO\_CONFIG = dual\_bank ----------|

|

OV\_TMR\_22 > 0 --------------| |AND -| FFG\_EGO22 := 1

;overvoltage. | | |

|OR --| |

P0156MALF = 1 --------------| |

;insufficient activity. | |

| |

P0161MALF = 1 --------------| |

;heater fault. |

| --- ELSE ---

|

| FFG\_EGO22 := 0

END: ego22\_ffg\_control

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

11.1.9 HEGO SENSOR INPUT PROCESSING (CDAN0)

OVERVIEW

+-----------------------------------+

| EGO\_INPUT\_COM10 |

+-----------------------------------+

|PUBLIC PROCEDURES: |

| .pid\_definitions |

| .ego\_input\_init |

| .background\_ego\_input\_processing |

+-----------------------------------+

|PRIVATE PROCEDURES |

| .read\_downstream\_sensors |

| .read\_upstream\_sensors |

| .upstream\_open\_circuit\_check |

+-----------------------------------+

|

| +------------------------------+

| | EGO\_INPUT\_XFER\_COM1 |

| \_\_\_\_\_\_>+------------------------------+

(Get A/D voltage for | / |PUBLIC PROCEDURES: |

upstream HEGOs.) | / | .background\_ego\_sampling |

INPUT\_XFER -> normal |/ +------------------------------+

ENHYS -> RLCF +

|\ +------------------------------+

| \ | EGO\_ENHYS\_COM1 |

| \ +------------------------------+

| ------>|PUBLIC PROCEDURES: |

| | .background\_ego\_sampling |

| +------------------------------+

|

| +------------------------------+

(Calculate adaptive | | EGO\_CSD\_COMPENSATION\_COM |

HEGO switchpoint.) | +------------------------------+

COM1 -> CSD algo | |PUBLIC PROCEDURES: |

COM2 -> stub |----->| .update\_adaptive\_switchpoint |

| +------------------------------+

|

| +------------------------------+

(Calculate byples | | EGO\_BYPLES\_COM |

value.) | +------------------------------+

COM1 -> normal | |PUBLIC PROCEDURES: |

COM2 -> RCLF |----->| .update\_byples |

| +------------------------------+

|

(Offset US\_SWTPOINT | +------------------------------+

stoich voltage for | | EGO\_US\_SWITCHPOINT\_COM |

alternate fuels.) | +------------------------------+

COM1 -> gasoline | |PUBLIC PROCEDURES: |

COM2 -> PM +----->| .update\_fixed\_switchpoint |

COM3 -> CNG +------------------------------+

Up to 4 HEGO sensors may be connected to an EEEC module. In accordance with

OBDII protocol, the names of these sensors contain reference to their

location and can be presented as HEGOxy, where

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

x = 1 for engine Bank1 and 2 for engine Bank2;########################

y = 1 for upstream HEGO sensor and 2 for downstream (rear) HEGO sensor.

For example, HEGO12 and HEGO22 sensors are located downstream of catalysts

for engine Bank1 and Bank2 respectively. Strategy parameters (flags, timers,

counters, etc.) which are associated with certain HEGO sensor have the same

designations as HEGO sensor. For example, EGOFL11 and EGOFL21 are the

rich/lean state flags for the upstream sensors.

However, some strategy parameters which are not associated with engine Bank1

or Bank2, but rather associated with location, have only location

designation. For example, HEGO switch point for upstream HEGO's is

US\_SWTPOINT, and for downstream HEGO's is DS\_SWTPOINT. It is therefore

important to remember that any HEGO parameters with single digit naming could

be referring to a Bank or a location (up/downstream). US\_SWTPOINT refers to

an upstream parameter, while LAMBSE1 refers to a Bank1 related parameter.

HEGO sensor output is defined as a voltage rather than counts in accordance

with the hardware transfer function formula. For the upstream HEGOS this

conversion is done in the ego\_enhys\_com module for Robust Closed Loop Fuel

(RCLF) applications, and in the ego\_input\_xfer\_com module for non-RCLF

applications. Under normal operating conditions HEGO voltage will switch

between from 0V (lean) to 1V (rich). S\_VEGOxy is the raw sensor voltage

parameter after conversion from A/D counts.

The raw sensor output voltage for the upstream HEGOs is fed into an adaptive

switchpoint algorithm. This algorithm tracks the current value for the HEGO

switchpoint, in order to compensate for voltage shifts away from normal

levels, which may be induced due to the sensor becoming contaminated. This

condition appears as a Characteristic Shift Downward (CSD) of the sensor

switching voltages. The adaptive switchpoint value represents the average

sensor voltage shift away from the normal stoichiometry switchpoint value

(US\_SWTPOINT) for gasoline fuel.

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(A/D Counts Raw HEGO (Add offset

from HW) voltage) due to CSD)

+--------------+

IEGOn1 | Convert | S\_VEGOn1 +---+ VEGOn1

--------->| A/D Counts |-----+--------------->| + |---------->

| to Volts | | +---+

+--------------+ | | (To Closed

(ego\_input\_xfer\_com) | | Loop Fuel)

OR | (0.45V -

(ego\_enhys\_com) | SWTPOINTn1)

v |

+-------------+ | (Adaptive switchpoint,

| Adaptive | | SWTPOINTn1)

| Switchpoint |-----------+

| Algorithm |

+-------------+

(ego\_csd\_compensation\_com)

1V +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ 1V

| | | | +-+ | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | |

| | | | | | +-+ | | | | | | | | | | | |

0V --+ +-+ +-+ | | | --+ +-+ +-+ +-+ +-+ +-+ +-+ 0V

S\_VEGOn1 +-+ | +-+ +-+ VEGOn1

| | | | |

+-+ | | | <--- (CSD)

| | |

-1V | +-+ +-- |

| |

| |

| 0.45V -------- <-- (US\_SWTPOINT) |

| \ |

+---> SWTPOINTn1 \ >---+

\

-0.55V --------

If an upstream HEGO is in CSD, the adaptive switchpoint calculation

SWTPOINTn1 is used to compensate for this negative voltage drift by shifting

the unsigned voltage parameter VEGOn1 back up to normal voltage levels. The

figures above illustrate this input processing for the upstream HEGOs. (If a

downstream HEGO goes into CSD, it will get clipped to 0V in VEGOn2.)

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- BYPLES\_TMn = Calculated time delay before lack of ego switching on bank

n.

- EGOCNTn1 = Number of switches since upstream, bank n sensor failed.

- EGOSSn1 = Switches since start for upstream, bank n sensor.

- EGOSSS1 = Switches since start for both upstream sensors.

- IEGOxy = A/D counts for HEGO bank x, location y sensor. Location = 1 is

upstream, location = 2 is downstream of the catalyst.

- lam\_at\_clip = Temporary clip flag LAMBSEn (bank n), 1 -> clip level has

been reached.

- LAMBSEn = Desired equivalence ratio for Bank n injectors.

- LESTMRn1 = Lack of HEGO switch timer for bank n sensor, sec.

- LAMMINn = Lower lambse clip calculated for bank n.

- LAMMAXn = Upper lambse clip calculated for bank n.

- NUMEGO = Switch indicating number of HEGO sensors present; select mono or

stereo.

- P0130FIL = Lack of EGO11 switch, EGO11 open circuit fault filter.

- P0150FIL = Lack of EGO21 switch, EGO21 open circuit fault filter.

- S\_VEGOxy = HEGO sensor output voltage after counts to volts conversion,

bank x, location y.

- SWTP\_BARn1 = Filtered value for SWTPOINTn1, used in the upstream monitor

to reduce variance and attenuation in the calculation of the peak

rich/lean signals.

- SWTPOINTn1 = Adaptive switchpoint calculation for bank n, volts.

- tempfl = Temporary register for EGOFLxy flag.

- US\_OFFSET = Offset voltage for the upstream HEGO sensor switchpoint, from

the calibrated stoichiometric voltage US\_SWTPOINT, due to methanol

content or compressed natural gas fuels.

- VEGOn1 = Bank n, upstream HEGO voltage compensated with an adaptive

switchpoint calculation to maintain switching output between 0 to 1

volts.

- VEGOn2 = Bank n downstream HEGO voltage.

Bit Flags:

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

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- DFIB\_LEANn1 = Flag which is set when the lo catcher calculation is stuck.

Initiates a lambse reset from the lean clip to as part of the switchpoint

recovery process.

- DFIB\_RICHn1 = Flag which is set when the hi catcher calculation is stuck.

Initiates a lambse reset from the rich clip to as part of the switchpoint

recovery process.

- EGOFLn1 = Bank n upstream HEGO flag.

- LEGOFGn1 = Lack of HEGO switching flag, bank n.

- LESFLG1 = Lack of HEGO switching flag; 1 -> HEGO is not switching, 0 ->

HEGO is switching.

- OLFLG = Open loop flag; 1 -> open loop fuel; 0 -> closed loop fuel.

- OPEN\_EGOn1 = Flag indicating open circuit detected on Upstream EGO bank n

sensor.

- SWTFLn1 = Bank n, upstream HEGO switch flag; 0 -> no HEGO switch, 1 ->

HEGO switch.

Calibration Constants:

- BYPLES1 = Time delay before lack of switch.

- DS\_SWTPOINT = Downstream HEGO input switch point, volts.

- FILHYS = Hysterisis band (number of counts) before clearing fault

filters.

- HEGO\_CONFIG = HEGO configuration register.

- P0130LVL = Lack of EGO11 switch, EGO11 open circuit fault filter

threshold.

- P0150LVL = Lack of EGO21 switch, EGO21 open circuit fault filter

threshold.

- P0130UP = Lack of EGO11 switch, EGO11 open circuit fault filter

increment.

- P0150UP = Lack of EGO21 switch, EGO21 open circuit fault filter

increment.

- SWTP\_FC\_AVG = Time constant for the switchpoint averaging filter.

- TC\_BYPLES = Time constant for ROLAV of time delay before lack of switch.

- US\_SWTPOINT = Upstream HEGO input switch point, volts.

- VABS\_OPEN\_HI = Upper limit for the open circuit voltage band, volts.

- VABS\_OPEN\_LO = Lower limit for the open circuit voltage band, volts.

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

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PROCESS

STRATEGY MODULE: EGO\_INPUT\_COM10

BEGIN: pid\_definitions

pid\_def(j1979\_01\_13, EGOMAP\_J1979)

pid\_def(j1979\_01\_14, min((VEGO11\*200), 255))

;this pid has resolution of 1.

pid\_def(j1979\_01\_151, min((VEGO12\*200), 255))

;this pid has resolution of 1.

pid\_def(j1979\_01\_152, 255)

;this pid has resolution of 1.

NUMEGO = 2 -----| pid\_def(j1979\_01\_18, min((VEGO21\*200), 255))

| ;this pid has resolution of 1.

|

| --- ELSE ---

|

| pid\_def(j1979\_01\_18, 255)

HEGO\_CONFIG <> 3 --| pid\_def(j1979\_01\_191, min((VEGO22\*200), 255))

| ;this pid has resolution of 1.

|

| --- ELSE ---

|

| pid\_def(j1979\_01\_191, 255)

pid\_def(j1979\_01\_192, 255)

END: pid\_definitions

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: definitions

;The following assignments are made to make the documentation more

;readable.

unconditionally ----| no\_aft\_hego := 0

| single\_bank := 1

| dual\_bank := 2

| y\_pipe := 3

| rich := 1

| lean := 0

| rich\_state := 1

| lean\_state := -1

| true := 1

| false := 0

| open\_loop := 1

| closed\_loop := 0

| closed\_throttle := -1

| stereo := 2

END: definitions

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

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BEGIN: ego\_input\_init

;Execute this process only when called (by monitor control module).

unconditionally ----| EGOFL11 := 0

| EGOFL21 := 0

| SWTFL11 := 0

| SWTFL21 := 0

| LESTMR11 := 0

| LESTMR21 := 0

| EGOCNT11 := 0

| EGOCNT21 := 0

| LESFLG1 := 0

| OPEN\_EGO11 := 0

| OPEN\_EGO21 := 0

| P0130FIL := 0

| P0150FIL := 0

| SWTP\_BAR11 := US\_SWTPOINT

| SWTP\_BAR21 := US\_SWTPOINT

END: ego\_input\_init

BEGIN: background\_ego\_input\_processing

;Perform the following once per background pass

unconditionally -------------------| Do: read\_upstream\_sensors

| Do: read\_downstream\_sensors

| Do: upstream\_open\_circuit\_check

LEGOFG11 = 1 ---------|

|

LEGOFG21 = 1 ----------|AND -|

| |

NUMEGO = 2 ------------| |OR --| LESFLG1 := 1

| | (HEGO is not switching)

LEGOFG11 = 1 ----------| | |

|AND -| |

NUMEGO = 1 ------------| |

| --- ELSE ---

|

| LESFLG1 := 0

| (HEGO is switching)

END: background\_ego\_input\_processing

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: read\_upstream\_sensors

;Perform the following process only when called.

For n := 11 and 21 perform the following:

n = 11 ----------------------------| bank := 1

|

| --- ELSE ---

|

| bank := 2

;

; The process background\_ego\_sampling samples the Upstream sensor voltage

; at background rates. The parameter SWTPOINTn1 contains the

; adaptive switchpoint calculation.

;

bank = 1 --------------------|

|OR --| S\_VEGO[n] :=

bank = 2 --------------| | | background\_ego\_sampling(bank,IEGO[n])

|AND -| | Do: update\_adaptive\_switchpoint(bank)

NUMEGO = 2 ------------| | ;update SWTPOINTn1 parameter

| csd\_bias := US\_SWTPOINT - SWTPOINT[n]

| VEGO[n] := max(S\_VEGO[n] + csd\_bias,0)

| tempfl := EGOFL[n]

| SWTP\_BAR[n] := rolav(SWTPOINT[n],

| SWTP\_FC\_AVG)

| ;filter switchpoint for US Mon.

|

| --- ELSE ---

|

| S\_VEGO[n] := 0

| VEGO[n] := 0

| ;bank2 does not exist.

;

; Add in upstream switchpoint voltage offset the calibrated

; stoichiometry value US\_OFFSET due to methanol content or

; compressed natural gas fuels. This offset will be 0 for

; gasoline applications.

;

unconditionally ---------| Do: update\_fixed\_switchpoint

| us\_swtpoint := US\_SWTPOINT + US\_OFFSET

VEGO[n] > us\_swtpoint -------------| EGOFL[n] := 1

|

| --- ELSE ---

|

| EGOFL[n] := 0

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;

; Switches forced by the adaptive switchpoint recovery process

; don't count.

;

DFIB\_LEAN[n] = 0 -----------------|

|

DFIB\_RICH[n] = 0 -----------------|

|

tempfl <> EGOFL[n] ---------------|AND -| SWTFL[n] := 1

|

| --- ELSE ---

|

| SWTFL[n] := 0

LAMBSE[bank] >= LAMMAX[bank] ----|

|OR --| lam\_at\_clip := 1

LAMBSE[bank] <= LAMMIN[bank] ----| |

| --- ELSE ---

|

| lam\_at\_clip := 0

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

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LESTMR[n] - LACK OF EGO SWITCHING TIMER (TIME SINCE LAST EGO SWITCH)

lam\_at\_clip = 0 -------------|

|OR --| LESTMR[n] := 0

OLFLG = 1 -------------------| |

| --- ELSE ---

|

| Count up LESTMR[n]

Additional logic associated with LESTMR[n];

SWTFL[n] = 1 ----------------------| Increment EGOCNT[n]

Calculate HEGO failure time delay criteria.

unconditionally -------------------| t\_byples = update\_byples(bank)

| ;calculate time delay to declare

| a HEGO failure (units = seconds)

|

| t\_byples = max(t\_byples,BYPLES1)

| ;clip value to BYPLES1 as a minimum

Assign value to BYPLES\_TM.

t\_byples >= BYPLES\_TM[bank] -------| BYPLES\_TM[bank] = t\_byples

| ;jump to new value to BYPLES\_TM

|

| --- ELSE ---

|

| BYPLES\_TM[bank] = rolav(t\_byples,

| TC\_BYPLES)

| ;gradually decrease BYPLES time delay

LESTMR[n] >= BYPLES\_TM[bank] ------| LEGOFG[n] := 1

| EGOCNT[n] := 0

EGOCNT[n] > 0 ---------------------| LEGOFG[n] := 0

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Upstream HEGO11 counters:

SWTFL[n] = 1 ----------------------| Increment EGOSS[n]

| Increment EGOSSS1

|

| --- ELSE ---

|

| Freeze Counters

END: read\_upstream\_sensors

BEGIN: read\_downstream\_sensors

;

;Perform the following process only when called.

;

HEGO\_CONFIG <> no\_aft\_hego --------| S\_VEGO12 = ego\_hw\_xfer\_fn(IEGO12)

| ;convert A/D counts to volts

| VEGO12 := max(S\_VEGO12,0)

|

| --- ELSE ---

|

| S\_VEGO12 := 0

| VEGO12 := 0

NUMEGO = stereo -------------|

|AND -| S\_VEGO22 = ego\_hw\_xfer\_fn(IEGO22)

HEGO\_CONFIG <> y\_pipe -------| | ;convert A/D counts to volts

| VEGO22 := max(S\_VEGO22,0)

|

| --- ELSE ---

|

| S\_VEGO22 := 0

| VEGO22 := 0

END: read\_downstream\_sensors

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EGO MONITOR CONTROL STRATEGY, HEGO SENSOR INPUT PROCESSING - CDAN2

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BEGIN: upstream\_open\_circuit\_check

;Perform the following process when called from

;background\_ego\_input\_processing.

;Check for open circuit fault conditions for each

;EGO sensor.

S\_VEGO11 < VABS\_OPEN\_HI -----|

|AND -| P0130FIL := P0130FIL +

S\_VEGO11 > VABS\_OPEN\_LO -----| | P0130UP

|

| --- ELSE ---

|

| P0130FIL := P0130FIL - 1

P0130FIL > P0130LVL ---------------| OPEN\_EGO11 := 1

| ;Open circuit detected.

|

| --- ELSE ---

|

P0130FIL < P0130LVL - FILHYS ------| OPEN\_EGO11 := 0

S\_VEGO21 < VABS\_OPEN\_HI -----|

|AND -| P0150FIL := P0150FIL +

S\_VEGO21 > VABS\_OPEN\_LO -----| | P0150UP

|

| --- ELSE ---

|

| P0150FIL := P0150FIL - 1

P0150FIL > P0150LVL ---------------| OPEN\_EGO21 := 1

| ;Open circuit detected.

|

| --- ELSE

|

P0150FIL < P0150LVL - FILHYS ------| OPEN\_EGO21 := 0

END: upstream\_open\_circuit\_check

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EGO MONITOR CONTROL STRATEGY, HEGO HARDWARE TRANSFER FUNCTION - CDAN2

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11.1.10 HEGO HARDWARE TRANSFER FUNCTION (CDAN0)

OVERVIEW

+-----------------------------------+

| EGO\_HW\_XFER |

+-----------------------------------+

|PUBLIC PROCEDURES: |

| .ego\_hw\_xfer\_fn |

+-----------------------------------+

HEGO sensor input A/D counts to volts transfer function for ML-II hardware.

This module was created so the same hardware transfer function call can be

shared between the background ego input, the upstream ego monitor, and Robust

Closed Loop Fuel fixed rate processing modules. This module helps align

strategy with the software implementation.

DEFINITIONS

Registers:

- hego\_volts = Local parameter used only by this function.

Calibration Constants:

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EGO MONITOR CONTROL STRATEGY, HEGO HARDWARE TRANSFER FUNCTION - CDAN2

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PROCESS

STRATEGY MODULE: EGO\_HW\_XFER\_COM1

BEGIN: ego\_hw\_xfer\_fn(counts)

;

; ML-II A/D counts to volts transfer function for HEGO sensor input.

; This function receives A/D counts as an input, converts counts to

; volts using hardware transfer function, and returns this voltage

; as an output:

;

; For ML-II, the transfer function is:

; HEGO sensor volts = (1/1023) \* (5/3) \* A/D counts

;

; ML-II voltages can have negative values. Sign information is

; transmitted in B5 of the transmitted data during A/D conversion.

; For ML-II, the "counts" input can range from -1024 to 1023.

;

; ML-II hardware does not need to use the IVCAL reference voltage

; in the transfer function (as does ML-I).

;

unconditionally -------------------| hego\_volts := (counts/1023) \*

| (5.0/3.0)

;

; This process should be implemented like a function, and return the

; value of the "hego\_volts" parameter. This parameter should be

; defined in software (i.e. size, bin point resolution, signed) the

; same as the HEGO voltage parameters S\_VEGOxy and S\_USVEGOxy.

;

unconditionally -------------------| Return hego\_volts

END: ego\_hw\_xfer\_fn(counts)

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EGO MONITOR CONTROL STRATEGY, CSD COMPENSATION ALGORITHM - CDAN2

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11.2 CSD COMPENSATION ALGORITHM (CDAN0)

OVERVIEW

+------------------------------+

| EGO\_CSD\_COMPENSATION |

+------------------------------|

|PUBLIC PROCEDURES: |

|. init\_adaptive\_switchpoint |

|. update\_adaptive\_switchpoint |

+------------------------------+

|PRIVATE PROCEDURES: (none) |

+------------------------------+

This module is "stubbed" into applications which do not use the CSD

compensation (aka adaptive switchpoint) algorithm. Global parameter outputs

from the algorithm are stubbed by this module to their default values.

This module allows common strategy and software modules to be used by the

rest of the HEGO Monitor with and without the algorithm.

DEFINITIONS

Registers:

- ADP\_STATEn1 = Current state for switchpoint stuck detection controller.

- CSD\_CUMLTn1 = Count the cumulative number of times the adaptive

switchpoint calculation falls below the adaptive switchpoint crossover

threshold (indicating HEGO CSD conditions). KAM parameter.

- SWTPOINTn1 = Normally use the fixed constant US\_SWTPOINT, but when CSD

occurs use the adaptive switchpoint calculation until the CSD condition

clears.

Bit Flags:

- DFIB\_LEANn1 = Flag which is set when the lo catcher calculation is stuck.

Initiates a lambse reset from the lean clip to as part of the switchpoint

recovery process.

- DFIB\_RICHn1 = Flag which is set when the hi catcher calculation is stuck.

Initiates a lambse reset from the rich clip to as part of the switchpoint

recovery process.

- SWTP\_STABLn1 = Flag which is set if the switchpoint is stable at normal

or csd operation levels. This flag is derived from the switchpoint

movement state machine above.

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EGO MONITOR CONTROL STRATEGY, CSD COMPENSATION ALGORITHM - CDAN2

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PROCESS

STRATEGY MODULE: EGO\_CSD\_COMPENSATION\_COM2

BEGIN: definitions

;

; The following represent definitions used throughout this module. This

; is not intended to be executed. It exists only to make the documentation

; more readable.

;

unconditionally ---------------------| true := 1

| false := 0

| ;adaptive switchpoint states

| switching\_ok := 0

| hi\_catcher\_stuck := 1

| lo\_catcher\_stuck := 2

| lost\_and\_retrying := 3

| lost\_and\_stopped := 255

| ;switchpoint movement states

| normal := 0

| drifting\_down := 1

| drifting\_up := 2

| in\_csd := 3

END: definitions

BEGIN: update\_adaptive\_switchpoint(bank)

;

; Stub the global parameter outputs from the adaptive switchpoint

; algorithm.

;

unconditionally ---------------------| SWTPOINT[bank]1 := US\_SWTPOINT

| ADP\_STATE[bank]1 := switching\_ok

| SWPT\_STABL[bank]1 := 1

| DFIB\_LEAN[bank]1 := 0

| DFIB\_RICH[bank]1 := 0

| ; stub adaptive switchpoint

END: update\_adaptive\_switchpoint(bank)

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EGO MONITOR CONTROL STRATEGY, CSD COMPENSATION ALGORITHM - CDAN2

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BEGIN: init\_adaptive\_switchpoint(bank)

;

; Execute the following process during RAM init and when called.

;

unconditionally ---------------------| SWTPOINT[bank]1 := US\_SWTPOINT

| ADP\_STATE[bank]1 := switching\_ok

| SWTP\_STABL[bank]1 := 1

| DFIB\_LEAN[bank]1 := 0

| DFIB\_RICH[bank]1 := 0

| ; stub global RAM parameters

|

| CSD\_CUMLT[bank]1 := 0

| ; clear KAM parameter

END: init\_adaptive\_switchpoint(bank)

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EGO MONITOR CONTROL STRATEGY, CSD DETECTION ALGORITHM - CDAN2

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11.3 CSD DETECTION ALGORITHM (CDAN0)

OVERVIEW

+----------------------------------+

| EGO\_CSD\_DETECTION |

+----------------------------------+

|PUBLIC PROCEDURES: |

|. csd\_detection\_init |

|. csd\_detection\_kam\_reset |

|. csd\_detection\_process |

+----------------------------------+

|PRIVATE PROCEDURES: |

+----------------------------------+

This module monitors HEGO sensor voltage levels for detection Characteristic

Shift Downward (CSD) conditions. CSD can occur several ways, but the bottom

line is the sensor voltage is shifted downward by up to 1 volt and is

rendered un-usable to the rest of the system. The purpose of this module is

to let the system know when this has happened.

This module will output FFG\_CSDn1 failure mode flags to indicate sensor

switching has stopped due to CSD. Logic to set the FFG\_CSD flags is very

similiar to the lack of switching LEGOFG logic. In a CSD condition, either

an FFG\_CSD flag, OR an LEGOFG flag, but not both, will be set depending on

the calibration of BYPLES time constant multiplier CSDMUL. If CSDMUL < 1,

then the FFG\_CSD flag gets set, otherwise the LEGOFG is set.

Because of their similiar definitions, FFG\_CSD and LEGOFG flags's are 'OR'ed

to control FMEM actions, including:

- 1) EGO Continuous Test: Hold fault filters after lack of switching

fault.

- 2) Adaptive Fuel: set the KAMRFn flags to 1 to disable adaptive table

updates.

- 3) Closed Loop Fuel: Set the FAILED\_BANK parameter.

- 4) Open Loop Fuel: Set the OL\_FMEM failure mode flag to go open loop.

If the CSD Detection algorithm is not used, then the "Com2" version should be

installed in place of this module to "stub" the FFG\_CSD flags.

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EGO MONITOR CONTROL STRATEGY, CSD DETECTION ALGORITHM - CDAN2

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DEFINITIONS

Registers:

- BYPLES\_TMn = Calculated time delay before lack of ego switching on bank

n.

- CSD\_SWITCHn1 = Number of EGO switches counted on bank n sensor, while the

sensor is in CSD.

- CSD\_SWITCH21 = Number of EGO switches since CSD detection on senosr 21,

counts.

- CSD\_TIMERn1 = Amount of time after S\_VEGOn1 goes negative before flagging

a CSD likely condition, seconds.

- S\_VEGOn1 = Bankn upstream signed HEGO voltage.

- LAMMINn = Lower lambse clip calculated for bank n.

Bit Flags:

- CSD\_LIKELYn1 = Flag set when voltage, switching, and lambse conditions

are such that CSD is suspected to be present on bank n sensor.

- FFG\_CSDn1 = Fault flag for CSD on bank n sensor.

- OLFLG = Open loop fuel flag; 1 -> Open Loop fuel; 0 -> Closed loop fuel

- SWTFLn1 = Bank n upstream HEGO switch flag.

Calibration Constants:

- CSDMUL = Multiplier on BYPLES\_TM to signal CSD fault, unitless.

- CSD\_SWITCHES = Number of EGO switches to recover from CSD FMEM, counts.

- CSD\_TM = Minimum amount of time after EGO voltage dips below CSD\_VOLTAGE

(goes negative) to set CSD\_LIKELY flag, seconds.

- CSD\_VOLTAGE = If the ego voltage S\_VEGO is below this threshold, then

enable CSD timers and switch counters to increment.

- US\_SWTPOINT = Upsteam sensor switchpoint, volts.

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EGO MONITOR CONTROL STRATEGY, CSD DETECTION ALGORITHM - CDAN2

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PROCESS

STRATEGY MODULE: EGO\_CSD\_DETECTION\_COM1

BEGIN: csd\_detection\_init

;

;Executed during RAM initialization or when called from within the

;EGO monitor control process (during an abort\_ego\_mon sequence).

;

CSD\_LIKELY11 = 1 ------------------------| CSD\_TIMER11 := CSD\_TM

|

| --- ELSE ---

|

| CSD\_TIMER11 := 0

CSD\_LIKELY21 = 1 ------------------------| CSD\_TIMER21 := CSD\_TM

|

| --- ELSE ---

|

| CSD\_TIMER21 := 0

END: csd\_detection\_init

BEGIN: csd\_detection\_kam\_reset

;

;Reset CSD detection KAM parameters during a KAM reset. This process

;is called from the EGO monitor control module.

;

unconditionally ------------------------| CSD\_LIKELY11 := 0

| CSD\_LIKELY21 := 0

END: csd\_detection\_kam\_reset

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EGO MONITOR CONTROL STRATEGY, CSD DETECTION ALGORITHM - CDAN2

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BEGIN: csd\_detection\_process

;This process, called on demand from the EGO\_MONITOR\_CONTROL

;module is used to detect a characteristic shift downward in

;the upstream EGO sensor voltage. This CSD can result from a

;couple of things. First if the sensor element is soaked with

;fuel and the reference side gets contaminated, the sensor

;output voltage tends to drift lower, even going negative

;eventually.

;Also microscopic cracks in the sensor element, caused by fluid

;droplets impinging on a hot element can allow leakage of

;exhaust gases into the reference side of the sensor, again

;leading to CSD.

;The transfer function between the EGO sensor and the AtoD converter in

;the module will allow the direct measurment of negative voltage on the

;EGO sensor (up to about -0.3 volts). The EGO voltage magnitude is

;deleivered to the EEC fromthe AICE during AtoD conversion in the normal

;10 bits. In addition bit 5 of register B inthe transmit data format

;from the AICE contains a sign bit. This information is being read in the

;EGO\_INPUT module and stored in the register S\_VEGOxy.

;When negative voltage persists long enough to disrupt the normal closed

;loop fuel control and drive the system to a rich or lean clip for a

;calibrated amount of time, a CSD fault will be identified. A fault code

;will only be stored if this fault results in the continuous ego switching

;test (see EGO\_CONTINUOUS\_TEST\_COM) identifying a fault also. A seperate

;code signifying CSD is present will be stored when lack of switching goes

;to store a code.

SWTFL11 = 1 --------------------------| CSD\_SWITCH11 = CSD\_SWITCH11 + 1

SWTFL21 = 1 --------------------------| CSD\_SWITCH21 = CSD\_SWITCH21 + 1

S\_VEGO11 < CSD\_VOLTAGE ---------------| CSD\_TIMER11 := CSD\_TM

| CSD\_SWITCH11 := 0

| CSD\_LIKELY11 := 1

S\_VEGO21 < CSD\_VOLTAGE ---------|

|AND -| CSD\_TIMER21 := CSD\_TM

NUMEGO = 2 ---------------------| | CSD\_SWITCH21 := 0

| CSD\_LIKELY21 := 1

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EGO MONITOR CONTROL STRATEGY, CSD DETECTION ALGORITHM - CDAN2

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S\_VEGO11 >= CSD\_VOLTAGE --------|

|

CSD\_TIMER11 = 0 ----------------|AND -| CSD\_LIKELY11 := 0

| | FFG\_CSD11 := 0

CSD\_SWITCH11 > CSD\_SWITCHES ----|

S\_VEGO21 >= CSD\_VOLTAGE --------|

|

CSD\_TIMER21 = 0 ----------------|AND -| CSD\_LIKELY21 := 0

| | FFG\_CSD21 := 0

CSD\_SWITCH21 > CSD\_SWITCHES ----|

OLFLG = 0 ----------------------|

|

LAMBSE1 <= LAMMIN1 -------------|

|

LESTMR11 > CSDMUL \* BYPLES\_TM1 -|AND -| FFG\_CSD11 := 1

| | ;signal to the continuous

S\_VEGO11 < US\_SWTPOINT ---------| | ;EGO switching test CSD

| | ;has been discovered.

CSD\_LIKELY11 = 1 ---------------|

OLFLG = 0 ----------------------|

|

LAMBSE2 <= LAMMIN2 -------------|

|

LESTMR21 > CSDMUL \* BYPLES\_TM2 -|AND -| FFG\_CSD21 := 1

| | ;signal to the continuous

S\_VEGO21 < US\_SWTPOINT ---------| | ;EGO switching test CSD

| | ;has been discovered.

CSD\_LIKELY21 = 1 ---------------|

END: csd\_detection\_process

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EGO MONITOR CONTROL STRATEGY, HEGO INPUT TRANSFER FUNCTION - CDAN2

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11.4 HEGO INPUT TRANSFER FUNCTION (CDAM0)

OVERVIEW

+-----------------------------------+

| EGO\_INPUT\_XFER\_COM1 |

+-----------------------------------+

|PUBLIC PROCEDURES: |

| .background\_ego\_sampling |

+-----------------------------------+

Sample and return the Upstream HEGO sensor input voltage at background input

processing rates. This module will be used by applications which do NOT have

Robust Closed Loop Fuel installed.

This module was split from the HEGO input processing module in order to

install hooks into the fixed sampling rate process used by Robust Closed Loop

Fuel (RCLF) applications. The purpose of this module is keep the

ego\_input\_com10 module common for RCLF and non-RCLF applications until RCLF

becomes installed across the board.

DEFINITIONS

Registers:

- bkgnd\_rate\_volts = Local parameter used only by this process.

Calibration Constants:

11-180

EGO MONITOR CONTROL STRATEGY, HEGO INPUT TRANSFER FUNCTION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EGO\_INPUT\_XFER\_COM1

BEGIN: background\_ego\_sampling(bank,counts)

;

;This process should be implemented like a function, and

;return the Upstream ego sensor voltage to the calling

;process. The ego voltage is calculated from the "counts"

;input parameter using the A/D counts to volts transfer

;function for ML-II hardware.

;

;The parameter "bkgnd\_rate\_volts" is used locally to this

;function and should be defined in software (i.e. size,

;bin point resolution, signed) the same as the HEGO voltage

;parameter SVEGO\_RCLFn1.

;

;The "banks" input parameter is not used by this function

;but is maintained for a common calling sequence with the

;non-RCLF function.

;

unconditionally -------------------| bkgnd\_rate\_volts :=

| ego\_hw\_xfer\_fn(counts)

| Return bkgnd\_rate\_volts

END: background\_ego\_sampling(bank,counts)

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EGO MONITOR CONTROL STRATEGY, HEGO LAMBSE CLIP STUB - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

11.5 HEGO LAMBSE CLIP STUB (CDAN0)

OVERVIEW

Set the lambse clip parameters LAMMINn and LAMMAXn to the calibration

constants LAMMIN and LAMMAX. This module is used only for applications which

do NOT yet support the adaptive lambse calculation.

For applications which DO have the new algorithm, use the COM2 version of

this module.

The ego\_lam\_clip\_comx modules are intended to allow common strategy to be

used independent of the lambse clip logic. This module, and the call to it,

can be absorbed back into the main strategy body after the adaptive lambse

clip algorithm is installed across the board.

DEFINITIONS

Registers:

- LAMMINn = Lower lambse clip calculated for bank n.

- LAMMAXn = Upper lambse clip calculated for bank n.

Calibration Constants:

- LAMMIN = Lower fixed lambse clip.

- LAMMAX = Upper fixed lambse clip.

PROCESS

STRATEGY MODULE: EGO\_LAM\_CLIP\_COM1

BEGIN: ego\_lambse\_clips

;

; Execute this process only when called. Set the lambse

; clips to the calibratable limits, because the adaptive

; lambse clip algorithm is not yet installed.

;

unconditionally -------------------| LAMMIN[1] := LAMMIN

| LAMMAX[1] := LAMMAX

| LAMMIN[2] := LAMMIN

| LAMMAX[2] := LAMMAX

END: ego\_lambse\_clips

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EGO MONITOR CONTROL STRATEGY, REV MONITOR - CDAN2

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11.6 EGO MONITOR CONTROL STRATEGY (CDAM0)

OVERVIEW

+------------------------+

| EGO\_REV\_COUNTER\_COM |

+------------------------+

| PUBLIC PROCESSES: |

| . rev\_counting\_process |

+------------------------+

This module is used to count engine revolutions during the upstream EGO

monitor intrusive fuel control. The revolutions counted will act as a delay

to allow stabilization of the fuel controller prior to measuring the EGO

sensor output voltage amplitude.

DEFINITIONS

Registers:

- EGO\_REV\_CTR = Count of the number of revolutions of the engine that have

occured since starting the rev cntg proc.

- EGO\_SYN\_CTR = Captured value of SYNC\_CTR at the PIP high interrupt

following the point when EGO\_REV\_FLG is set.

- SYNC\_CTR = Sequence counter incremented every PIP rising edge that is

used to indentify the cycle and position.

Bit Flags:

- EGO\_REV\_ENA = Flag used to enable the rev\_counting\_process in the

foreground.

- EGO\_REV\_FLG = Flag used to trigger the capture of the SYNC\_CTR in the

foreground rev\_counting\_process.

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EGO MONITOR CONTROL STRATEGY, REV MONITOR - CDAN2

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PROCESS

STRATEGY MODULE: EGO\_REV\_COUNTER\_COM1

BEGIN: rev\_counting\_process

;This process is triggered from the background

;ego\_monitor\_controller. It is used to count revolutions of the engine

;used to delay entry into the ego monitor procedures. This procedure is

;executed during the PIP high interrupt.

EGO\_REV\_FLG = 1 ------------------|

|AND -| EGO\_SYN\_CTR := SYNC\_CTR

EGO\_REV\_ENA = 1 ------------------| | ;capture starting point.

EGO\_REV\_FLG = 0 ------------------|

|

SYNC\_CTR = EGO\_SYN\_CTR -----------|AND -| EGO\_REV\_CTR := EGO\_REV\_CTR + 1

|

EGO\_REV\_ENA = 1 ------------------|

EGO\_REV\_FLG = 1 ------------------|

|AND -| EGO\_REV\_FLG := 0

EGO\_REV\_ENA = 1 ------------------| | ;stop capturing the starting

| ;point.

END: rev\_counting\_process

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EGO MONITOR CONTROL STRATEGY, UPSTREAM SENSOR SWITCHPOINT CALCULATION - CDAN2

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11.7 UPSTREAM SENSOR SWITCHPOINT CALCULATION (CDAM0)

OVERVIEW

+-----------------------------------+

| EGO\_US\_SWTPOINT\_COM |

+-----------------------------------+

|PUBLIC PROCEDURES: |

| .update\_fixed\_switchpoint |

+-----------------------------------+

This module calculates an offset voltage for the upstream HEGO sensor

switchpoint, from the normal stoichiometric voltage US\_SWTPOINT calibrated

for gasoline fuel type applications, due to methanol content or compressed

natural gas fuels.

This module was split from the HEGO input processing module in order to

remove this hardware dependent logic. This allows the input processing

module to be common all applications regardless of fuel type.

DEFINITIONS

Registers:

- US\_OFFSET = Offset voltage for the upstream HEGO sensor switchpoint, from

the calibrated stoichiometric voltage US\_SWTPOINT, due to methanol

content or compressed natural gas fuels.

Bit Flags:

Calibration Constants:

PROCESS

STRATEGY MODULE: EGO\_US\_SWTPOINT\_COM1

BEGIN: update\_fixed\_switchpoint

;

;The process is a stub, used only to maintain a common software

;module for ego input processing.

;

;This module supports gasoline fuel type applications.

;

;Gasoline applications use the cal constant US\_SWTPOINT for the

;upstream sensor switchpoint. No offset voltage from this

;calibrated stoichiometry value, due to methanol content or

;compressed natural gas fuels, is required.

;

unconditionally ----| US\_OFFSET := 0

| ;no offset from calibrated stoich needed.

END: update\_fixed\_switchpoint

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EGO MONITOR CONTROL STRATEGY, HEGO BYPLES CALCULATION - CDAN2

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11.8 HEGO BYPLES CALCULATION (CDAN0)

OVERVIEW

Calculate the HEGO Bypass Lack of Switching (byples) time constant for the

Upstream HEGOs. This time constant is tied to the transport delay for the

engine bank, and is used to set the time threshold for which lambse can

remain at a clip before flagging a lack of switching fault condition.

This module is only used for applications which do not have Robust Closed

Loop Fuel (RCLF). For applications which do have RCFL, use the COM2 version

of this module.

The ego\_byples\_comx modules allow the ego\_input\_com10 module to remain common

for both RCLF and non-RCLF applications.

DEFINITIONS

Registers:

- BIAS\_Gn = Closed loop fuel bias Bank n.

- LOAD = Universal normalized load parameter.

- N = Engine RPM.

- PTPAMPn = Limit cycle peak-to-peak amplitude for bank n.

- rpm = Local parameter used only by this function.

- t\_byples = Local parameter used only by this function.

Calibration Constants:

- FN1351 = System transport lag time table.

- FN346 = Expected number of PIPs multiplier. Input = |BIAS/PTPAMP|. O

Output = Multiplier.

- TDREV\_DELAY = Number of transport delays to wait prior to going open

loop.

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EGO MONITOR CONTROL STRATEGY, HEGO BYPLES CALCULATION - CDAN2

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PROCESS

STRATEGY MODULE: EGO\_BYPLES\_COM1

BEGIN: update\_byples(bank)

;

; Byples time calculation function for the input engine bank parameter.

;

unconditionally -------------------| rpm = max(60,N)

| ;clip value to 60rpm as a minimum

|

| t\_byples = FN1351(N,LOAD) \*

| FN346(|BIAS\_G[bank]|/

| PTPAMP[bank]) \*

| TDREV\_DELAY \* 60 / rpm

| ;calculate time delay to declare

| ;a HEGO failure (units = seconds)

;

; This process should be implemented like a function, and return the

; value of the "t\_byples" parameter. This returned parameter should

; be defined in software (i.e. size, bin point resolution, signed)

; the same as the ego\_input\_com10 parameters BYPLES\_TMn.

;

unconditionally -------------------| Return t\_byples

END: update\_byples(bank)

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EGO MONITOR CONTROL STRATEGY, HEGO BYPLES CALCULATION - CDAN2

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CHAPTER 12

EGR STRATEGY

12-1

EGR STRATEGY

12.1 FEATURE: EGR - PFE - V1.11\_EGR\_PFE (CDAN0)

12.1.1 EGR SYSTEM INITIALIZATION (CDAN0)

OVERVIEW

This module contains initialization logic for the PFE EGR control system.

EGR parameters will be initialized whenever EGR\_INIT\_FLG is set to zero.

DEFINITIONS

Registers:

- EGR\_SHT\_TMR = EGR shut timer.

- EPTBAR = Filtered EGR sensor reading, counts.

- EPTZER = Learned EGR valve position sensor zero reading, counts.

- EPTZER\_TMR2 = Time since EPTZER updated.

- IEGR = Unfiltered EPT sensor analog channel reading.

Bit Flags:

- EGR\_INIT\_FLG = Flag to indicate EGR parameters have been initialized.

- EGR\_RETRY = Flag to indicate EGR monitor is on second pass

Calibration Constants:

- EGR\_REP\_SW = Enables EGR fault retesting. 1 -> retest alwalys, 2 ->

retest after first pass.

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EGR STRATEGY, PRESSURE FEEDBACK EGR - CDAN2

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PROCESS

STRATEGY MODULE: EGR\_INIT\_COM1

The following logic initializes EGR parameters after a RAM clear.

EGR\_INIT\_FLG = 0 -----------------|

;initialization in progress |AND -| EGR\_RETRY = 1

| | ;set second pass flag

EGR\_REP\_SW = 2 -------------------| |

;do not retest on first pass |

| --- ELSE ---

|

EGR\_INIT\_FLG = 0 -----------------------| EGR\_RETRY = 0

;initialization in progress | ;start out on first pass

EGR\_INIT\_FLG = 0 -----------------------| EPTBAR = EPTZER

| ;initialize to closed position

| EPTZER\_TMR2 = 255

| ;set time since EPTZER update

| ;to max

| IEGR = 307

| ;set to intermediate value

| EGR\_SHT\_TMR = 31.875

| ;initialize to close valve value

| EGR\_INIT\_FLG = 1

| ;initialization complete

12-3

EGR STRATEGY, EGR ENABLE - CDAN2

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12.1.2 EGR ENABLE (CDAL0)

OVERVIEW

This module enables or disabled the PFE EGR system based on engine operating

conditions.

DEFINITIONS

Registers:

- ACSTRT = Air Charge temperature at start.

- APT = Throttle Mode Flag; -1 -> Closed Throttle, 1 -> Wide Open Throttle,

0 -> Part Throttle.

- EGRENA\_TM = Time since start at which EGR is enabled, sec.

- EGREN\_TMR = EGR Enable timer.

- EGR\_WOT\_TMR = Time at WOT for EGR enable, seconds.

- N = Engine speed, rpm.

- TCSTRT = Temperature of ECT at cold start, deg F.

- TP\_REL = Throttle position relative to closed position.

Bit Flags:

- AFMFLG = Flag indicating that ACT sensor has failed.

- BFMFLG = Flag indicating that BP sensor has failed; 1 -> failure.

- CFMFLG = Flag indicating that ECT sensor is in/out of range.

- CRKFLG = Flag indicating engine status; 1 -> Crank mode.

- DIS\_FMEM = Distributorless ignition failure mode.

- EFMFLG = Flag indicating that EVP EGR sensor has failed.

- EGREN = Flag which indicates EGR enabled if set to 1.

- EGR\_HOSE\_TST = Flag to Enable EGR OBDII Hose Integrity checks.

- EGR\_TPCUTOUT = Disable EGR based on throttle position flag.

- ER\_EGR\_FLG = Engine Running Self Test requests EGR.

- MFMFLG = Flag indicating that MAF sensor has failed.

- TFMFLG = Flag indicating that TP sensor has failed.

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EGR STRATEGY, EGR ENABLE - CDAN2

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Calibration Constants:

- EGREN\_TM\_RT = ACT at start weighting in FN230A input.

- EGR\_DYNO\_ENA = EGR unconditional enable switch.

- EGR\_DYNO\_DIS = EGR unconditional disable switch.

- EGR\_TP\_HYST = EGR TP cutout hysteresis.

- FN203(N) = TP\_REL above which to disable EGR.

- FN230A(TCSTRT) = Time since start to enable EGR, sec.

- PFEHP = Switch to select EGR strategy; 0 -> use Sonic strategy, 1 -> use

PFE strategy, 2 -> do not use any EGR.

- WOTEGRTM = Maximum amount of time to allow WOT EGR.

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EGR STRATEGY, EGR ENABLE - CDAN2

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PROCESS

STRATEGY MODULE: EGR\_ENABLE\_COM2

CRKFLG = 1 -----------------------------| EGREN\_TMR = 0

;in crank mode | ;reset time since start

always ---------------------------------| EGRENA\_TM = FN230A(ACSTRT \*

| EGREN\_TM\_RT + TCSTRT \*

| (1 - EGREN\_TM\_RT))

| ;calc enable time as fn of

| ;ECT and ACT at start

TP\_REL > FN203(N) + EGR\_TP\_HYST --------|S Q -| EGR\_TPCUTOUT

;throttle above cutout threshold | | ;EGR cutout flag

|

TP\_REL <= FN203(N) ---------------------|C

;throttle below cutout threshold

;EGR\_WOT\_TMR is a free running up counting timer. It is reset to zero

;when not at WOT.

APT <> 1 -------------------------------------| EGR\_WOT\_TMR = 0

;not at wide open throttle | ;reset wide open throttle

| ;timer

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EGR STRATEGY, EGR ENABLE - CDAN2

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EGR\_DYNO\_ENA = 1 -----------------------|

;egr unconditionally enabled |

|

EGR\_DYNO\_DIS = 0 -----------------| |

;egr not disabled | |

| |

PFEHP <> 2 -----------------------| |OR --| EGREN = 1

;EGR hardware present | | | ;enable EGR

| | |

EGR\_HOSE\_TST = 0 -----------------| | |

;EGR hose test disabled | | |

| | |

ER\_EGR\_FLG = 1 -------------| | | |

;self test requests EGR | |AND -| |

| | |

EGREN\_TMR > | | |

EGRENA\_TM -----| | | |

;time since start | | | |

;long enough | | | |

| | | |

APT <> -1 ------------| |OR --| |

;not closed | | |

;throttle | | |

| | |

EGR\_TPCUTOUT = 0 -----| | |

;no throttle cutout | | |

| | |

EGR\_WOT\_TMR <= | | |

WOTEGRTM ----| | |

;not at WOT too long | | |

| | |

CRKFLG = 0 -----------| | |

;not in crank mode | | |

| | |

AFMFLG = 0 -----------| | |

;air temp sensor o.k.| | |

|AND -| |

BFMFLG = 0 -----------| |

;BP sensor O.K. | |

| |

CFMFLG = 0 -----------| |

;ect sensor o.k. | |

| |

EFMFLG = 0 -----------| |

;EGR sensor o.k. | |

| |

MFMFLG = 0 -----------| |

;mass flow meter o.k.| |

| |

TFMFLG = 0 -----------| |

;tp sensor o.k. | |

| |

DIS\_FMEM = 0 ---------| |

;dis o.k. |

| --- ELSE ---

|

| EGREN = 0

| ;disable EGR

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EGR STRATEGY, DESIRED EGR MASS FLOW - CDAN2

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12.1.3 DESIRED EGR MASS FLOW (CDAN0)

OVERVIEW

This module calculates the desired egr flow rate, EGRATE, in percent of total

engine mass flow rate and desired egr mass flow rate, DESEM, in lbs/min.

Desired EGR flow is calculated as a function engine speed, load, coolant

temperature, air charge temperature, and percent load.

DEFINITIONS

Registers:

- ACT = Air charge temperature degrees Farenheit.

- AM = Air mass flow, lb/min.

- DESEM = Desired EM, lb/min.

- ECT = Coolant temperature degrees Farenheit.

- EGRATE = Desired EGR rate, percent.

- LOAD = Universal load at ratio of air charge over standard.

- N = Engine speed rpm.

- PCT\_LOAD = Percent of maximum load attainable for current conditions.

- TCSTRT = Temperature of ECT at cold start, deg F.

- TSEGRE = Accumulated time EGR is enabled.

Bit Flags:

- CAT\_TST\_PRG = Catalyst Test in Progress flag, indicates that closed loop

fuel control is turned over to downstream HEGO sensors; 1 -> control from

downstream HEGO sensors.

- EGREN = Flag which indicates EGR enabled if set to 1.

- ER\_EGR\_FLG = Engine Running Self Test requests EGR.

- TSEGRE\_FLG = Flag to enable counting up of timer TSEGRE.

Calibration Constants:

- CTLOW = Cold Start maximum ECT, deg F.

- CAT\_EGRATE = Desired EGR flow rate during catalyst test, percent.

- EGR\_ADD = Constant EGR adder.

- EGR\_MUL = EGRATE multiplier for development.

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EGR STRATEGY, DESIRED EGR MASS FLOW - CDAN2

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- EGRMPT = Calibration time delay to ramp EGR in, sec. (EGRATE ramp time

for TCSTRT <= CTLOW).

- ER\_EGRATE = Engine running requested EGRATE.

- FN070(N) = N normalizing function for table lookup.

- FN071(LOAD) = Load normalizing function for table lookup.

- FN211(ECT) = Multiplier as a function of Engine Coolant Temperature ECT.

- FN212A(BP) = Multiplier as a function of BP for desired EGR rate.

- FN217A(BP) = Multiplier as a function of BP for desired EGR rate.

- FN220(ACT) = Multiplier as a function of Air Charge Temperature.

- FN248(PCT\_LOAD) = Maximum EGR attainable at altitude.

- FN908A(N,LOAD) = Base desired EGR rate at sea level in percent;

X = FN070(N) - Normalized engine speed, RPM

Y = FN071(LOAD) - Normalized Load.

- FN908B(N,LOAD) = Base desired EGR rate at altitude in percent;

X = FN070(N) - Normalized engine speed, RPM

Y = FN071(LOAD) - Normalized Load.

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EGR STRATEGY, DESIRED EGR MASS FLOW - CDAN2

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PROCESS

STRATEGY MODULE: EGR\_DESIRED\_COM4

BEGIN: egr\_desired

Background process to calculate the desired EGR flow rate.

TIME SINCE EGR ENABLED LOGIC

TCSTRT > CTLOW ------------| TSEGRE = EGRMPT

;coolant temp at start | ;make TSEGRE/EGRMPT = 1

;high |

| --- ELSE ---

|

EGREN = 1 -----------------| TSEGRE\_FLG = 1

;EGR enabled | ;count up timer TSEGRE

| ;ramp TSEGRE/EGRMPT multiplier to 1

| TSEGRE = min(TSEGRE,EGRMPT)

| ;clip multiplier to 1

|

| --- ELSE ---

|

| TSEGRE\_FLG = 0

| ;freeze TSEGRE timer

FINAL DESIRED EGR RATE CALCULATION

The base desired egr rate is calculated as a function of engine speed, load,

coolant temperature, air charge temperature, and time since first enabled.

It is then clipped to the maximum EGR attainable due to limited vacuum at

altitude as a function of PCT\_LOAD.

EGREN = 0 -----------------| EGRATE = 0

;egr disabled | ;do not flow EGR

|

| --- ELSE ---

|

ER\_EGR\_FLG = 1 ------------| EGRATE = ER\_EGRATE

;in KOER | ;set to constant percent egr

|

| --- ELSE ---

|

| Do: egr\_rate\_lookup

| ;get desired EGR rate

12-10

EGR STRATEGY, DESIRED EGR MASS FLOW - CDAN2

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DESIRED EGR MASS FLOW RATE CALCULATION

Convert desired EGR rate to desired EGR mass flow rate, DESEM, which has

units of lbm/min. The actual definition of DESEM is ( EGRATE \* AMPEM / 100).

It is not formulated this way in the strategy because the addition of EGR

changes AMPEM which affects DESEM. In other words this implementation is

iterative and causes a delay in achieving the final value of DESEM. The

relationship is reformulated to give the correct value directly:

always --------------------| DESEM = EGRATE \* AM / ( 100 - EGRATE )

| ;calc. desired egr mass

END: egr\_desired

BEGIN: egr\_rate\_lookup

Local procedure to perform the table lookups and calculations necessary to

determine the desired EGR rate.

unconditionally -----------| egrate\_tmp = FN211(ECT) \* FN220(ACT) \*

| (FN908A(N,LOAD) \* FN212A(BP) +

| FN908B(N,LOAD) \* FN217A(BP)) \*

| (TSEGRE / EGRMPT)

| ;lookup desired EGR rate

| egrate\_tmp = min(egrate\_tmp,FN248(PCT\_LOAD))

| ;clip to max attainable given vacuum

| ;constraints

EGR\_IMR\_MOD = 1 -----------| egrate\_tmp = egrate\_tmp \* EGR\_IMR\_MUL

;IMRC requests EGR | ;modify desired EGR for IMRC

;modification

unconditionally -----------| EGRATE = (EGR\_MUL \* egrate\_tmp) + EGR\_ADD

| ;apply development multipliers

END: egr\_rate\_lookup

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EGR STRATEGY, DELTA PRESSURE FEEDBACK EGR - CDAN2

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12.1.4 DELTA PRESSURE FEEDBACK EGR (CDAN0)

OVERVIEW

DPFE EGR precisely regulates the EGR flow according to calibrated tables and

functions. The DPFE EGR strategy uses delta pressure across an orifice

measured using an EGR pressure transducer (EPT) as the feedback signal for

control of EGR. The EGR flow is proportional to square root of the pressure

drop across the sharp-edged orifice. The EGR valve itself operates as the

downstream pressure regulator. When the valve is closed, the downstream and

upstream pressures are equal. As the valve opens, the downstream pressure

decreases due to the influence of the intake manifold vacuum.

|------------------------------|

| Exhaust Pressure |

| |--------------------------| |

| | |---| |---| EPT

| | | |<-- Sensor

| | Control |---------| EGR

| | Orifice | | Valve

| | | |---| |---| |

| | V | | V

---| |--------------------------| |----------------------

| \ /

| \ / Intake

Exhaust \/ Manifold

Manifold /\ Vacuum

| Control chamber / \

| / \

---------------------------------------------------------

The EEC controls the EGR valve with vacuum supplied by the EGR Vacuum

Regulator (EVR). The strategy in the EEC accomplishes this by calculating a

desired pressure in the control chamber called CONPR. The actual pressure is

measured and is called EPTBAR. The EVR controller uses EGR\_ERROR, which is

the difference between CONPR and EPTBAR, to modulate the EVR valve so that

EPTBAR is as close as possible to CONPR.

12-12

EGR STRATEGY, DELTA PRESSURE FEEDBACK EGR - CDAN2

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DEFINITIONS

Registers:

- AM = Air mass flow, lb/min.

- APT = Throttle Mode Flag; -1 -> Closed Throttle, 1 -> Wide Open Throttle,

0 -> Part Throttle.

- BP = Barometric pressure, " Hg.

- BP\_WORD = Word resolution value of BP, " Hg.

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CONPR = Desired EPT sensor value, counts.

- DELPR = Actual pressure drop across the control orifice, " H20.

- DESDP = Filtered desired downstream pressure, " H2O.

- DESEM = Desired EM, lb/min.

- DSDRPM = Desired RPM as defined in ISC section.

- EGREN\_TMR = EGR enable timer.

- EGRENA\_TM = Time since start at which EGR is enabled.

- EGR\_ERROR = Error in control chamber pressure in PFE systems and EGR

valve position in sonic systems, counts.

- EGR\_N\_FIL = Filtered engine speed for EGR logic.

- EGR\_SHT\_TMR = Unconditionally up counting timer to indicate elapsed time

since EGR valve was commanded shut.

- EM = Actual EGR mass flow, lb/min.

- EPTBAR = Rolling average of the synchronously sampled EPT sensor (time

constant = TCEPT), counts.

- EPTZER = Rolling average of the synchronously sampled EPT sensor at idle

(time constant = TCEPTZER), stored in Keep Alive Memory, counts.

- EPTZER\_OFF = EPTZER when engine is not running.

- EPTZER\_TMR2 = Timer to record time since EPTZER was last updated,

seconds.

- IEGR = EPT sensor data for PFE EGR.

- N = Engine speed, rpm.

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EGR STRATEGY, DELTA PRESSURE FEEDBACK EGR - CDAN2

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Bit Flags:

- CRKFLG = Flag indicating engine status; 1 -> Crank mode.

- DESEM\_FLG = When set, DESEM is large enough to turn EGR on. This is a

flip flop flag.

- EGR\_ON\_FLG = When set, the EVR is being controlled and when clear there

is no duty cycle output to the EVR.

- EGREN = Flag which indicates EGR enabled if set to 1.

- EFMFLG = Flag indicating that EVP EGR sensor has failed.

- EPT\_OK\_FLG = When set, the EPT sensor is not saturated.

- EVLOPNFM\_FLG = EGR valve stuck open failure mode flag.

- FIRST\_PIP = Indicates that first PIP has been received.

- KAM\_ERROR = Indicates keep alive RAM invalid.

- PxxxFLT = Flag to indicate fault xxx exists; 1 -> malfunction currently

exists for fault xxx.

- WRM\_IDL\_FLG = Warm idle flag used for EGR.

Calibration Constants:

- DP\_MAX = Maximum clip for DESDP and dp.

- DP\_MIN = Minimum clip for DESDP and dp.

- EGR\_VLV\_SHT = Time to allow EGR valve to shut when commanded.

- EGR\_WRM\_TM = Time before EGR is first enabled to allow EPTZER to update.

- EPTBAR\_CH = Above this value, the EPT sensor is saturated, counts.

- EPTBAR\_SL = Below this value, the EPT sensor is not saturated, counts.

- EPTZER\_IV = Initial or default value for EPTZER and EPTBAR.

- EPTZER\_UPTOL = Tolerence on EPTZER required before it's value is said to

be good.

- FN246A(DELPR) = EGR mass flow as a function of DELPR, lb/min.

- FN247A(DESEM) = Desired pressure drop, DESDP, across the PFE orifice.

- IERPMH = Idle RPM hysteresis term for EPTZER update.

- IXFRPR = Transfer function = 1/XFREPT, Counts/" H2O.

- MINDES\_CL = The desired EGR mass, DESEM, below which the EGR is turned

off because the flow is too low to deliver accurately.

12-14

EGR STRATEGY, DELTA PRESSURE FEEDBACK EGR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- MINDES\_SH = The desired EGR mass, DESEM, above which the EGR is turned on

because the flow is high enough to deliver accurately.

- TCDELPR = Time constant for filtering DELPR, sec.

- TCDP = dp filter time constant.

- TCEPT = Time constant for EPT, sec.

- TCEPTZER = Time constant for filtering EPTZER, sec.

- TCEPTZER\_OFF = Time constant for engine off eptzer reading.

- XFREPT = Transfer function of EPT sensor, " H20/counts.

OTHER

- egr\_codes = Set of (P1400, P1401). The set of OBD-II fault codes that

relate to the EGR monitor.

- P1400 = Fault code for EVP/EPT circuit below minimum voltage.

- P1401 = Fault code for EVP/EPT circuit above maximum voltage.

12-15

EGR STRATEGY, DELTA PRESSURE FEEDBACK EGR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EGR\_PFE\_COM3

CHECK EPTZER UPDATE CONDITIONS AND UPDATE EPTZER

always ---------------------------------| EGR\_N\_FIL = ROLAV(N,TC\_EGR\_N)

| ;filter N for warm idle detection

CRKFLG = 0 -----------------------|

;not in crank mode |

|

APT = -1 -------------------------|

;closed throttle |

|

EGR\_N\_FIL < DSDRPM + IERPMH ------|AND -| WRM\_IDL\_FLG = 1

;filtered engine speed near idle | | ;warm idle conditions met

| |

EGREN\_TMR >= EGRENA\_TM - | |

EGR\_WRM\_TM -------------| | |

;EGR valve warm |OR --| |

| | |

CCM\_ER\_ENA = 1 -------------| | |

;in KOER | |

| |

EGR\_SHT\_TMR > EGR\_VLV\_SHT --------| |

;EGR valve is closed at idle |

| --- ELSE ---

|

| WRM\_IDL\_FLG = 0

| ;warm idle conditions not met

KAM\_ERROR = 1 --------------------|

;keep alive memory failure |

|

P1400FLT = 1 ---------------------|OR --| EPTZER = EPTZER\_IV

;EPT sensor failed low | | ;initialize to default value

| |

P1401FLT = 1 ---------------------| |

;EPT sensor failed high |

| --- ELSE ---

|

EVLOPNFM\_FLG = 1 -----------------------| EPTZER = EPTZER\_OFF

;EGR valve failed open | ;set to engine off reading

|

| --- ELSE ---

|

WRM\_IDL\_FLG = 1 ------------------------| EPTZER = ROLAV(IEGR,TCEPTZER)

;engine at warm idle | ;update closed valve reading

12-16

EGR STRATEGY, DELTA PRESSURE FEEDBACK EGR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TIME SINCE EPTZER UPDATE CALCULATION

EPTZER\_TMR2 is an actuated up-counting timer actuated by the condition:

WRM\_IDL\_FLG = 0. When WRM\_IDL\_FLG = 1, timer is held at it's current value.

EPTZER > EPTBAR - EPTZER\_UPTOL ---|

;EPTZER above min |

|

EPTZER < EPTBAR + EPTZER\_UPTOL ---|AND -| EPTZER\_TMR2 = 0

;EPTZER below min | | ;indicate short time since EPTZER

| | ;update

WRM\_IDL\_FLG = 1 ------------------|

;EPTZER update conditions met

ENGINE OFF EPTZER CALCULATION

KAM\_ERROR = 1 --------------------|

;keep alive memory failure |

|

P1400FLT = 1 ---------------------|OR --| EPTZER\_OFF = EPTZER\_IV

;EPT sensor failed low | | ;initialize to default value

| |

P1401FLT = 1 ---------------------| |

;EPT sensor failied high |

| --- ELSE ---

CRKFLG = 1 -----------------------| |

;in CRANK mode |AND -| EPTZER\_OFF =

| | ROLAV(IEGR,TCEPTZER\_OFF)

FIRST\_PIP = 0 --------------------| | ;engine off EPTZER update

;engine has not rotated

EGR PRESSURE CALCULATION

FIRST\_PIP = 0 --------------------|

;engine has not rotated |OR --| EPTBAR = ROLAV(IEGR,TCEPT)

| | ;get filtered valve position

CRKFLG = 0 -----------------------|

;not in crank mode

12-17

EGR STRATEGY, DELTA PRESSURE FEEDBACK EGR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EPT SENSOR SATURATION TEST

EPTBAR < EPTBAR\_SL ---------------|S Q -| EPT\_OK\_FLG

;EPT sensor is not saturated | | ;sensor not saturated flag

|

EPTBAR > EPTBAR\_CH ---------------|C

;EPT sensor is saturated

CHECK FOR GREATER THAN MINIMUM EGR REQUEST

DESEM >= MINDES\_SH ---------------|S Q -| DESEM\_FLG

;more than minimum requested |

|

DESEM < MINDES\_CL ----------------|C

EGR operation is disabled via EGR\_ON\_FLG if the desired EGR is too low.

EGR\_SHT\_TMR is an unconditionally up-counting timer to indicate how long EGR

has been disabled.

DESEM\_FLG = 1 --------------------|

;more than min EGR requested |

|

EGREN = 1 ------------------------|AND -| EGR\_ON\_FLG = 1

;EGR enabled | | ;OK to turn on EGR

| | EGR\_SHT\_TMR = 0

EPT\_OK\_FLG = 1 -------------------| | ;indicate EGR valve open

;EPT sensor is not saturated |

| --- ELSE ---

|

| EGR\_ON\_FLG = 0

| ;turn off EGR

DELTA PRESSURE DETERMINATION

unconditionally ------------------------| delpr = clip((XFREPT \*

| (EPTBAR - EPTZER)),

| DP\_MIN, DP\_MAX)

| ;calculate delta pressure and

| ;clip

| DELPR = ROLAV(-delpr, TCDELPR)

| ;filter delta pressure

12-18

EGR STRATEGY, DELTA PRESSURE FEEDBACK EGR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Now that delta pressure across the orifice is known, actual EGR mass flow can

be computed. The computed EGR mass flow rate is set to zero under known

closed valve conditions to prevent exhaust pulsations and sensor drift from

causing false readings.

Note that the equation for EGR mass is of the form:

dm/dt = K \* sqrt(delpr \* density)

where density = K2 \* pressure/temperature. Data show P/T to vary

proportional to barometric pressure. Hence,

dm/dt = sqrt(K3 \* delpr) \* (sqrt(BP/standard BP)).

FN246A is the sqrt(K3 \* x) function developed at standard pressure.

Desired pressure is calculated later in the strategy by solving for delpr in

the above equation:

delpr = ((dm/dt)\*\*2 \* (standard BP/BP)) / K3

FN247A is the (x\*\*2/K3) function developed at standard pressure.

EFMFLG = 1 -----------------------|

;EGR sensor failed |

|

EGR\_SHT\_TMR > EGR\_VLV\_SHT --------|OR --| EM = 0

;EGR valve is closed | | ;set EGR mass flow rate to zero

| |

DELPR <= 0 -----------------------| |

;negative delta pressure | --- ELSE ---

|

| em = FN246A(DELPR) \*

| SQRT(BP\_WORD / 29.875)

| ;calculate EGR mass flow rate

| EM = min(em,1.99)

| ;clip to max

Knowing the desired EGR mass flow through the valve, the desired pressure

drop across the orifice can be calculated.

EGR\_ON\_FLG = 1 -------------------------| desdel = clip((-FN247A(DESEM) \*

;ok to turn on EGR | 29.875 / BP),

| DP\_MIN, DP\_MAX)

| ;calculate desired delta pressure

|

| --- ELSE ---

|

| desdel = 0

| ;set desired delta pressure to 0

12-19

EGR STRATEGY, DELTA PRESSURE FEEDBACK EGR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Filter desired delta pressure and convert to counts.

always ---------------------------------| DESDP = ROLAV(desdel, TCDP)

| ;filter desired pressure

| CONPR = IXFRPR \* DESDP + EPTZER

| ;convert to counts

Calculate EGR\_ERROR

EGR\_ON\_FLG = 1 -------------------------| EGR\_ERROR = EPTBAR - CONPR

;ok to open EGR valve |

| --- ELSE ---

|

| EGR\_ERROR = 0

12-20

EGR STRATEGY, EVR CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

12.1.5 EVR CONTROLLER - (EGRDC CALCULATION) (CDAN0)

OVERVIEW

This module calculates EGR duty cycle using a combination of a second order

closed loop controller and an open loop feed forward prediction of the duty

cycle required to start to open the EGR valve.

DEFINITIONS

INPUTS

Registers:

- EGRDC = Desired EVR duty cycle, %/100.

- EGRDC1 = Last pass value of EGRDC.

- EGRDC2 = Last pass value of EGRDC1.

- EGR\_ERROR = Error in control chamber pressure in PFE systems and EGR

valve position in sonic systems, counts.

- EGR\_ERROR1 = Last pass value of EGR\_ERROR.

- EGR\_ERROR2 = Last pass value of EGR\_ERROR1.

- ER\_EGR\_FLG = Flag to indicate EGR KOER test is in progress

- SYS\_DELPR = EGR System delta pressure.

Bit Flags:

- EGR\_ON\_FLG = 1 -> EVR is being controlled, 0 -> no duty cycle output to

the EVR.

- EGRFLG = Flag that indicates whether EGR is in closed loop control.

- OSM\_EO\_OFF = Off state requested for OSM outputs during engine off

on-demand test.

- OSM\_EO\_ON = ON state requested for OSM outputs during engine off

on-demand test.

Calibration Constants:

- COEFDC = Coefficient used in EGR control algorithm, used to filter the

EGRDC calculation.

- COEFER1 = Coefficient used in EGR control algorithm. Its value is

determined through a control theory analysis.

- COEFER2 = Coefficient used in EGR control algorithm. Its value is

determined through a control theory analysis.

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EGR STRATEGY, EVR CONTROLLER - CDAN2

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- EGR\_TST\_DC = Minimum EGRDC for running of 1409 test.

- EGRDC\_MAX = Maximum clip for EGRDC, %/100.

- EGRGAIN = Coefficient used to set overall gain of the EGR control

algorithm.

- FN201(SYS\_DELPR) = EGR Valve Start to Open Duty Cycle vs SYS\_DELPR.

OUTPUTS

Registers:

- EGRDC = See above.

- EGRDC1 = See above.

- EGRDC2 = See above.

- EGR\_ERROR1 = See above.

- EGR\_ERROR2 = See above.

Bit Flags:

- EGRFLG = See above.

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EGR STRATEGY, EVR CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EGR\_CONTROL\_COM2

OSM\_EO\_ON = 1 -----------------| egrdc = 1

;OSM test commanding output | ;command maximum output

;on |

| --- ELSE ---

EGR\_ON\_FLG = 0 ----------| |

;DESEM below minimum |OR --| egrdc = 0

| | ;command minimum output

OSM\_EO\_OFF = 1 ----------| | EGRFLG = 0

;OSM test commanding | ;not in closed loop control

;output off | EGRDC1 = 0

| EGRDC2 = 0

| ;reset last pass values of duty cycle

|

| --- ELSE ---

|

EGRFLG = 0 --------------------| EGR\_ERROR1 = EGR\_ERROR

;initial entry into closed | EGR\_ERROR2 = EGR\_ERROR

;loop control | ;reset last pass values of error

| egrdc = clip(COEFDC \* EGRDC1 +

| (1 - COEFDC) \* EGRDC2 +

| EGRGAIN \* [EGR\_ERROR -

| (COEFER1 \* EGR\_ERROR1) +

| (COEFER2 \* EGR\_ERROR2)],

| -FN201(SYS\_DELPR),

| EGRDC\_MAX - FN201(SYS\_DELPR))

| ;calculate control effort

| EGRDC1 = egrdc

| ;save last pass value of duty cycle

| egrdc = egrdc + FN201(SYS\_DELPR)

| ;add in feed forward start to open

| ;duty cycle

| EGRFLG = 1

| ;in closed loop control

|

| --- ELSE ---

|

| egrdc = clip(COEFDC \* EGRDC1 +

| (1 - COEFDC) \* EGRDC2 +

| EGRGAIN \* [EGR\_ERROR -

| (COEFER1 \* EGR\_ERROR1) +

| (COEFER2 \* EGR\_ERROR2)],

| -FN201(SYS\_DELPR),

| EGRDC\_MAX - FN201(SYS\_DELPR))

| ;calculate control effort

| EGR\_ERROR2 = EGR\_ERROR1

| EGR\_ERROR1 = EGR\_ERROR

| ;last pass values of error

| EGRDC2 = EGRDC1

| EGRDC1 = egrdc

| ;last pass values of duty cycle

| egrdc = egrdc + FN201(SYS\_DELPR)

| ;add in feed forward start to open

| ;duty cycle

12-23

EGR STRATEGY, EVR CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ER\_EGR\_FLG = 1 ----------------| egrdc = max(egrdc,EGR\_TST\_DC)

;in KOER | ;clip to minimum

always ------------------------| Do: substitute(7,egrdc)

| ;output state control override

| EGRDC = egrdc

12-24

EGR STRATEGY, ACTUAL PERCENT EGR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

12.1.6 ACTUAL PERCENT EGR (CDAA0)

OVERVIEW

EGRACT is used to modify spark advance (see SAF calculation). To prevent

large instantaneous changes in calculated spark, EGRACT is filtered using the

rolling average filter routine.

DEFINITIONS

INPUTS

Registers:

- AM = Air mass flow bin 10.

- AMPEM = Air mass flow plus EGR mass flow, lb/min.

- EM = Actual EGR mass flow, lb/min.

Calibration Constants:

- TCEACT = Time constant for filtering EGRACT, sec.

OUTPUTS

Registers:

- EGRACT = Actual EGR percent = 100 \* EM / AMPEM.

PROCESS

STRATEGY MODULE: EGR\_ACTUAL\_COM1

Calculate AMPEM:

AMPEM = AM + EM

Calculate the actual EGR rate as a percent of AMPEM:

egract = (EM / AMPEM) \* 100

EGRACT = ROLAV(egract,TCEACT)

12-25

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

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12.1.7 EGR OBDII TEST LOGIC (CDAN0)

OVERVIEW

This strategy module contains the OBDII tests that are carried out during

normal engine operation and during on-demand testing on the delta PFE EGR

system. It sets up flags to light the MIL light and also disables EGR system

operation if necessary.

The tests in this monitor are run in a predefined sequence to prevent the

setting of multiple codes for a single failure. While some tests are run on

a "continuous" basis, no test is allowed to run until it's predecessors have

been run. If a failure occurs, previous tests are allowed to continue

running but subsequent tests are inhibited until the fault is cleared.

The following tests are run during various phases of the EGR monitor:

Code Description

---- -----------

P0401 Insufficient EGR flow

P0402 EGR valve stuck open

P1400 EPT sensor signal out of range low

P1401 EPT sensor signal out of range high

P1405 EPT upstream hose disconnected or plugged

P1406 EPT downstream hose disconnected or plugged

P1408 On-demand insufficient flow

P1409 Output driver fault

During normal engine operation the following test sequence is performed:

P1409 P1400 P1401

| | |

| -----|-----

| |

| P0402

| |

| -----------

| | |

| P1405 P1406

| | |

---------------------

|

P0401

After successful completion of the P0401 test the executive is flagged that

the EGR monitor has run to completion.

During engine off on-demand, the P1409, P1400, and P1401 tests run

simultaneously.

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

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During engine running on-demand, the tests run in the following order:

P1409 P1400 P1401

| | |

| -----|-----

| |

| P0402

| |

----------------

|

P1408

After successful completion of the P1408 test the OBDII executive is informed

that the EGR monitor on-demand test has run to completion, allowing

subsequent tests to run.

DEFINITIONS

Registers:

- ACT = Air Charge Temperature, deg. F.

- ACT\_EGR = Filtered ACT for use in EPT hose test.

- AIR\_CHG = Air charge value after the filling model.

- AIR\_CHG\_CUR = Air charge mass inducted per intake stroke corrected for

backflow and leakage.

- AM = Air Mass flow, bin 10.

- ARCH\_PROP\_D = The rate of change of air charge being inducted any

instant.

- BP = Barometric Pressure. (Note: Upper byte of BP\_WORD.)

- DELPR = Pressure drop across PFE orifice.

- DELPR\_FLW = Filtered DELPR during test for mode 06 reporting, in H2O.

- DELPR\_HOSE = Filtered DELPR during test for mode 06 reporting, in H2O.

- DEMAND\_TIMER = Utility timer for sequenced on demand tests.

- EGRACT = Actual EGR rate.

- EGRDC = EGR duty cycle.

- EGRDC\_FLW = Filtered EGRDC during test for mode 06 reporting.

- EGRENA\_TM = Time since start at which EGR is enabled, sec.

- EGREN\_TMR = EGR Enable timer.

- EGRMON\_TMR = EGR monitor timeout timer, sec.

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- EGR\_OFF\_TMR = Timer enabled when EGREN = 0.

- EGR\_RTST\_TMR = EGR no-flow test retest timer, sec.

- EPTBAR = Rolling average of EPT transducer

- EPTBAR\_OPN = Filtered EPTBAR during test for mode 06 reporting.

- EPTZER = EPT sensor value at idle.

- EPTZER\_OFF = EPTZER when engine is not running.

- EPTZER\_TMR2 = Timer to record time since EPTZER was last updated to a

correct value.

- ER\_RPM = Register that contains RPM value requested during engine running

self test, rpm.

- ER\_STATUS = State pointer that indicated current state of engine running

State pointer that indicated current state of engine running on demand

test on demand test, state.

- HOSE\_TST\_AMB = Value of INFAMB\_KAM at start of hose tests, deg. F.

- INF\_MVAC = Inferred Manifold Vacuum.

- MIN\_DELPR = Minimum allowed DELPR for a given SYS\_DELPR at high EGRDC.

- MIN\_DELPR\_FL = Filtered MIN\_delpr during test for mode 06 reporting, in

H2O.

- N = RPM.

- PEXHAUST = Exhaust Back Pressure, inches H2O.

- PxxxFLT\_TMR = Timer to indicate length of time fault xxx has been

present.

- PxxxTST\_TMR = Timer to determine length of time test xxx has been

running.

- SYS\_DELPR = EGR System delta pressure.

Bit Flags:

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled.

- CHK\_VPLG\_FLG = OK to check for EGR Valve Plugged, for EGR OBDII test.

- DEMAND\_ABORT = Flag indicating that an on demand test is in the progress

of a abort.

- DEMAND\_LAST = Last pass value of DEMAND\_MODE.

- DEMAND\_MODE = Flag set when an On-Demand self test mode is active.

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

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- EFMFLG = EGR FMEM flag.

- EGR\_EFM\_FLG = Flag to disable retry based failure mode.

- EGREN = EGR enabled flag.

- EGRFLG = FN201(SYS\_DELPR) already added to EGRDC if set.

- EGR\_HOSE\_TST = Flag to Enable EGR OBDII Hose Integrity checks.

- EGR\_MON = Monitor flag for EGR (sent to OBD-II exec); 1 -> all EGR faults

have been monitored at least once since power-up.

- EGRMON\_DN = Down count actuation flag for EGRMON\_TMR.

- EGRMON\_UP = Up count actuation flag for EGRMON\_TMR.

- EGR\_ON\_FLG = Flag to indicate more than minimum EGR requested.

- EGR\_RETRY = Second pass of EGR monitor flag.

- EGR\_TST\_ENA = EGR test enable flag; (sent by OBD-II exec); 1 -> test

enabled

- EGR\_TST\_LST = Last pass value of EGR\_MON.

- EGR\_TST\_RDY = EGR test ready flag; (sent to OBD-II exec.); 1 -> all local

condition have been met; ready to run EGR tests. Note: EGR tests are

allways ready to run (except in the case of an abort).

- EGR\_TST\_RNNG = EGR continuous monitor is in progress flag.

- ENG\_STDY\_FLG = Engine Steady for EGR OBDII tests.

- ER\_EGR\_FLG = EGR is in Engine Running On Demand mode flag.

- ER\_ISC\_REQ = Flag to request ER\_RPM from ISC system.

- EVLOPNFM\_FLG = EGR valve open failure mode flag.

- FFG\_EGR = OBDII system FMEM flag for the system; 1 -> EGR system not

currently operating reliably.

- FFG\_EGR\_LST = Last pass value of FFG\_EGR.

- HOSE\_TST\_CNT = Flag to force continuation of hose tests.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II scan tool

reset message.

- PxxxDN\_FLG = Flag to enable down counting of fault xxx fault timer.

- PxxxENA = Flag to enable counting up of fault xxx test timer.

- PxxxFLT = Indicates fault xxx is present.

- PxxxOLD = Last pass value of PxxxFLT.

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PxxxMALF = Malfunction flag for code Pxxx; 1 -> a malfunction currently

exists for fault Pxxx.

- PxxxUP\_FLG = Flag to enable up counting of fault xxx fault timer.

- VAC\_RNG\_FLG = OK Vac Range for EGR OBDII tests.

- WRM\_IDL\_FLG = Warm Idle Flag. Used for EGR.

Calibration Constants:

- BP\_EGRMON = Allow EGR monitor to complete below this BP, in/Hg.

- DELARCH\_EGR = Air Charge delta used in OBDII EGR test.

- DELPR\_ON\_DEM = Minimum DELPR allowed to pass OBDII on-demand test.

- DELPR\_THRES1 = Threshold on DELPR to check for downstream vacuum hose

off.

- DELPR\_THRES3 = Threshold on DELPR to check for upstream vacuum hose off.

- EGRACT\_MON = Minimum EGR\_RATE\_ACT for proper operation of EGR monitor,

percentage.

- EGR\_CLR\_RT = Fraction of EGR fault test time to consider a fault to have

cleared.

- EGR\_ER\_DONE = Value for state of ER\_STATUS to indicate engine running EGR

test is complete, pointer.

- EGR\_ER\_INIT = Value for state of ER\_STATUS to request engine running egr

test, pointer.

- EGR\_ER\_RPM = Engine running on-demand test requested engine speed.

- EGR\_FLT\_MAP = Bit mapped word used to selectively remap EGR fault codes

to the generic EGR fault code P0400.

- EGR\_FLT\_RT = Fraction of EGR fault test time to consider a fault to be

present.

- EGR\_HT\_AM\_MX = EGR OBDII Hose Test Air Mass Maximum, lb/min.

- EGR\_MIN\_AMB = Minimum ambient temp for reporting of EGR faults, deg. F.

- EGR\_MON\_ACTH = Allow EGR monitor to complete above this ACT, degrees F.

- EGR\_MON\_ACTL = Allow EGR monitor to complete below this ACT, degrees F.

- EGRMON\_TM = EGR monitor completion timeout time, seconds.

- EGR\_OBD\_NMAX = NMAX for EGR OBDII tests.

- EGR\_REP\_SW = Enables EGR fault retesting. 1 -> retest always, 2 ->

restest after first pass.

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- EGR\_RTST\_TM = EGR no-flow test retest time, sec.

- EGRTST\_TM = Time required to run OBDII EGR tests before EGR is enabled.

- EGR\_TWO\_TIME = Enables EGR monitor retest mode.

- EGR\_VLV\_OPN = Time taken for EGR Valve to open, worst case, for OBDII

tests, seconds.

- EGR\_VLV\_SHT = Time taken for the EGR Valve to shut under worst case

conditions, for OBDII EGR Hose tests.

- EGR\_WRM\_TM = Time before EGR is first enabled to allow EPTZER to update,

sec.

- EPTMAX = Maximum EPT reading (open), counts.

- EPTMIN = Minimum EPT reading (short), counts.

- EPT\_VOPN\_IDL = EPT change to indicate EGR valve stuck open at idle.

- EPTZER\_VALID = Max time since EPTZER update for valid EPTZER value.

- FN004 = BP correction for exhaust backpressure calculation, "Hg.

- FN074B(AM) = Upstream pressure as a function of AM; Used in calculating

exhaust pressure, " H2O.

- FN202(SYS\_DELPR) = Minimum DELPR at high EGRDC.

- MAX\_MVAC = Maximum Manifold Vacuum for EGR OBDII tests.

- MIN\_MVAC = Minimum Manifold Vacuum for EGR OBDII tests.

- PE\_OBD\_THRES = Exhaust Backpressure Threshold for OBDII EGR tests, " H20.

- PxxxTST\_TM = Duration of test Pxxx.

- TC\_DELPR\_M6 = Time constanst for DELPR for mode 06 reporting, sec.

- TC\_EGRDC\_M6 = Time constant for EGRDC for mode 06 reporting, sec.

- TC\_EPTBAR\_M6 = Time constanst for EPTBAR for mode 06 reporting, sec.

- TC\_HOSE\_M6 = Tome constant for DELPR for mode 06 reporting, sec.

- TC\_M\_DEL\_M6 = Time constant for MIN\_DELPR for mode 06 reporting, sec.

- TCSYS\_DELPR = Filter time constant for SYS\_DELPR.

- V\_EGRDC\_MAX = Minimum EVR duty cycle for running insufficient flow test.

OTHER

- egr\_codes = Set of (P0400, P0401, P0402, P1400, P1401, P1405, P1406,

P1408, P1409). The set of OBD-II fault codes that relate to the EGR

monitor.

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

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- malfunction(egr,Pxxx)= Public procedure updating the MIL control status

provided by the MIL control module.

- P0400 = Fault code for EGR system malfunction.

- P0401 = Fault code for insufficient EGR flow.

- P0402 = Fault code for EGR Valve stuck open.

- P1400 = Fault code for EVP/EPT circuit below minimum voltage.

- P1401 = Fault code for EVP/EPT circuit above maximum voltage.

- P1405 = Fault code for DPFE Upstream hose off.

- P1406 = Fault code for DPFE Downstream hose off.

- P1408 = Fault code for insufficient EGR flow.

- P1409 = Fault for driver failure.

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

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PROCESS

STRATEGY MODULE: EGR\_OBDII\_COM1

OBD-II EXECUTIVE INTERFACE

PFEHP = 1 -------------------|

;EGR enabled |

|

EGREN\_TMR >= EGRENA\_TM - |AND -| EGR\_TST\_RDY = 1

EGR\_WRM\_TM ----| | | ;monitor ready

;EGR system warm | | |

;enough to test | | |

|OR --| |

CCM\_ER\_ENA = 1 --------| |

;KOER in progress | |

| |

CCM\_EO\_ENA = 1 --------| |

;KOEO in progress |

| --- ELSE ---

|

| EGR\_TST\_RDY = 0

EGR\_TST\_RDY = 1 -------------|

;monitor enabled |

|

EGR\_TST\_ENA = 1 -------| |AND -| EGR\_TST\_RNNG = 1

;enabled by exec | | | ;enable monitor

| | |

CCM\_ER\_ENA = 1 --------|OR --| |

;KOER in progress | |

| |

CCM\_EO\_ENA = 1 --------| |

;KOEO in progress |

| --- ELSE ---

|

| EGR\_TST\_RNNG = 0

| ;disable monitor

MONITOR RESET CONDITIONS

OBDII\_RESET = 1 -------------|

;reset command issued |OR --| Do: egr\_clear\_timers

| | ;reset monitor

DEMAND\_MODE <> DEMAND\_LAST --|

;going into or out of

;demand mode

12-33

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

To prevent the setting of false codes and activation of the MIL light, it is

necessary for a fault condition to be present for a calibrated period of time

before the code is set. Two timers are used for each test to perform this

function. The first timer is used to indicate the amount of time spent in

the test for determination of test completion. This timer is named

PxxxTST\_TMR, where xxx is the fault code being tested. This timer operation

is controlled through the flag PxxxENA according to the following logic:

PxxxTST\_TMR

PxxxENA Operation

-------- -----------

0 freeze

1 count up

The second timer is used to indicate the amount of time the fault conditions

are present during the test. This timer is named PxxxFLT\_TMR and is

contolled by the flags PxxxUP\_FLG and PxxxDN\_FLG according to the following

logic:

PxxxFLT\_TMR

PxxxUP\_FLG PxxxDN\_FLG Operation

----------- ----------- ------------

0 0 freeze

0 1 count down

1 0 count up

EPT OUT OF RANGE LOW TEST

EGR\_TST\_RNNG = 0 ------------------| Do: egr\_test\_disabled(P1400)

;monitor not enabled |

| --- ELSE ---

|

EPTBAR < EPTMIN -------------------| Do: egr\_fault\_detected(P1400)

;low sensor reading |

| --- ELSE ---

|

| Do: egr\_no\_fault(P1400)

EPT OUT OF RANGE HIGH TEST

EGR\_TST\_RNNG = 0 ------------------| Do: egr\_test\_disabled(P1401)

;monitor not enabled |

| --- ELSE ---

|

EPTBAR > EPTMAX -------------------| Do: egr\_fault\_detected(P1401)

;EPT voltage high |

| --- ELSE ---

|

| Do: egr\_no\_fault(P1401)

12-34

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

STUCK OPEN VALVE TEST

Check for EPTBAR being high at idle, indicating a stuck open valve.

P1400TST\_TMR <= P1400TST\_TM -|

;sensor failed low test |

;not complete |

|

P1401TST\_TMR <= P1401TST\_TM -|

;sensor failed high test |

;not complete |

|

P1400FLT = 1 ----------------|

;sensor failed low |

|

P1401FLT = 1 ----------------|

;sensor failed high |

|OR --| Do: egr\_test\_disabled(P0402)

P1409FLT = 1 ----------------| |

;EVR driver failed | |

| |

EGR\_TST\_RNNG = 0 ------------| |

;monitor not in progress | |

| |

WRM\_IDL\_FLG = 0 -------------| |

;not in warm idle state | |

| |

CCM\_EO\_ENA = 1 --------------| |

;in KOEO |

| --- ELSE ---

|

EPTBAR > EPTZER\_OFF + |

EPT\_VOPN\_IDL ---------| Do: egr\_fault\_detected(P0402)

;valve position above engine off | EPTBAR\_OPN = ROLAV(EPTBAR,TC\_EPTBAR\_M6)

;value + tolerance | ;filter EPTBAR for mode 06 reporting

|

| --- ELSE ---

|

| Do: egr\_no\_fault(P0402)

| EPTBAR\_OPN = ROLAV(EPTBAR,TC\_EPTBAR\_M6)

| ;filter EPTBAR for mode 06 reporting

always ----------------------------| EPT\_OPN\_MAX = EPTZER\_OFF + EPT\_VOPN\_IDL

| ;store failure condition for mode 06

12-35

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DPFE HOSE DISCONNECTION CHECK ENABLE

This test is run when the EGR valve is closed. When the EGR valve is closed,

the EPT pressure should approach zero (i.e. EPTBAR should approach EPTZER).

NOTES:

1 - This test is intrusive if EGR is enabled. It will attempt to run before

EGR is enabled, however, in which case it is non-intrusive.

2 - Test is disabled if complete and no fault was detected. If a fault was

detected, the test will continue to run non-intrusively. This is to allow

clearing of the fault in case of ice melting in the EPT lines, etc.

3 - Test is forced to continue if an insufficient EGR flow (0401) is detected

and the ambient temperature at the start of the tests is low. This is to aid

in recovery from a condition where both EPT hoses are frozen. If one hose

thaws before the other, it will be detected as a plugged or disconnected hose

(1405 or 1406). Presence of a 1405 or 1406 when an 0401 is present indicates

to the software that a frozen hose condition is present. Testing is started

from the beginning if this condition occurs.

P0401FLT = 1 ----------|

;insufficient EGR flow|

|AND -|

HOSE\_TST\_AMB < | |

EGR\_MIN\_AMB --| |

;coolant temp at start of |

;hose tests low |

|

P1405TST\_TMR <= P1405TST\_TM -|

;upstream hose test not |

;complete |OR --| HOSE\_TST\_CNT = 1

| | ;continue running hose tests

P1406TST\_TMR <= P1406TST\_TM -| |

;downstream hose test not | |

;complete | |

| |

P1405FLT = 1 ----------------| |

;upstream hose fault | |

| |

P1406FLT = 1 ----------------| |

;downstream hose fault |

| --- ELSE ---

|

| HOSE\_TST\_CNT = 0

| ;do not force hose test continuation

always ----------------------------| PEXHAUST = FN074B(AM) \*

| 29.875 / FN004(BP)

| ;calculate inferred exh. pressure

| ;corrected for barometric pressure

12-36

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HOSE\_TST\_CNT = 0 ------------|

;hose tests not forced on |

|

P0402TST\_TMR <= P0402TST\_TM -|

;stuck open test not done |

|

P1400FLT = 1 ----------------|

;EPT sensor failed low |

|

P1401FLT = 1 ----------------|

;EPT sensor failed high |

|

P0402FLT = 1 ----------------|

;EGR valve stuck open |

|

P1409FLT = 1 ----------------|

;EVR driver failed |

|

EGR\_TST\_RNNG = 0 ------------|OR --| EGR\_HOSE\_TST := 0

;monitor not enabled | | ;Do not request Hose Test

| |

PEXHAUST < PE\_OBD\_THRES -----| |

;exhaust pressure too low | |

| |

EPTZER\_TMR2 > EPTZER\_VALID --| |

;too long since valid valve | |

;closed position update | |

| |

EGREN\_TMR < EGRENA\_TM | |

- EGRTST\_TM ---------| |

;long enough time since | |

;start for valid test - | |

;try to run before EGR | |

;enabled if possible | |

| |

CCM\_ER\_ENA = 1 --------------| |

;in KOER | |

| |

CCM\_EO\_ENA = 1 --------------| |

;in KOEO | |

| |

AM > EGR\_HT\_AM\_MX -----------| |

;Air mass flow rate too |

;high for test due to |

;intake pulsations |

| --- ELSE ---

|

| EGR\_HOSE\_TST := 1

| ;Request Hose Test.

| DELPR\_HOSE = ROLAV(DELPR,TC\_HOSE\_M6)

| ;filter DELPR for mode 06 reporting

12-37

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P1405TST\_TMR = 0 ------------|

;hose tests not started |AND -| HOSE\_TST\_AMB = INFAMB\_KAM

| | ;ambient temp at start of hose tests

EGR\_HOSE\_TST = 1 ------------|

;hose tests requested

EGREN = 1 -------------------------| EGR\_OFF\_TMR = 0

;EGR enabled | ;restart time since valve closed

UPSTREAM EPT HOSE DISCONNECTED TEST

EGR\_HOSE\_TST = 0 ------------|

;hose test not enabled |OR --| Do: egr\_test\_disabled(P1405)

| |

EGR\_OFF\_TMR < EGR\_VLV\_SHT ---| |

;valve not closed long enough |

| --- ELSE ---

|

DELPR <= DELPR\_THRES3 -------------| Do: egr\_fault\_detected(P1405)

;large negative delta pressure |

| --- ELSE ---

|

| Do: egr\_no\_fault(P1405)

DOWNSTREAM EPT HOSE DISCONNECTED TEST

EGR\_HOSE\_TST = 0 ------------|

;hose test not enabled |OR --| Do: egr\_test\_disabled(P1406)

| |

EGR\_OFF\_TMR < EGR\_VLV\_SHT ---| |

;valve not closed long enough |

| --- ELSE ---

|

DELPR > DELPR\_THRES1 --------------| Do: egr\_fault\_detected(P1406)

;high delta pressure |

| --- ELSE ---

|

| Do: egr\_no\_fault(P1406)

12-38

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MANIFOLD VACUUM RANGE CHECK

INF\_MVAC > MIN\_MVAC ---------|

|AND -| VAC\_RNG\_FLG = 1

INF\_MVAC < MAX\_MVAC ---------| | ;vacuum in range

;vacuum within allowable range |

| --- ELSE ---

|

| VAC\_RNG\_FLG = 0

RATE OF CHANGE IN AIR CHARGE

always ----------------------------| ARCH\_PROP\_D = Abs(AIR\_CHG\_CUR -

| AIR\_CHG)/AIR\_CHG

STEADY ENGINE CHECK

ARCH\_PROP\_D < DELARCH\_EGR ---|

;steady engine load |AND -| ENG\_STDY\_FLG = 1

| | ;engine steady

N < EGR\_OBD\_NMAX ------------| |

;rpm below max |

| --- ELSE ---

|

| ENG\_STDY\_FLG = 0

12-39

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

INSUFFICIENT EGR FLOW TEST

The following test first infers the pressure difference between the inlet

manifold and the exhaust back pressure (SYS\_DELPR). This is used to

determine a minimum allowed EGR delta pressure during high EGR.

The test is performed when EGRDC is above a minimum value and a comparison is

made between actual DELPR (EPT delta pressure) and the expected DELPR for the

current SYS\_DELPR and a calibrated EGR valve duty cycle. Should the actual

DELPR be less than the estimated DELPR for the limiting duty cycle, as

calibrated, then a fault exists.

always ----------------------------| SYS\_DELPR = ROLAV(INF\_MVAC +

| PEXHAUST/13.6,TCSYS\_DELPR)

| ;exhaust - intake pressure

VAC\_RNG\_FLG = 1 -------------|

;vacuum in range |AND -| CHK\_VPLG\_FLG = 1

| | ;valve plugged test running

ENG\_STDY\_FLG = 1 ------------| | MIN\_DELPR = FN202(SYS\_DELPR)

;engine is steady | ;minimum delta pressure for SYS\_DELPR

|

| --- ELSE ---

|

| CHK\_VPLG\_FLG = 0

| ;valve plugged test not running

12-40

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P1405TST\_TMR <= P1405TST\_TM -|

;upstream hose test not |

;complete |

|

P1406TST\_TMR <= P1406TST\_TM -|

;downstream hose test not |

;complete |

|

P1409TST\_TMR <= P1409TST\_TM -|

;drive test not complete |

|

P1400FLT = 1 ----------------|

;sensor failed low |

|

P1401FLT = 1 ----------------|

;sensor failed high |

|

P1405FLT = 1 ----------------|

;upstream hose off |

|

P1406FLT = 1 ----------------|

;downstream hose off |OR --| Do: egr\_test\_disabled(P0401)

| |

P0402FLT = 1 ----------------| |

;EGR valve stuck open | |

| |

P1409FLT = 1 ----------------| |

;EVR driver failed | |

| |

P0401FLT = 1 ----------------| |

;test has failed | |

| |

EGR\_TST\_RNNG = 0 ------------| |

;test not in progress | |

| |

CHK\_VPLG\_FLG = 0 ------------| |

;valve plugged test not in |

;progress |

| --- ELSE ---

DELPR < MIN\_DELPR -----------| |

;delta pressure below min |AND -| Do: egr\_fault\_detected(P0401)

| | EGRDC\_FLW = ROLAV(EGRDC,TC\_EGRDC\_M6)

EGRDC > V\_EGRDC\_MAX ---------| | ;filter EGRDC for mode 06

;high duty cycle | DELPR\_FLW = ROLAV(DELPR,TC\_DELPR\_M6)

| ;filter DELPR for mode 06

| MIN\_DELPR\_FL = ROLAV(MIN\_DELPR,

| TC\_M\_DEL\_M6)

| ;filter MIN\_DELPR for mode 06

|

| --- ELSE ---

(continued on next page)

12-41

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

DELPR > MIN\_DELPR -----------------| Do: egr\_no\_fault(P0401)

| EGRDC\_FLW = ROLAV(EGRDC,TC\_EGRDC\_M6)

| ;filter EGRDC for mode 06

| DELPR\_FLW = ROLAV(DELPR,TC\_DELPR\_M6)

| ;filter DELPR for mode 06

| MIN\_DELPR\_FL = ROLAV(MIN\_DELPR,

| TC\_M\_DEL\_M6)

| ;filter MIN\_DELPR for mode 06

|

| --- ELSE ---

|

| P0401ENA = 0

| P0401UP\_FLG = 0

| P0401DN\_FLG = 0

| ;stop test and fault timers

12-42

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE RUNNING ON DEMAND - INSUFFICIENT FLOW TEST

The following logic commands the engine speed and EGR flow to desired

values for operation of the P1409 and P1408 tests. Note that the P1409 test

must run to completion prior to operation of the P1408 test.

ER\_STATUS = EGR\_ER\_INIT -----|

;EGR on demand test |

;requested |

|

ER\_EGR\_FLG = 0 --------------|AND -| ER\_ISC\_REQ = 1

;not running last pass | | ;command engine speed

| | ER\_RPM = EGR\_ER\_RPM

P0402TST\_TMR > P0402TST\_TM --| | ;set commanded engine speed

;stuck open valve | ER\_EGR\_FLG = 1

;test complete | ;command EGR action

| DEMAND\_TIMER = 0

| ;reset time since test started

|

| --- ELSE ---

ER\_STATUS = EGR\_ER\_INIT -----| |

;EGR on demand test | |

;requested | |

| |

EGR\_TST\_RNNG = 0 ------| | |

;monitor disabled | | |

| | |

P1408TST\_TMR > | | |

P1408TST\_TM ---------| | |

;EGR KOER test done | |AND -| ER\_ISC\_REQ = 0

| | | ;stop commanding engine speed

P0402FLT = 1 ----------| | | ER\_EGR\_FLG = 0

;stuck open test done | | | ;stop commanding EGR

| | | ER\_STATUS = EGR\_ER\_DONE

P1400FLT = 1 ----------| | | ;indicate EGR on-demand test complete

;low voltage test |OR --|

;complete |

|

P1401FLT = 1 ----------|

;high voltage test |

;complete |

|

P1409FLT = 1 ----------|

;driver test complete |

|

DEMAND\_ABORT = 1 ------|

;KOER aborted

12-43

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P1409TST\_TMR <= P1409TST\_TM -|

;EVR driver test not |

;complete |

|

P0402TST\_TMR <= P0402TST\_TM -|

;valve stuck open test not |

;complete |

|

P1400FLT = 1 ----------------|

;sensor failed low |

|

P1401FLT = 1 ----------------|

;sensor failed high |

|

P0402FLT = 1 ----------------|OR --| Do: egr\_test\_disabled(P1408)

;EGR valve stuck open | |

| |

P1409FLT = 1 ----------------| |

;EVR driver failed | |

| |

EPTZER\_TMR2 > EPTZER\_VALID --| |

;too long since zero | |

;flow pressure update | |

| |

EGR\_TST\_RNNG = 0 ------------| |

;monitor disabled | |

| |

ER\_EGR\_FLG = 0 --------------| |

;Not in ER EGR demand mode | |

| |

DEMAND\_TIMER < EGR\_VLV\_OPN --| |

;Not on for sufficient time |

;for valve to open |

| --- ELSE ---

|

DELPR < DELPR\_ON\_DEM --------------| Do: egr\_fault\_detected(P1408)

;DELPR indicates low/no flow |

| --- ELSE ---

|

| Do: egr\_no\_fault(P1408)

12-44

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TEST COMPLETION LOGIC

Monitor has run to completion if all continuous monitor filters have exceeded

their respective levels. Completion is also flagged if the monitor is unable

to run for an excessive amount of time due to high altitude or extreme air

charge temperatures.

ACT < EGR\_MON\_ACTL ---------|

;low ACT |

|

ACT > EGR\_MON\_ACTH ---------|OR --|

;high ACT | |

| |

BP < BP\_EGRMON -------------| |

;low barometric pressure |

|

EGRACT < EGRACT\_MON --------------|AND -| EGRMON\_UP = 1

;low EGR flow | | EGRMON\_DN = 0

| | ;count up EGRMON\_TMR

EGREN = 1 ------------------------| |

;egr system enabled | |

| |

P0401TST\_TMR = 0 -----------------| |

;insufficient flow test not |

;running |

| --- ELSE ---

ACT >= EGR\_MON\_ACTL --------| |

;ACT not too low | |

| |

ACT <= EGR\_MON\_ACTH --------|AND -| |

;ACT not too high | | |

| | |

BP >= BP\_EGRMON ------------| | |

;not at high altitude |OR --| EGRMON\_UP = 0

| | EGRMON\_DN = 1

EGRACT >= EGRACT\_MON -------------| | ;count down EGRMON\_TMR

;high EGR flow | |

| |

P0401TST\_TMR > 0 -----------------| |

;insufficient flow test is in |

;progress |

| --- ELSE ---

|

| EGRMON\_UP = 0

| EGRMON\_DN = 0

| ;freeze EGRMON\_TMR

P1405TST\_TMR <= P1405TST\_TM ------------| EGRMON\_TMR = 0

;hose test is not complete | ;reset timer

12-45

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P0401TST\_TMR >

P0401TST\_TM ----------|

|

P0402TST\_TMR > |

P0402TST\_TM ----------|

|

P1400TST\_TMR > |

P1400TST\_TM ----------|

|

P1401TST\_TMR > |

P1401TST\_TM ----------|

|AND -|

P1405TST\_TMR > | |

P1405TST\_TM ----------| |

| |

P1406TST\_TMR > | |

P1406TST\_TM ----------| |

| |OR --| EGR\_MON = 1

P1409TST\_TMR > | | | ;EGR OBDII monitor has run to

P1409TST\_TM ----------| | | ;completion

| |

EGRMON\_TMR > | |

EGRMON\_TM ------------------| |

;timer counted up |

| --- ELSE ---

|

OBDII\_RESET = 1 ------------------------| EGR\_MON = 0

;reset in progress | ;reset to initial state

12-46

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OBDII EGR FAILURE MODE FLAG

All OBDII testing affected by EGR is disabled if FFG\_EGR is set.

P0401FLT = 1 ---------------------|

;EGR valve plugged |

|

P0402FLT = 1 ---------------------|

;EGR valve stuck open |

|

P1400FLT = 1 ---------------------|

;EPT sensor failed low |

|

P1401FLT = 1 ---------------------|OR --| FFG\_EGR = 1

;EPT sensor failed high | | ;EGR OBDII failure present

| |

P1405FLT = 1 ---------------------| |

;EPT upstream hose failure | |

| |

P1406FLT = 1 ---------------------| |

;EPT downstream hose failure | |

| |

P1409FLT = 1 ---------------------| |

;EVR driver failed |

| --- ELSE ---

|

| FFG\_EGR = 0

12-47

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FROZEN HOSE RECOVERY AND FAULT RETEST LOGIC

If a fault is detected during the first pass through the EGR monitor, all

tests are restarted from the beginning to verify the fault. This is done to

avoid setting the wrong code if the test was run out of sequence.

If the upstream or downstream hose tests (1405 or 1406) go from a failed to a

passing state and the ACT at the start of the tests was low, ice is assumed

to have melted in one of the hoses and the tests are restarted from the

beginning.

If an insufficient flow failure is present during a low temperature

condition, the tests are restarted after a time delay. This has the effect

of turning on the EGR system to test 0401 over after all other tests have

completed. This could result in poor driveability if the fault is still

present, as the failure mode effect of ice in both EPT hoses is a fully

opened valve. The system is not turned on again, however, until the

individual hose tests (1405 and 1406) have run to completion.

If an insufficient flow failure is present and an upstream or downstream hose

failure becomes active, the ice in a single hose is assumed to have melted

and the testing is restarted from the beginning. Note that this condition

can only become true if the ACT at the start of the hose tests was low.

If the insufficient EGR flow code (0401) changes from a failed state to a

passing state, it is possible that a single hose has melted subsequent to

both EPT hoses containing ice. Because the no-flow test is not reliable when

one hose is plugged, it is necessary under these conditions to start testing

over from the beginning of the hose tests. This condition can only occur if

the ice melts after the 1405 and 1406 tests are complete but before the 0401

test begins.

P0401FLT = 0 ----------------------| EGR\_RTST\_TMR = 0

;insufficient flow failure | ;reset retest timer

;not present

EGR\_MON = 1 -----------------|

;monitor complete |

|

FFG\_EGR = 1 -----------------|OR --| EGR\_EFM\_FLG = 1

;a fault has been detected | | ;first pass complete

|

EGR\_REP\_SW <> 2--------------|

;retest only after first

;pass complete

12-48

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P1405FLT = 0 ----|

;upstream test |

;not failed |AND -|

| |

P1405OLD = 1 ----| |

;failed last pass |

|

P1406FLT = 0 ----| |

;downstream test| |

;not failed |AND -|OR --|

| | |

P1406OLD = 1 ----| | |

;failed last pass | |AND -|

| | |

EGR\_RTST\_TMR > | | |

EGR\_RTST\_TM ------| | |

;time to retest | |

| |

HOSE\_TST\_AMB < EGR\_MIN\_AMB --| |

;ambient temp at start of |

;hose tests low |

|

P0401FLT = 1 ----------------| |

;insufficient flow | |

|AND -|OR --| Do: egr\_clear\_timers

P1405FLT = 1 ----------| | | | ;reset monitor

;upstream hose | | | | EGR\_RETRY = 1

;failure |OR --| | | ;keep EGR system off

| | | FFG\_EGR = 0

P1406FLT = 1 ----------| | | ;reset failure flag

;downstream hose failure |

|

FFG\_EGR = 1 -----------------| |

;a fault has been detected | |

| |

EGR\_RETRY = 0 ---------------|AND -|

;on first pass |

|

EGR\_REP\_SW <> 0 -------------|

;fault verification enabled

FFG\_EGR = 0 ----------------------|

;no faults detected |

|

FFG\_EGR\_LST = 1 ------------| |

;fault present last pass | |

|OR --|

EGR\_MON = 1 ----------| | |AND -| EGR\_RETRY = 0

;monitor is complete |AND -| | | ;reset to first pass

| |

EGR\_TST\_LST = 0 ------| |

;monitor not complete |

;last pass |

|

EGR\_RETRY = 1 --------------------|

;on second pass

12-49

EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGR FAILURE MODE FLAG

EGR strategy disabled if EFMFLG is set

P0401FLT = 1 ---------------------|

;Insufficient flow failure |

|

P1400FLT = 1 ---------------------|

;EPT sensor failed low |

|

P1401FLT = 1 ---------------------|

;EPT sensor failed high |

|OR --| EFMFLG = 1

P1405FLT = 1 ---------------------| | ;disable EGR strategy

;EPT upstream hose failure | |

| |

P1406FLT = 1 ---------------------| |

;EPT downstream hose failure | |

| |

EGR\_RETRY = 1 --------------| | |

;on second pass | | |

| | |

P1405TST\_TMR <= | | |

P1405TST\_TM -------------|AND -| |

;hose reversal test | |

;not complete | |

| |

EGR\_EFM\_FLG = 1 ------------| |

;EFM not inhibited on |

;first pass |

| --- ELSE ---

|

| EFMFLG = 0

EGR VALVE STUCK OPEN FAILURE MODE FLAG

EGR valve closed position learning disabled if EVLOPNFM\_FLG set

P0402FLT = 1 ------------------------| EVLOPNFM\_FLG = 1

;EGR valve stuck open | ;disable EPTZER learning

|

| --- ELSE ---

|

| EVLOPNFM\_FLG = 0

| ;EPTZER learning not disabled

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

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OBDII EXECUTIVE CODE AND MIL CONTROL INTERFACE

The mapping of EGR system faults to fault codes is controlled by the

calibration word EGR\_FLT\_MAP. This is a bit-mapped word with the following

mapping:

BIT CAL VALUE STRATEGY NAME CODE

--- --------- ------------- ----

0 1 p0401bit P0401

1 2 p0402bit P0402

2 4 p1400bit P1400

3 8 p1401bit P1401

5 32 p1405bit P1405

6 64 p1406bit P1406

7 128 p1408bit P1408

8 256 p1409bit P1409

HOSE\_TST\_AMB >= EGR\_MIN\_AMB --|

;high enough ambient temp |

|AND -| Do: malfunction(egr,P0401)

P0401FLT = 1 -----------------| | EGR\_MON = 1

| | ;test complete

p0401bit = 0 -----------------| |

| --- ELSE ---

|

P0401MALF = 1 ----------------------| Do: clear\_malf(P0401)

INFAMB\_KAM >= EGR\_MIN\_AMB ----|

;high enough ambient temp |

|AND -| Do: malfunction(egr,P0402)

P0402FLT = 1 -----------------| | EGR\_MON = 1

| | ;test complete

p0402bit = 0 -----------------| |

| --- ELSE ---

|

P0402MALF = 1 ----------------------| Do: clear\_malf(P0402)

INFAMB\_KAM >= EGR\_MIN\_AMB ----|

;high enough ambient temp |

|AND -| Do: malfunction(egr,P1400)

P1400FLT = 1 -----------------| | EGR\_MON = 1

| | ;test complete

p1400bit = 0 -----------------| |

|

|

| --- ELSE ---

|

P1400MALF = 1 ----------------------| Do: clear\_malf(P1400)

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

INFAMB\_KAM >= EGR\_MIN\_AMB ----|

;high enough ambient temp |

|AND -| Do: malfunction(egr,P1401)

P1401FLT = 1 -----------------| | EGR\_MON = 1

| | ;test complete

p1401bit = 0 -----------------| |

| --- ELSE ---

|

P1401MALF = 1 ----------------------| Do: clear\_malf(P1401)

HOSE\_TST\_AMB >= EGR\_MIN\_AMB --|

;high enough temp |

|AND -| Do: malfunction(egr,P1405)

P1405FLT = 1 -----------------| | EGR\_MON = 1

| | ;test complete

p1405bit = 0 -----------------| |

| --- ELSE ---

|

P1405MALF = 1 ----------------------| Do: clear\_malf(P1405)

HOSE\_TST\_AMB >= EGR\_MIN\_AMB --|

;high enough temp |

|AND -| Do: malfunction(egr,P1406)

P1406FLT = 1 -----------------| | EGR\_MON = 1

| | ;test complete

p1406bit = 0 -----------------| |

| --- ELSE ---

|

P1406MALF = 1 ----------------------| Do: clear\_malf(P1406)

P1408FLT = 1 -----------------|

|AND -| Do: store\_code(egr,P1408)

p1408bit = 0 -----------------| |

| --- ELSE ---

|

P1408MALF = 1 ----------------------| Do: clear\_malf(P1408)

INFAMB\_KAM >= EGR\_MIN\_AMB ----|

;high enough ambient temp |

|AND -| Do: malfunction(egr,P1409)

P1409FLT = 1 -----------------| | EGR\_MON = 1

| | ;test complete

p1409bit = 0 -----------------| |

| --- ELSE ---

|

P1409MALF = 1 ----------------------| Do: clear\_malf(P1409)

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HOSE\_TST\_AMB >=

EGR\_MIN\_AMB ---------|

|

p0401bit = 1 -----------|AND -|

| |

P0401FLT = 1 -----------| |

|

INFAMB\_KAM >= |

EGR\_MIN\_AMB ---------| |

;high enough ACT | |

|AND -|

p0402bit = 1 -----------| |

| |

P0402FLT = 1 -----------| |

|

INFAMB\_KAM >= |

EGR\_MIN\_AMB ---------| |

;high enough ACT | |

|AND -|

p1400bit = 1 -----------| |

| |

P1400FLT = 1 -----------| |

|

INFAMB\_KAM >= |

EGR\_MIN\_AMB ---------| |

;high enough ACT | |

|AND -|

p1401bit = 1 -----------| |

| |

P1401FLT = 1 -----------| |

|

HOSE\_TST\_AMB >= |

EGR\_MIN\_AMB ---------| |

| |

p1405bit = 1 -----------|AND -|

| |OR --| Do: malfunction(egr,P0400)

P1405FLT = 1 -----------| | | ;indicate EGR system failure

| | EGR\_MON = 1

HOSE\_TST\_AMB >= | | ;indicate monitor completion

EGR\_MIN\_AMB ---------| | |

| | |

p1406bit = 1 -----------|AND -| |

| | |

P1406FLT = 1 -----------| | |

| |

p1408bit = 1 -----------| | |

|AND -| |

P1408FLT = 1 -----------| | |

| |

INFAMB\_KAM >= | |

EGR\_MIN\_AMB ---------| | |

| | |

p1409bit = 1 -----------|AND -| |

| |

P1409FLT = 1 -----------| |

| --- ELSE ---

|

P0400MALF = 1 ----------------------| Do: clear\_malf(P0400)

;EGR malfunction flag set ;clear EGR malfunction flag

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

LAST PASS VALUE STORAGE

always ----------------------------| P1405OLD = P1405FLT

| P1406OLD = P1406FLT

| P0401OLD = P0401FLT

| ;last pass values of PxxxFLT

| DEMAND\_LAST = DEMAND\_MODE

| ;last pass value of demand mode

| FFG\_EGR\_LST = FFG\_EGR

| ;last pass value of fault flag

| EGR\_TST\_LST = EGR\_MON

| ;laast pass value of monitor

| ;completion flag

BEGIN: egr\_test\_disabled(cxxxx)

This is a global subroutine used to control the fault timers and flags for

the EGR OBDII strategy when the test is disabled.

always ----------------------------| cxxxxENA = 0

| ;stop test timer

| cxxxxUP\_FLG = 0

| cxxxxDN\_FLG = 0

| ;stop fault timer

cxxxxTST\_TMR <= cxxxxTST\_TM -------| cxxxxTST\_TMR = 0

;test not complete | ;reset test timer

cxxxxFLT\_TMR <= cxxxxTST\_TM \*

EGR\_CLR\_RT ----------------| cxxxxFLT = 0

;fault timer below fault clear | ;indicate no fault

;time

cxxxxFLT = 0 ----------------------| cxxxxFLT\_TMR = 0

;fault not present | ;reset fault timer

END: egr\_test\_disabled

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

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BEGIN: egr\_fault\_detected(cxxxx)

This is a global subroutine used to control the fault timers and flags for

the EGR OBDII strategy when fault is present.

always ----------------------------| cxxxxENA = 1

| ;count up test timer

| cxxxxDN\_FLG = 0

| ;do not count down fault timer

cxxxxFLT\_TMR < cxxxxTST\_TM --------| cxxxxUP\_FLG = 1

;fault timer below test time | ;count up fault timer

|

| --- ELSE ---

|

| cxxxxUP\_FLG = 0

| ;stop fault timer

cxxxxFLT\_TMR > cxxxxTST\_TM

\* EGR\_FLT\_RT ----------------| cxxxxFLT = 1

;fault timer above fault | ;indicate fault present

;time

END: egr\_fault\_detected

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EGR STRATEGY, EGR OBDII TEST LOGIC - CDAN2

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BEGIN: egr\_no\_fault(cxxxx)

This is a global subroutine used to control the fault timers and flags for

the EGR OBDII strategy when a passing condition is detected.

always ----------------------------| cxxxxENA = 1

| ;count up test timer

| cxxxxUP\_FLG = 0

| cxxxxDN\_FLG = 1

| ;count down fault timer

cxxxxFLT\_TMR <= cxxxxTST\_TM \*

EGR\_CLR\_RT ----------------| cxxxxFLT = 0

;fault timer below fault clear | ;indicate no fault

;time

END: egr\_no\_fault

BEGIN: egr\_clear\_timers

This is a global subroutine used to clear out all of the EGR related fault

timers and fault bits.

always ----------------------------| P0401FLT\_TMR = 0

| P0401TST\_TMR = 0

| P0401FLT = 0

| P0401OLD = 0

| P0402FLT\_TMR = 0

| P0402TST\_TMR = 0

| P0402FLT = 0

| P1400FLT\_TMR = 0

| P1400TST\_TMR = 0

| P1400FLT = 0

| P1401FLT\_TMR = 0

| P1401TST\_TMR = 0

| P1401FLT = 0

| P1405FLT\_TMR = 0

| P1405TST\_TMR = 0

| P1405FLT = 0

| P1405OLD = 0

| P1406FLT\_TMR = 0

| P1406TST\_TMR = 0

| P1406FLT = 0

| P1406OLD = 0

| P1408FLT\_TMR = 0

| P1408TST\_TMR = 0

| P1408FLT = 0

| P1409FLT\_TMR = 0

| P1409TST\_TMR = 0

| P1409FLT = 0

END: egr\_clear\_timers

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EGR STRATEGY, SCCD OUTPUT COMMAND - CDAN2

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12.2 SCCD OUTPUT COMMAND (CDAN0)

OVERVIEW

This routine outputs the Exhaust Gas Vacuum Reservoir (EVR) current command

to the SCCD smart driver. It also provides SCCD diagnostics.

DEFINITIONS

INPUTS

Registers:

- EGRDC = EGR duty cycle.

- EVR\_STATUS = EVR smart output driver fault status.

Calibration Constants:

- EGR\_TST\_DC = Minimum duty cycle to allow passing of SCCD test.

OUTPUTS

Registers:

- EVR\_STATUS = See above.

Bit Flags:

- PxxxENA = Flag to enable up counting of fault xxx test timer.

- PxxxUP\_FLG = Flag to enable up counting of fault xxx fault timer.

- PxxxDN\_FLG = Flag to enable down counting of fualt xxx fault timer.

PROCESS

STRATEGY MODULE: EGR\_SCCD\_COM1

always ---------------------------------| EVR\_STATUS := output(EGRDC)

| ;output to SCCD

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EGR STRATEGY, SCCD OUTPUT COMMAND - CDAN2

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EVR DRIVER DIAGNOSTICS

The following logic interfaces to the EGR diagnostics. See the

EGR\_OBDII\_COMx module for documentation on the fault filtering scheme.

EVR\_STATUS is placed in a non-zero state by the operating system if an over

or under current condition is detected. It is not possible to detect an over

current condition when EGRDC is zero. The lack of fault logic is therefore

only run when EGRDC is non-zero.

EGR\_TST\_RNNG = 0 -----------------|

;monitor disabled |

|OR --| Do: egr\_test\_disabled(P1409)

EGRDC < EGR\_TST\_DC ---------| | |

;duty cycle below min |AND -| |

| |

EVR\_STATUS = 0 -------------| |

;driver status indeterminate |

| --- ELSE ---

|

EVR\_STATUS > 0 -------------------------| Do: egr\_fault\_detected(P1409)

;output driver fault detected |

|

| --- ELSE ---

|

EGRDC >= EGR\_TST\_DC --------------------| Do: egr\_no\_fault(P1409)

;duty cycle above min

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CHAPTER 13

IDLE SPEED CONTROL

13-1

IDLE SPEED CONTROL, GENERIC ISC - CDAN2

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13.1 GENERIC IDLE SPEED CONTROL (CDAL0)

OVERVIEW

This chapter describes the adaptive air bypass idle speed control system. In

general, the ISC system is designed to regulate the duty cycle to an air

bypass solenoid as necessary to obtain the desired engine speed for all idle

operating conditions (base idle; hi-cam; various accessory loads) and provide

for a dashpot action. Predicted airflows for the different load states at

idle are adaptively corrected to minimize the impact of hardware variability.

Acceptable idling performance is achieved by a careful balance of bypass air

solenoid control and feedback spark control.

Feedback Spark offers the fastest way to change engine torque. As such, its

use is important in the control of load transitions like A/C, power steering,

and neutral/drive changes. Aggressive use of Feedback Spark is very

effective in limiting rpm changes during these conditions. The Feedback

Spark strategy is described in the spark chapter.

The amount of airflow through the air bypass is controlled by the solenoid

position, which is in turn determined by the solenoid duty cycle. The

objective of the idle speed control strategy is to determine ISCDTY. As

mentioned above, calibration of the bypass actuator control must be

coordinated with that of Feedback Spark.

The overall bypass air ISC logic sets ISCDTY to one of the following:

I. CRANK:

a) Engine Stopped:

ISCDTY = 0%

b) Engine Moving:

ISCDTY = FN884(TCSTRT)%

II. FMEM (MAP and TP sensor out of range):

ISCDTY = FMMISC

III. NORMAL RUNNING ISC:

ISCDTY = IDCMUL \* FN8000(DEBYMA,PERLOAD\_ISC) + IDCOFS

IV. SPECIAL SELF TEST CONDITIONS

Key On Engine off; OSM\_EO\_ON = 1 - ISCDTY = 100%

OSM\_EO\_OFF = 1 - ISCDTY = 0

Key On Engine Running; ER\_ISC\_HLD = 1 - ISCDTY is frozen.

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IDLE SPEED CONTROL, GENERIC ISC - CDAN2

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NORMAL ISC

OVERVIEW

Under most operating conditions, ISCDTY is obtained from the Normal ISC

logic. During Normal ISC, the strategy can operate in any one of four modes:

DASHPOT PREPOSITION, DASHPOT, RPM CONTROL, or LOCKOUT. The modes will be

described in more detail shortly.

Regardless of which of the four modes is active, the strategy first

calculates a total desired idle airflow, DESMAF:

DESMAF = DESMAF\_PRE + DASPOT + IPSIBR + ISCKAM

ISC\_A\_PROP + ISC\_A\_DER

DESMAF represents the total engine airflow required for idle. There are

slight differences in the calculation of DESMAF depending on which mode is

active. These differences are summarized below and will be described in more

detail in the discussion of each individual mode.

DASHPOT PREPOSITION MODE (ISCFLG = 0)

DESMAF\_PRE = Initial prediction, based on rpm, load, & temperature

DASPOT = DASPTK \* (DSTPBR - (RATCH + DELHYS)) + FN830

IPSIBR = Fixed at last calculated value (not updated in this mode)

ISCKAMn = KAM cell n, where n is selected by ISFLAG

DASHPOT MODE (ISCFLG = -1)

DESMAF\_PRE = Initial prediction, based on rpm, load, & temperature

DASPOT = old DASPOT - FN879(DASPOT)

IPSIBR = Fixed at last calculated value (not updated in this mode)

ISCKAMn = KAM cell n, where n is selected by ISFLAG

RPM CONTROL MODE (ISCFLG = 1)

DESMAF\_PRE = Initial prediction, based on rpm, load, & temperature

DASPOT <= DASCTL (DASPOT must be below DASCTL to enter RPM control)

IPSIBR = old IPSIBR + ISCPSI

ISCKAMn = KAM cell n, where n is selected by ISFLAG

RPM CONTROL LOCKOUT MODE (ISCFLG = 2)

DESMAF\_PRE = Initial prediction, based on rpm, load, & temperature

DASPOT <= DASCTL (DASPOT must be below DASCTL to enter lockout mode)

IPSIBR = old IPSIBR + ISCPSI

ISCKAMn = KAM cell n, where n is selected by ISFLAG

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IDLE SPEED CONTROL, GENERIC ISC - CDAN2

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NORMAL ISC - continued

During Normal ISC, the strategy executes a number of tasks in a specific

order. These tasks perform the actual logic and calculations required for

any of the four modes of operation. The order of execution of the tasks is

listed below. The details of each task are described in separate sections

which follow.

NORMAL ISC TASKS

1) DSDRPM\_CALC - calculation of DSDRPM & DESMAF\_PRE & setting of ISFLAG

2) RPMERR\_CALC - calculation of RPMERR\_A & RPMERR\_S

3) DASPOT\_CALC - calculation of DASPOT

4) MODE\_SELECT - selection of mode & setting of ISCFLG

5) IPSIBR\_CALC - IPSIBR update & calculation of DESMAF

6) ISCDTY\_CALC - calculation of DEBYMA & ISCDTY

7) ISCKAM\_UPDATE - adaptive update of ISCKAM

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IDLE SPEED CONTROL, GENERIC ISC - CDAN2

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DEFINITIONS

Registers:

- APT = Throttle Mode flag.

- DSDRPM = Desired engine speed.

- DSTPBR = Dashpot filtered throttle position.

- GR\_CM = Commanded gear for shift solenoids.

- GR\_CM\_LST = Commanded gear in last background pass.

- IPSIBR = The closed loop integration component of total DESMAF, ppm.

Designed to provide integral feedback, IPSIBR adjusts the value of DESMAF

to correct for sustained changes in idle load. An increase or decrease

in IPSIBR results in a corresponding change to bypass valve duty cycle.

- ISC\_A\_DER = Derivative contribution to DESMAF.

- ISC\_A\_PROP = Proportional contribution to DESMAF.

- ISCDTY = Idle speed control duty cycle.

- ISCFLG = ISC mode indicator flag; -1 -> Dashpot Mode, 0 -> Dashpot

Preposition Mode, 1 -> closed Loop RPM Control Mode, 2 -> Closed Loop RPM

Control (Lock\_out entry to RPM control).

- N = Engine revolutions, RPM.

- N\_RATCH = RPM value which only ratchets down. When not at closed

throttle, N = N\_RATCH. When at closed throttle, N\_RATCH is only allowed

to go down. N\_RATCH is an input to the minimum daspot clip. N\_RATCH

ratchets down to prevent rpm flares after a declutch.

- OSM\_EO\_ON = On state requested for OSM outputs during engine off on

demand test.

- OSM\_EO\_OFF = Off state requested for OSM outputs during engine off on

demand test.

- PERLOAD\_ISC = Used by ISC logic as the Y input to FN8000. 0-1.0 scale,

unitless.

- RATCH = Closed throttle position, counts.

- SUBST\_REQ[0] = Output state control substitution requested flag for

channel 0.

- TCSTRT = Temperature of ECT at Cold Start-up, deg F.

- TSLPIP = Time since last PIP (msecs).

- VSBAR = Filtered vehicle speed for transmission.

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IDLE SPEED CONTROL, GENERIC ISC - CDAN2

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Bit Flags:

- CRKFLG = Crank Mode flag; 1 -> Crank mode.

- ER\_ISC\_HLD = Engine run ISC Flag used to freeze ISCDTY to it current

value.

- FLG\_DASMNQ = VSBAR flip-flop flag for minimum DASPOT clip.

- HCAMFG = Flag indicating the completion of Hi-Cam; 0 -> no desired engine

speed adder exists, 1 -> RPM adder above base idle is present. Flag is

used in the ISC adaptive update routine to disable updates when HCAMFG =

1.

- MFMFLG = MAF Failure flag; 1 -> MAF out of range.

- NDSFLG = 0 -> transmission in Neutral, 1 -> transmission in gear.

- RUNUP\_FLG = Flag indicating that initial runup is complete; 1 -> initial

runup complete.

- TFMFLG = TP Failure flag; 1 -> TP out of range.

Calibration Constants:

- DASMHYST = Hysteresis for DASMPH.

- DASMPH = Minimum VSBAR for declutch DASPOT clip, mph.

- FMMDSD = Failure Mode Management default desired RPM.

- FMMISC = Default Duty cycle to ISC, fraction.

- FN884(TCSTRT) = ISC Duty Cycle in Crank, deg.

- FN8000 = ISCDTY as a function of DEBMYA and PERLOAD\_ISC.

- TRLOAD = Transmission Load.

0 -> Manual Transmission, no clutch or gear switches,

forced neutral state (NDSFLG = 0).

1 -> Manual Transmission, no clutch or gear switch.

2 -> Manual Transmission, one clutch or gear switch.

3 -> Manual Transmission, both clutch and gear switches.

4 -> Auto Transmission, non-electronic, neutral drive switch.

5 -> Auto Transmission, non-electronic, neutral pressure switch,

(AXOD).

6 -> Auto Transmission, electronic, PRNDL sensor - park,

reverse, neutral, overdrive, manual 1, manual 2.

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IDLE SPEED CONTROL, GENERIC ISC - CDAN2

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PROCESS

STRATEGY MODULE: ISC\_OVERVIEW\_COM8

OVERALL BYPASS AIR ISC LOGIC

The purpose of the ISC logic is to determine ISCDTY. Under certain

conditions, ISCDTY is set to specific values. Under most operating

conditions, ISCDTY is determined from the Normal ISC logic which is described

later. The logic below describes, at highest level, how ISCDTY is

determined.

OSC response logic: If Output State Control has been requested for ISCDTY

but the local conditions will not allow for the substitution, a general

reject message will be sent.

SUBST\_REQ[0] = 0 -----------------------| do nothing

| (no OSC required)

|

| --- ELSE ---

ER\_ISC\_HLD = 1 -------------------| |

(flag set by diagnostic test) | |

| |

CRKFLG = 1 -----------------| | |

|AND -| |

TSLPIP < 2000 ms -----------| | |

| |

RUNUP\_FLG = 0 --------------| |OR --| (OSC substitute requested but local

|AND -| | conditions will not allow

CRKFLG = 0 -----------| | | | substitution)

|OR --| | |

TSLPIP < 2000 ms -----| | | Do: OSC\_RESPONSE(0,22h)

(no PIPs yet or stall) | |

| |

MFMFLG = 1 -----------------| | |

|AND -| |

TFMFLG = 1 -----------------| |

| --- ELSE ---

|

| do nothing

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IDLE SPEED CONTROL, GENERIC ISC - CDAN2

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OSM\_EO\_ON = 1 --------------------------| ISCDTY = 1.0

;output commanded on by KOEO test |

| --- ELSE ---

|

OSM\_EO\_OFF = 1 -------------------------| ISCDTY = 0

;output commanded off by KOEO test |

| --- ELSE ---

|

| (ISC logic disabled)

ER\_ISC\_HLD = 1 -------------------------| freeze ISCDTY

(flag set by diagnostic test) | EXIT ISC LOGIC

|

| --- ELSE ---

|

| (engine stopped)

CRKFLG = 1 -----------------------| |

(in crank mode) |AND -| iscdty = 0

| | (0% - actuator closed)

TSLPIP >= 2000 ms. ---------------| | IPSIBR = 0

(no PIPs yet or stall) | DSTPBR = RATCH

| Do: substitute(0,iscdty)

| ISCDTY = iscdty

| (output state control override)

|

| EXIT ISC LOGIC

|

| --- ELSE ---

|

CRKFLG = 1 -----------------------| | (engine moving)

(in crank mode) |OR --| Do: DSDRPM\_CALC

| | Do: RPMERR\_CALC

RUNUP\_FLG = 0 --------------------| | (update RUNUP\_FLG)

(runup not completed) | ISCDTY = FN884(TCSTRT)%

| (duty cycle function of

| temperature at start)

| IPSIBR = 0

| DSTPBR = RATCH

| EXIT ISC LOGIC

|

| --- ELSE ---

|

MFMFLG = 1 -----------------------| | (FMEM fault present)

|AND -| ISCDTY = FMMISC

TFMFLG = 1 -----------------------| | DSDRPM = FMMDSD

| ISCFLG = 0

| RUNUP\_FLG = 1

| HCAMFG = 1

| EXIT ISC LOGIC

|

| --- ELSE ---

|

| (normal ISC)

| update FLG\_DASMNQ

| update N\_RATCH

| ISCDTY is calculated from the

| Normal ISC logic described later

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IDLE SPEED CONTROL, GENERIC ISC - CDAN2

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FLG\_DASMNQ and N\_RATCH LOGIC

This logic is used by DASPOT. It is shown here because it is executed as

part of the OVERALL ISC LOGIC. It is executed anytime the Normal ISC logic

is done so it will be available, if required by DASPOT mode.

FLG\_DASMNQ

VSBAR >= DASMPH + DASMHYST ------|S Q -| FLG\_DASMNQ

| | (Prepare to add dashpot

VSBAR < DASMPH ------------------|C | to prevent declutch stall)

N\_RATCH

APT = 0 OR 1 --------------------|

(PT or WOT) |

|

TRLOAD = 3 ----------------| |

(manual w/both switches) |AND -|

| |

NDSFLG = 1 ----------------| |

(driveline engaged) |

|OR --| N\_RATCH = N

TRLOAD > 3 ----------------| | |

(automatic) | | |

| | |

GR\_CM = 3 -----------------|AND -| |

(now in 3rd gear) | | |

| | |

GR\_CM\_LST = 4 -------------| | |

(was in 4th) | |

| |

APT = -1 ------------------| | |

(closed throttle) |AND -| |

| |

N <= N\_RATCH --------------| |

(RPM decreasing) |

| --- ELSE ---

|

| no change to N\_RATCH

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IDLE SPEED CONTROL, GENERIC ISC - CDAN2

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13.2 FEATURE: ISC\_DSDRPM - V1.A1\_ISC\_DSDRPM (CDAN0)

13.2.1 DSDRPM CALCULATION (CDAL0)

OVERVIEW

This module controls the calculation of desired idle rpm (DSDRPM) including

HICAM. DSDRPM is used as a control input for closed loop and adaptive idle

speed control. It is also used to calculate DESMAF\_PRE.

The strategy calculates a desired value for engine speed, DSDRPM. While in

idle speed control mode the strategy attempts to maintain the engine speed at

the desired value. The previous value of DSDRPM is saved in the register

DSDRPM\_LST. DSDRPM is composed of a Base portion, IS\_TRAN\_RPM, plus

additional adders for A/C, Power Steering and High Speed Fan. It also

contains a HICAM term which is explained later.

In general terms, DSDRPM is calculated in ISC\_DSDRPM\_LOADS\_COMx as follows,

DSDRPM = IS\_TRAN\_RPM + HICAM + ISADD\_ACRPM + ISADD\_POWS + ISADD\_HEDF

GPAS Requirements:

Automatic transmission vehicles operating in drive are limited by Ford GPAS

requirements to a maximum desired idle rpm. Under these conditions, DSDRPM,

including all adders, is clipped to the value GPAS\_CLIP as a maximum.

GPAS\_CLIP is calculated in the ISC\_DSDRPM\_trans\_COMx module, and passed

across the Transmission/Engine interface.

HICAM portion of DSDRPM:

The HICAM portion of DSDRPM is composed of a variety of adders for special

operating conditions (ECT, ACT, CTNTMR, etc.). It is calculated in the

module ISC\_DSDRPM\_HICAM\_COMx as follows;

HICAM = FN825A + FN825B + FN821B + FN880 + BZZRPM + FN826A + FN826B

DEFINITIONS

See other ISC\_DSDRPM\_xx modules.

PROCESS

STRATEGY MODULE: ISC\_DSDRPM\_COM10

BEGIN: DSDRPM\_CALC

Unconditionally --------------| do: dsdrpm\_timer

| do: dsdrpm\_hicam

| do: dsdrpm\_base

| do: gpas\_clip

| do: dsdrpm\_loads

| do: dsdrpm\_output

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

END: DSDRPM\_CALC

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

13.2.2 IS\_TRAN\_RPM And MAXIMUM CLIP CALCULATION - (CDAL0)

GENERAL TRANSMISSION

OVERVIEW

This module has two purposes. The generation of a base desired engine speed

and the generation of a maximum value for DSDRPM, (i.e GPAS clip).

The first section describes the calculation of desired idle rpm, IS\_TRAN\_RPM,

appropriate for the current transmission state of any transmission.

IS\_TRAN\_RPM is used in the ISC\_DSDRPM\_COMx module to generate the final

DSDRPM value. This value will reflect engine loads in addition to the

transmission state.

The second section calculates the GPAS clip.

DEFINITIONS

INPUTS

Registers:

- ALT\_CAL\_FLG = Flat to indicate use of alternate calibration.

- ATMR3 = Timer which counts up in RUN mode. (Reset to zero at powerup)

Bit Flags:

- DNDSUP = Delayed neutral/drive flag; 0 -> in neutral, no load, 1 -> in

drive, loaded.

Calibration Constants:

- CRKTIM = Time after start to delay clip on desired RPM.

- DRBASE = Base desired engine speed in drive.

- ISCLPD = A clip on the maximum desired speed that can be requested with

vehicle in drive. Usually the GPAS defined speed allowed at 0.2 miles on

a cold start.

- ISCLPD\_ALT = Alternate calibration value of ISCLPD.

- NUBASE = Base desired engine speed in neutral.

- DRBASE\_ALT = Alternate calibration DRBASE.

- NUBASE\_ALT = Alternate calibration NUBASE.

- TCTRAN\_RPM = Time constant used to filter changes in DSDRPM due to

changes in transmission state.

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION CDAN2

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- TRLOAD = Transmission Load switch:

0 -> Manual transmission, no clutch or gear switch, NDSFLG = 0

1 -> Manual trans, no clutch or gear switch

2 -> Manual trans, one clutch or gear switch

3 -> Manual trans, both switches

4 -> Automatic trans, NDS

5 -> Automatic trans, NPS

6 -> Automatic trans, 7 position PRNDL

7 -> Automatic trans, PRNDL switches (4EAT)

OUTPUTS

Registers:

- GPAS\_CLIP = Maximum permissible value of DSDRPM, GPAS clip.

- IS\_TRAN\_RPM = Desired engine speed based on transmission load

requirements.

PROCESS

STRATEGY MODULE: ISC\_DSDRPM\_BASE\_COM1

BEGIN: dsdrpm\_base

Select base on whether alternate calibration is required:

ALT\_CAL\_FLG = 1 ------------------------| pre\_nubase = NUBASE\_ALT

| pre\_drbase = DRBASE\_ALT

|

| --- ELSE ---

|

| pre\_nubase = NUBASE

| pre\_drbase = DRBASE

IS\_TRAN\_RPM CALCULATION lOGIC:

TRLOAD <= 3 ----------------------|

; Manual Transmission |OR --| IS\_TRAN\_RPM = pre\_nubase

| |

DNDSUP = 0 -----------------------| |

;In neutral | --- ELSE ---

|

| IS\_TRAN\_RPM = ROLAV(pre\_drbase,

| TCTRAN\_RPM)

| ; Filter N-D shifts in DSDRPM

END: dsdrpm\_base

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: gpas clip

For automatic transmissions in drive, pre\_isclpd is used to prevent creeping

and harsh engagements.

ALT\_CAL\_FLG = 1 ------------------------| pre\_isclpd := ISCLPD\_ALT

|

| --- ELSE ---

|

| pre\_isclpd := ISCLPD

ATMR3 > CRKTIM -------------------|

; Delay has timed out. |

|

TRLOAD > 3 -----------------------|AND -| GPAS\_CLIP := pre\_iscpld

; Non Man. Trans. | | ;Vehicle stationary clip

| |

DNDSUP = 1 -----------------------| |

;In Drive | --- ELSE ---

|

|

| GPAS\_CLIP := 4080

| ;set clip to max value, i.e no clip

END: gpas clip

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IDLE SPEED CONTROL, DESIRED RPM (HICAM) CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

13.2.3 DSDRPM (HICAM) CALCULATION (CDAJ0)

OVERVIEW

This module describes the calculation of HICAM which is a speed adder to

DSDRPM. DSDRPM is used as a control input for closed loop and adaptive idle

speed control.

The HICAM portion of DSDRPM is composed of a variety of adders which are

enabled under specific operating conditions of ECT, ACT, CTNTMR, etc.

HICAM = FN825A + FN825B + FN821B + FN880 + BZZRPM + FN826A + FN826B

HICAM is allowed to rise instantaneously, but any decrease in value is

filtered to prevent a sudden drop in DSDRPM. This filtered value of HICAM is

called DESNLO (time constant TCDESN). The flag, HCAMFG, is set if HICAM is

non zero. HCAMFG is used to prevent adaptive airflow updates (ISCKAM).

DEFINITIONS

INPUTS

Registers:

- ACT = Air charge temperature, deg. F.

- ALT\_CAL\_FLG = Flat to indicate use of alternate calibration.

- ATMR1 = Timer which counts up in run/underspeed mode.

- ATMR3 = Timer which counts up in run mode. (Reset to 0 only at powerup).

- DESNLO = Filtered value of the high cam portion of the DSDRPM register.

Applied only when Hicam is decreasing, using time constant TCDESN.

- ECT = Engine coolant temperature, deg. F.

- HCTMR = High Cam timer which counts up in RUN/UNDERSPEED mode.

- HICAM = Symbol used to represent the hi-cam adders to DSDRPM.

- IS\_TRAN\_RPM = Base desired engine idle speed. Determined from

transmission state.

- PDL = PRNDL position.

- TCSTRT = Temperature of ECT at Cold Startup, deg F.

- VOLTMR = Timer which records time that the system voltage is below

battery charging level, sec.

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IDLE SPEED CONTROL, DESIRED RPM (HICAM) CALCULATION - CDAN2

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Bit Flags:

- CTNFLG = 1 -> closed throttle neutral idle.

- DNDSUP = Delayed neutral/drive flag; 0 -> in neutral, no load, 1 -> in

drive, loaded.

- ER\_ISC\_REQ = Engine Running ISC request flag. If set DSDRPM value is

loaded with ER\_RPM.

- HCDFLG = Flag used to ensure that FN826A is locked out of HICAM, once it

has been used once.

- LOWVOL\_FLG = Flag used to indicate the flip-flop state of Low voltage

timer.

- PTSCR = Part throttle since crank mode flag; 0 -> driver has not tipped

in since start, 1 -> driver tipped in, kick down desired RPM.

Calibration Constants:

- BZZRPM = RPM adder intended to provide a short increase in RPM for engine

cleanout on start-up. The buzz-up function is not affected by the part

throttle kickdown until BZZTM expires.

- BZZRPM\_ALT = Alternate calibration for BZZRPM.

- BZZTM = Time for which BZZRPM adder is in effect.

- BZZTM\_ALT = Alternate calibration for BZZTM.

- CHGTM = Time delay after leaving Closed Throttle to permit VOLTMR to

decrement, sec.

- FN803A(ACSTRT) = Throttle kick down timer value as a function of ACSTRT.

- FN821B(VOLTMR) = RPM adder as a function of VOLTMR to provide battery

charge control.

- FN825A(ECT) = RPM adder as a function of ECT. Provides base Hi-Cam

function.

- FN825A\_ALT = Alternate calibration for FN825A.

- FN825B(ACT) = RPM adder as a function of ACT. Provides higher idle at

very low ambients.

- FN826A(TCSTRT) = RPM adder as a function of ECT at start. This adder is

not used when either the first part throttle transition since exiting

crank is observed or the time since start exceeds a calibrated value

(FN803A).

- FN826B(ACT) = Start-up RPM adder as a function of ACT. This adder is not

used when either the first part throttle transition since exiting crank

is observed or the time since start exceeds a calibrated value (TKDTN).

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IDLE SPEED CONTROL, DESIRED RPM (HICAM) CALCULATION - CDAN2

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- FN880(CTNTMR) = DSDRPM adder vs. time at idle and in neutral (CTNTMR -

See timer chapter for exact definition) Used as part of the

inspection/maintenance strategy. Remember that any RPM above base idle

disables ISCKAM adaptive learning via HCAMFG.

- HCDCLP = Maximum HICAM RPM clip for battery charging in drive.

- HCNCLP = Maximum HICAM RPM clip for battery charging in Neutral.

- LOWVOL\_CH = Hysteresis term for LOWVOL\_SL, volts.

- LOWVOL\_SL = System voltage level, below which the battery is discharging,

volts.

- TC\_VBAT = Rolav time constant used to generate VBATBAR in VOLTMR logic.

- TCDESN = Filter constant for the desired engine speed calculated value

(DSDRPM). Used to slow changes in desired speed in the decreasing

direction.

- TKDTN = Time since start after which FN826B(ACT) is eliminated.

- VBAT = Rolling average of IKYPWR.

- VOLTCLP = Maximum clip value to freeze VOLTMR at upper threshold.

OUTPUTS

Registers:

- DESNLO = See above.

- VBATBAR = Rolling average of VBAT, (Time constant of TC\_VBAT).

Bit Flags:

- HCAMFG = Flag indicating the completion of Hi-Cam; 0 -> no desired engine

speed adder exists, 1 -> an RPM adder above base idle is present. Flag

is used in the ISC adaptive update routine to disable updates when HCAMFG

= 1.

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IDLE SPEED CONTROL, DESIRED RPM (HICAM) CALCULATION - CDAN2

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PROCESS

STRATEGY MODULE: ISC\_DSDRPM\_HICAM\_COM1

BEGIN: dsdrpm\_hicam

ALT\_CAL\_FLG = 1 ------------------------| pre\_bzzrpm := BZZRPM\_ALT

| pre\_fn825a := FN825A\_ALT

| pre\_bzztm := BZZTM\_ALT

| ; use alt. values

|

| --- ELSE ---

|

| pre\_bzzrpm := BZZRPM

| pre\_fn825a := FN825A

| pre\_bzztm := BZZTM

| ; use standard values

unconditionally ------------------------| hicam\_base := pre\_fn825a + FN825B

FN880(CTNTMR) Inspection maintenance logic:

CTNFLG = 1 -----------------------------| hicam\_insp := FN880

|

| --- ELSE ---

|

| hicam\_insp := 0.0

FN821B(VOLTMR) Battery charge & clipping logic:

unconditionally ------------------------| hicam\_bat := FN821B

DNDSUP = 0 -----------------------------| tmp\_clip = HCNCLP

| ; Clip for Neutral

|

| --- ELSE ---

|

| tmp\_clip = HCDCLP

| ; Clip in DRIVE

hicam\_base + hicam\_insp >= hicam\_bat ---| hicam := hicam\_base + hicam\_insp

|

| -- ELSE --

|

| hicam := min(hicam\_bat,tmp\_clip)

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IDLE SPEED CONTROL, DESIRED RPM (HICAM) CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BZZRPM logic:

ATMR1 < pre\_bzztm ----------------------| hicam := hicam + pre\_bzzrpm

|

| --- ELSE ---

|

| NO ACTION

FN826A(ECT at Start) Logic: This logic is intended to provide:

1) Additional rpm for engine stability and warmup and to assist with

catalyst lightoff.

2) Extended demist capability at low ECT/ACT at start

Note: On an auto. transmission package, the logic is disabled in DRIVE.

In order to reduce RPM as quickly as possible to avoid transmission

engagement harshness, PDL, and not DNDSUP, is used in the logic.

HCDFLG = 0 -----------------------|

;'Lock-out' is false |

|

TRLOAD =< 3 ----------------| |

;Man Trans | |

|OR --|

PDL = 7 --------------| | |

;Park |OR --| |AND -| hicam = hicam + FN826A

| | | ; add FN826A(ECT at START)

PDL = 5 --------------| | |

;Neutral | |

| |

HCTMR < FN803A(ACSTRT) -----------| |

| |

PTSCR = 0 ------------------| | |

;No tip-in yet |OR --| |

| |

ATMR1 < pre\_bzztm ----------| |

| --- ELSE ---

|

| HCDFLG = 1

| ;Set 'lock-out' flag

HCTMR - High Cam Timer Logic:

CRKFLG = 0 -----------------------------| COUNT UP HCTMR

|

| --- ELSE ---

|

| HCTMR = 0

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IDLE SPEED CONTROL, DESIRED RPM (HICAM) CALCULATION - CDAN2

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FN826B(ACT) Logic: This logic is intended to enhance hot start performance.

ATMR1 < TKDTN --------------------|

|AND -| HICAM = hicam + FN826B

PTSCR = 0 ------------------| | | ; add FN826B(ACT)

;No tip-in yet |OR --| |

| |

ATMR1 < pre\_bzztm ----------| |

| --- ELSE ---

|

| HICAM = hicam

| ; Assign hicam to HICAM

ON-DEMAND Diagnostic TEST:

ER\_ISC\_REQ = 1 -------------------------| DESNLO := ER\_RPM - IS\_TRAN\_RPM

| DESNLO := max(DESNLO,0)

|

| --- ELSE ---

|

| NO ACTION

DESNLO down filter for Hicam:

HICAM < DESNLO -------------------------| DESNLO := ROLAV(HICAM,TCDESN)

| HICAM := DESNLO

| ; HICAM is decreasing - do filter

|

| --- ELSE ---

|

| DESNLO := HICAM

| ; Not decreasing - no filter

END: dsdrpm\_hicam

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IDLE SPEED CONTROL, DESIRED RPM (HICAM) CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: dsdrpm\_timer

VOLTMR - LOW VOLTAGE TIMER

\* Low voltage timer (VOLTMR) represents the amount of time that filtered

battery voltage, as indicated by the VBATBAR calculation, is in a

'low voltage' state. This state is indicated by the LOWVOL\_FLG flag.

\* VOLTMR is referenced by FN821B to determine the increase in engine speed

necessary to provide battery charge compensation.

\* A filter time constant, TC\_VBAT, is provided to desensitise the logic to

transient changes in VBAT. The default calibration is zero, i.e VBATBAR =

VBAT.

unconditionally ------------------------| VBATBAR := ROLAV(VBAT,TC\_VBAT)

| ;Form filtered VBAT

VBATBAR < LOWVOL\_SL --------------|S Q -| LOWVOL\_FLG

| | ;In low voltage state

VBATBAR >= LOWVOL\_CH -------------|C

CRKFLG = 0 -----------------------|

;RUN/UNDERSPEED mode) |

|AND -| Increment VOLTMR

LOWVOL\_FLG = 1 -------------------| | ;Clip VOLTMR to VOLTCLP

| |

APT = -1 -------------------------| |

;Closed Throttle |

| --- ELSE ---

NACTMR >= CHGTM ------------------| |

|AND -| Decrement VOLTMR

LOWVOL\_FLG = 0 -------------------| |

| --- ELSE ---

|

| Freeze VOLTMR

END: dsdrpm\_timer

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IDLE SPEED CONTROL, DESIRED RPM (LOADS) CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

13.2.4 DSDRPM (LOADS) CALCULATION (CDAL0)

OVERVIEW

This module describes the calculation of desired idle rpm (DSDRPM). DSDRPM

is used as a control input for closed loop and adaptive idle speed control.

It is also used to calculate DESMAF\_PRE.

This module is compatible with Transmission/Engine Modularity in that the

base desired engine RPM, IS\_TRAN\_RPM, and the GPAS\_CLIP are both passed into

this engine module across the Transmission/Engine interface.

The strategy calculates a desired value for engine speed - DSDRPM. While in

idle speed control mode the strategy attempts to maintain the actual engine

speed at the value of DSDRPM. The previous value of DSDRPM is saved as

DSDRPM\_LST.

DSDRPM is composed of a Base portion, IS\_TRAN\_RPM, plus a HICAM portion, plus

additional adders for A/C, Power Steering and High Speed Fan.

In general;

DSDRPM = IS\_TRAN\_RPM + HICAM + ISADD\_ACRPM + ISADD\_POWS + ISADD\_HEDF

This module supports the Fail-Safe cooling strategy in that if the engine has

overheated, so setting COOL\_FLG, then the calibratable COOL\_BASE, is

substituted for IS\_TRAN\_RPM, giving:

DSDRPM = COOL\_BASE + HICAM + ISADD\_ACRPM + ISADD\_POWS + ISADD\_HEDF

The HICAM portion of DSDRPM is calculated in the ISC\_DSDRPM\_HICAM\_COMx

module.

TOT Based RPM Requirements:

This module supports a minimum desired engine speed clip, IS\_TOT\_RPM, which

when fully supported is determined from transmission oil temperature.

IS\_TOT\_RPM is calculated in the ISC\_DSDRPM\_TOT\_COMx module.

GPAS Requirements:

Automatic transmission vehicles operating in drive are limited by Ford GPAS

requirements to a maximum desired idle rpm. Under these conditions, DSDRPM,

including all adders, is clipped to the value GPAS\_CLIP as a maximum.

GPAS\_CLIP is calculated in the ISC\_DSDRPM\_trans\_COMx module, and passed

across the Transmission/Engine interface.

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IDLE SPEED CONTROL, DESIRED RPM (LOADS) CALCULATION - CDAN2

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DEFINITIONS

INPUTS

Registers:

- ACIOTMR = A/C off delay timer, for ISC. sec

- DSDRPM = Desired engine speed. See Overview section for definition of

the various uses of this register.

- COOL\_FLG = Flag indicating that engine is overheating; 1 -> Engine

overheated.

- DSDRPM\_LST = Previous value of DSDRPM; from last background loop.

- ER\_RPM = DSDRPM value for engine run diagnostic test.

- GPAS\_CLIP = Maximum permissible value of DSDRPM. It is passed across

from the Engine/Transmission boundary.

- HEDFHP = Two speed for output present.

- HICAM = Symbol used to represent the hi-cam adders to DSDRPM.

- IBGPSI = BG loop CTR for PSI calac. in ISC.

- IS\_TRAN\_RPM = Base desired engine RPM determined by transmission load.

Bit Flags:

- ACRQST = A/C requested; 1 -> A/C request.

- AC\_RPM\_FLG = A/C request flag to add RPM to DSDRPM.

- DNDSUP = Delayed neutral/drive flag; 0 -> in neutral, no load, 1 -> in

drive, loaded.

- ER\_ISC\_REQ = Engine Running ISC request flag. If set DSDRPM value is

loaded with ER\_RPM.

- HSF\_FLG = Flag indicating the status of high speed Fan

- IS\_RPM\_NCLIP = Flag indicating whether DSDRPM has been clipped to a

minimum value (Clipped = 1) - Used to set HCAMFG to disable ISCKAM

learning.

- POWSFG = Flag used to indicate that power steering load is high; 1 ->

power steering on.

- PSFLAG = Flag to indicate last pass value of power steering to check for

transitions; 1 -> power steering was on.

Calibration Constants:

- AC\_OFF\_DLY = Time to maintain DNAC\_DR/DNAC\_NEUT RPM adder after A/C has

been disengaged.

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IDLE SPEED CONTROL, DESIRED RPM (LOADS) CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- COOL\_BASE = Base desired engine speed when engine overheated.

- DNAC\_DR = RPM increment requested with the A/C on in drive.

- DNAC\_NEUT = RPM increment requested with the A/C on in neutral.

- DNPOWS = If a power steering pressure switch is used, this parameter

increments the desired RPM when an increased load is sensed.

- HEDFRPM = DSDRPM adder when high speed fan is on, rpm.

- TRLOAD = Transmission Load switch:

0 -> Manual transmission, no clutch or gear switch

1 -> Manual trans, no clutch or gear switch

2 -> Manual trans, one clutch or gear switch

3 -> Manual trans, both switches

4 -> Automatic trans, NDS

5 -> Automatic trans, NPS

6 -> Automatic trans, 7 position PRNDL

7 -> Automatic trans, PRNDL switches (4EAT)

OUTPUTS

Registers:

- DSDRPM = See above.

- ISADD\_ACRPM = Speed adder for air-conditioning load.

- ISADD\_HEDF = Speed adder for high speed fan load.

- ISADD\_POWS = Speed adder for power steering load.

Bit Flags:

- HCAMFG = Flag indicating the completion of Hi-Cam; 0 -> no desired engine

speed adder exists, 1 -> an RPM adder above base idle is present. Flag

is used in the ISC adaptive update routine to disable updates when HCAMFG

= 1.

- PSFLAG = Flag to indicate last pass value of power steering to check for

transitions; 1 -> power steering was on.

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IDLE SPEED CONTROL, DESIRED RPM (LOADS) CALCULATION - CDAN2

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PROCESS

STRATEGY MODULE: ISC\_DSDRPM\_LOADS\_COM1

BEGIN: dsdrpm\_loads

AC\_RPM logic: It may be desirable to reduce the severity of any change

in DSDRPM due to A/C load application. For this reason the AC rpm adder,

ISADD\_ACRPM, is filtered in both increasing and decreasing directions.

Filter time constant is ACFILTC. Separate rpm adders are provided for

neutral and drive.

TRLOAD <= 3 ----------------------|

;Manual transmission |OR --| isadd\_acrpm := DNAC\_NEUT

| | ; Select Neutral DNAC

DNDSUP = 0 -----------------------| |

;In neutral |

| --- ELSE ---

|

| isadd\_acrpm := DNAC\_DR

| ; Select Drive DNAC

ACRQST = 1 -----------------------|S Q -| AC\_RPM\_FLG

;A/C requested |

|

ACIOTMR > AC\_OFF\_DLY -------------|C

AC\_RPM\_FLG = 1 -------------------------| ISADD\_ACRPM :=

| rolav(isadd\_acrpm,ACFILTC)

|

| --- ELSE ---

|

| ISADD\_ACRPM := rolav(0.0,ACFILTC)

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IDLE SPEED CONTROL, DESIRED RPM (LOADS) CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DNPOWS LOGIC: (Also affects PSFLAG, HCAMFG, and IBGPSI)

Note 1: A check on Hardware present switches is made in the appropriate

input processing sections. POWSFG & PSFLAG are therefore always correct.

Note 2: HCAMFG will be set/cleared, in the HCAMFG logic, when POWSFG is

set/cleared.

POWSFG = 1 -----------------------|

;PS on now |AND -| ISADD\_POWS := DNPOWS

| | ;PS off -> on transition

PSFLAG = 0 -----------------------| | PSFLAG := 1

;Off last time | IBGPSI := 0

| ;HCAMFG is set in the HCAMFG logic

|

| --- ELSE ---

POWSFG = 1 -----------------------| |

;PS on now |AND -| ISADD\_POWS := DNPOWS

| | ;PS on, not a transition

PSFLAG = 1 -----------------------| | ;HCAMFG is set in the HCAMFG logic

;On last time |

| --- ELSE ---

POWSFG = 0 -----------------------| |

;PS off now |AND -| ISADD\_POWS := 0.0

| | ;PS on -> off transition

PSFLAG = 1 -----------------------| | PSFLAG := 0

;On last time | IBGPSI := 0

| ;HCAMFG is cleared in the HCAMFG

| ;logic

|

| --- ELSE ---

|

| ISADD\_POWS := 0.0

| ;PS off

HEDFRPM logic:

HEDFHP = 1 -----------------------|

|AND -| ISADD\_HEDF := HEDFRPM

HSF\_FLG = 1 ----------------------| |

| --- ELSE ---

|

| ISADD\_HEDF := 0.0

END: dsdrpm\_loads

13-26

IDLE SPEED CONTROL, DESIRED RPM (LOADS) CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: dsdrpm\_output

TOT based minimum RPM:

unconditionally ---------------------| do: dsdrpm\_tot

| ; Calculate IS\_TOT\_RPM, minimum

| ; desired RPM based on TOT

Fail-Safe Cooling interupt:

COOL\_FLG = 1 ------------------------| base\_temp := COOL\_BASE

;Fail Safe Cooling mode | ; Use fail safe value as base RPM

|

| --- ELSE ---

|

| base\_temp := IS\_TRAN\_RPM

| ; Use base desired value

Calculation of DSDRPM & DSDRPM\_LST:

ER\_ISC\_REQ = 1 ----------------------| dsdrpm := ER\_RPM

;On-Demand Diag. test |

| --- ELSE ---

|

| dsdrpm\_raw := base\_temp + HICAM

| + ISADD\_ACRPM + ISADD\_POWS

| + ISADD\_HEDF

| dsdrpm := max(dsdrpm\_raw,IS\_TOT\_RPM)

| ; Catch any TOT based constraints.

Minimum Clip detect Logic:

dsdrpm > dsdrpm\_raw ----------|

|AND -| IS\_RPM\_NCLIP := 1

ER\_ISC\_REQ = 0 ----------------| | ; dsdrpm has been clipped above

| ; dsdrpm\_raw - minimum clip is active,

| ; ISCKAM learning will be disabled.

|

| --- ELSE ---

|

| IS\_RPM\_NCLIP := 0

| ; No min. clip is active

unconditionally ---------------------| DSDRPM\_LST = DSDRPM

| ; Save last value of DSDRPM

|

| DSDRPM := min(dsdrpm,GPAS\_CLIP)

| ;Then the GPAS constraints.

END: dsdrpm\_output

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IDLE SPEED CONTROL, DESIRED RPM (TOT) CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

13.2.5 IS\_TOT\_RPM CALCULATION (CDAL0)

OVERVIEW

The module provides the null assignment to IS\_TOT\_RPM for all those

strategies that do not have the functional requirement for a TOT based

minimum desired engine speed.

DEFINITIONS

OUTPUTS

Registers:

- IS\_TOT\_RPM = Minimum value of desired engine speed based on TOT

constraints.

PROCESS

STRATEGY MODULE: ISC\_DSDRPM\_TOT\_COM2

BEGIN: dsdrpm\_tot

TOT Based Minimum DSDRPM Clip.

Note : In this strategy, there is no functional requirement

for a TOT based minimum desired RPM. For reasons of

commonality, this module returns a null value.

Unconditionally ----------------------| IS\_TOT\_RPM := 0.0

END: dsdrpm\_tot

13.3 FEATURE: ISC\_DESMAF\_PID - V1.2\_ISC\_DESMAF\_PID (CDAN0)

13.3.1 KAM UPDATE (ISCKAM\_UPDATE) (CDAN0)

OVERVIEW

This section describes the adaptive ISC update routine. In general, under

steady state conditions on a stabilized engine at idle, the adaptive ISC

logic will evaluate whether the open loop prediction of airflow requires

correction. If a correction factor was applied, IPSIBR has a non-zero value,

the adaptive ISC strategy will roll this correction value into KAM and drive

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IDLE SPEED CONTROL, KAM UPDATE - CDAN2

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the IPSIBR term back to zero. Control of the rate at which the IPSIBR value

is driven to zero is calibration-dependent.

There are six ISCKAM cells designated for idle corrections. The appropriate

cell is pointed to by the flag ISFLAG which tracks the load state at idle.

The following logic must be satisfied to update KAM:

\* In RPM control

\* Within the RPM deadband for a calibrated time interval (UPDISC)

\* No hi-cam adder present (HCAMFG = 0)

\* No kam errors

\* IBGPSI >= UPDATM

\* ISCKAM learning overide flag, ISCKAM\_HLT, is clear. For example, PCOMP

is off

\* IPSIBR non zero

ISCKAM corrections are clipped to the same maximum and minimum limits as the

C/L RPM integrator (PSIBRM/PSIBRN). Each time the update criteria are

satisfied both IPSIBR and ISCKAM are adjusted one bit (0.00024 ppm) in

opposite directions until IPSIBR = 0.

If the KAM cells are invalid the fault flag KAM\_ERROR will have been set. In

this situation the ISCKAM cells will be zeroed and ISCKAM updates will be

inhibited until the KAM\_ERROR flag is clear.

An error flag IAC\_ERR3 is used to indicate an error condition associated with

the KAM logic. This flag is processed by the FMEM module and is used in the

OBDII executive routine.

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IDLE SPEED CONTROL, KAM UPDATE - CDAN2

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DEFINITIONS

Registers:

- IAC\_ERR3 = IAC error flag used for KAM malfunction detection.

- IBGPSI = Background loop counter, used to pace ISCKAMn update.

- IPSIBR = The closed loop integration component of total DESMAF, ppm.

Designed to provide integral feedback, IPSIBR adjusts the value of DESMAF

to correct for sustained changes in idle load. An increase or decrease

in IPSIBR results in a corresponding change to bypass valve duty cycle.

- ISCKAMn = Adaptive ISC correction for each load condition n, where n is

the value of ISFLAG. The calculated value of ISCKAMn is added to the

total desired idle air flow (DESMAF).

- ISCTMR = RPM sample timer for adaptive ISC, (0.125 secs). Timer is

cleared if |RPMERR\_A| exceeds the rpm deadband, RPMDED.

- ISKSUM = CHECKSUM for adaptive idle speed KAM cells, used in KAM

initialization strategy.

- RPMERR\_A = Filtered value of RPMERR for airflow control, time constant

TCBPA.

Bit Flags:

- CTPTFG = Closed throttle to part/wide open throttle transistion flag; 1->

transistion occurred

- HCAMFG = Flag indicating the completion of Hi-Cam; 0 -> no desired engine

speed adder exists, 1 -> an rpm adder above base idle is present. Flag

is used in the ISC adaptive update routine to disable updates when HCAMFG

= 1.

- ISCFLG = ISC mode indicator flag; -1 -> Dashpot Mode; 0 -> Dashpot

Preposition Mode; 1 -> Closed Loop RPM Control Mode; 2 -> Closed Loop RPM

Control (Lock-out entry to RPM control)

- ISFLAG = Idle load state indicator used to select the ISCKAM cell.

- ISLAST = Value of ISFLAG from last background pass.

- ISCKAM\_HLT = ISCKAM learning override flag. When set ISCKAM learning is

disabled.

- KAM\_ERROR = KAM error flag; 1 -> KAM data invalid.

Calibration Constants:

- PSIBRM = Maximum allowed value for ISCKAMn. ISCKAMn is clipped to this

value.

- PSIBRN = Minimum allowed value for ISCKAMn. ISCKAMn is clipped to this

value.

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IDLE SPEED CONTROL, KAM UPDATE - CDAN2

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- RPMDED = Adaptive ISC learning deadband. Learning is disabled if

RPMERR\_A exceeds this deadband.

- UPDATM = Pacing at which the IPSIBR correction factor is rolled into KAM.

Value is in terms of background loop counts.

- UPDISC = Time that engine speed must be within the specified deadband

(RPMDED) prior to KAM update.

CALIBRATION INFORMATION

The following typical values are provided for calibration constants:

- RPMDED = 50 rpm.

- UPDATM = 5 background passes.

- UPDISC = 2 seconds.

PROCESS

STRATEGY MODULE: ISC\_ISCKAM\_COM1

BEGIN: ISCKAM\_UPDATE

; ISCTMR (Update) timer control:-

; The Full description of the strategy describing ISCTMR

; functionality is given in the Timer chapter. The following

; logic is actually implemented within the ISCKAM update code.

|RPMERR\_A| > RPMDED --------|

; speed outside range |AND -| ISCTMR := 0

| |

ISCFLG = 1 -----------------| |

; In Closed loop RPM control |

| --- ELSE ---

|

| ; Increment free

| ; running ISCTMR

; ISCKAM\_HLT flag update:

unconditionally ------------------| Do: ISCKAM\_HLT\_UPDATE

| ; update ISCKAM\_HLT flag

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IDLE SPEED CONTROL, KAM UPDATE - CDAN2

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; KAM Error check, Update IBGPSI and determine whether time to update KAM

KAM\_ERROR = 1 --------------------|

|

ISCKAMn < PSIBRN -----------------|

;less than minimum |OR --| Do: ISCKAM\_CLEAR

| | ;ISCKAM is invalid

ISCKAMn > PSIBRM -----------------| | ;kam check failed

;greater than maximum | ;or ISC cells

| ;corrupted

| IBGPSI := 0

| ;zero counter

|

| --- ELSE ---

ISCFLG <> 1 ----------------------| |

;not in closed loop ISC | |

| |

ISCTMR < UPDISC ------------------| |

;speed not in range long enough | |

| |

HCAMFG = 1 -----------------------| |

;HICAM mode- learning disabled |OR --| IBGPSI := 0

| | ;zero counter

ISCKAM\_HLT = 1 -------------------| |

;ISCKAM learning disabled | |

| |

IPSIBR = 0 -----------------------| |

;no integral correction | |

| |

ISFLAG <> ISLAST -----------------| |

;Load State Transistion | |

| |

CTPTFG = 1 -----------------------| |

;Transistion from closed throttle |

| --- ELSE ---

|

IBGPSI >= UPDATM -----------------------| IBGPSI := 0

;time to update KAM | IAC\_ERR3 := 0

| ;clear IAC KAM error flag

| Do: ISCKAM\_FINAL

|

| --- ELSE ---

|

| IBGPSI := IBGPSI + 1

| ; increment KAM update counter

| ; and clip at maximum.

END: ISCKAM\_UPDATE

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IDLE SPEED CONTROL, KAM UPDATE - CDAN2

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BEGIN: ISCKAM\_CLEAR

;This process is executed only when called from, or via, ISCKAM\_UPDATE

Unconditionally --------------------------| ISCKAM(0) := 0.0

| ISCKAM(1) := 0.0

| ISCKAM(2) := 0.0

| ISCKAM(3) := 0.0

| ;Assume ISCKAM cells are invalid

| ; and reinitialize to zero

| ISKSUM := 0

| ; Zero check-sum

END: ISCKAM\_CLEAR

BEGIN: ISCKAM\_FINAL

;This process is executed only when called from ISCKAM\_UPDATE

IPSIBR > 0 -----------------------|

|AND -| Increment ISCKAMn

ISCKAMn < PSIBRM -----------------| | Increment ISKSUM

| Decrement IPSIBR

|

| --- ELSE ---

IPSIBR <= 0 ----------------------| |

|AND -| Decrement ISCKAMn

ISCKAMn > PSIBRN -----------------| | Decrement ISKSUM

| Increment IPSIBR

|

| --- ELSE ---

ISCKAMn = PSIBRN ----------------| |

|OR --| IAC\_ERR3 := 1

ISCKAMn = PSIBRM ----------------| | ;set error code

;KAM at limits | ;kam on limit

|

| --- ELSE ---

|

| No Action

END: ISCKAM\_FINAL

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IDLE SPEED CONTROL, ISCKAM\_HLT FLAG CONTROL - CDAN2

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13.3.2 ISCKAM\_HLT FLAG CONTROL (CDAN0)

OVERVIEW

This section describes the determination of the ISCKAM\_HLT. This flag is

used to disable KAM learning. This version of the module returns the enable/

disable learn status based on PCOMP requirements.

DEFINITIONS

Bit Flags:

- FLOW\_RUNNING = Purge flow monitor test is running flag; 1 -> test is

running.

- ISCKAM\_HLT = ISCKAM learning override flag; used to disable ISCKAM

learning when set.

- PCOMP\_ENA = PCOMP strategy enabled flag; 1 -> PCOMP is enabled; adaptive

fuel disabled.

Calibration Constants:

- PRG\_FLOW\_SW = Calibration switch indicating if Purge Flow test is

present.

- PUR\_ENA\_SW = Purge enable switch for adaptive ISC control; 0 -> adaptive

ISC is enabled during purge, 1 -> IPSIBR is reset after purge and ISCKAM

is disabled during purge, 2 -> ISCKAM is disabled during purge. Note

that ISCKAM learning is enabled/disabled via the ISCKAM\_HLT flag.

PROCESS

STRATEGY MODULE: ISC\_ISCKAM\_HLT\_COM2

BEGIN: ISCKAM\_HLT\_UPDATE

PRG\_FLOW\_SW = 1 ------------|

;Test is valid |AND -|

| |

FLOW\_RUNNING = 1 -----------| |

;purge flow test is active |OR --| ISCKAM\_HLT = 1

| | ; Disable ISCKAM

PUR\_ENA\_SW >= 1 ------------| | | ; learning

|AND -| |

PCOMP\_ENA = 1 --------------| |

;Pcomp is enabled |

| --- ELSE ---

|

| ISCKAM\_HLT := 0

| ; Enable ISCKAM

| ; learning

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IDLE SPEED CONTROL, ISCKAM\_HLT FLAG CONTROL - CDAN2

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END: ISCKAM\_HLT\_UPDATE

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IDLE SPEED CONTROL, IPSIBR CALCULATION - CDAN2

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13.3.3 IPSIBR CALCULATION (CDAN0)

OVERVIEW

IPSIBR is the closed loop integration component of total DESMAF. Designed to

provide integral feedback, IPSIBR adjusts the value of DESMAF to correct for

sustained changes in idle load. An increase or decrease in IPSIBR results in

a corresponding change to bypass valve duty cycle.

The IPSIBR calculation has the following characteristics:

- IPSIBR is only updated in rpm control or lockout mode.

- Different time constants are used depending on whether RPM is too high or

too low.

- IPSIBR is not updated if the ISC valve is at its maximum position, i.e

ISCDTY > 99%. Nor is it updated if the requested idle mass airflow,

DEBYMA, is below the minimum clip, DEBYCP.

- IPSIBR is not updated if the closed loop air mass correction term,

IPSIBR, is already at its maximum or minimum value (PSIBRM and PSIBRN,

respectively).

- On load state transitions (A/C, N/DR and CT/PT), IPSIBR is always clipped

to zero as a minimum.

- The IPSIBR update has no deadband. Instead, it is driven by an RPM error

term RPMERR\_A (A for "air"). The time constant is TCBPA.

- Calibration of gain is not required. The term (DESMAF\_PRE / DSDRPM) in

the ISCPSI calculation automatically adjusts the gain for RPM,

temperature and accessory loads.

- The IPSIBR pacing calibration is controlled by the two scalars TC\_OVER

and TC\_UNDER for speed higher and lower than desired, respectively.

These scalars represent time constants for the engine to respond to

changes in duty cycle.

- This module also determines if an OBDII error condition has occurred.

IAC\_ERR1 and IAC\_ERR2 are used to indicate over/underspeed conditions

respectively.

- To eliminate speed hang up on entry to c/loop ISC caused by abnormal

loading when last in c/loop, an optional IPSIBR clip is provided

(IPSIMAX). The clip functions in dashpot and dashpot prepositioning

load. This concern may be apparent with a high clutch switch operating

point. It is important that the clip is calibrated high enough to cope

with the green engine condition.

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IDLE SPEED CONTROL, IPSIBR CALCULATION - CDAN2

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DEFINITIONS

Registers:

- BG\_TMR = Background loop time, secs.

- DASPOT = Dashpot contribution to idle air flow, ppm. Used to provide a

preposition air flow in Part Throttle and Wide Open Throttle Modes, which

is "bled off" after a transition to Closed Throttle. This gradual air

decrement allows a smooth transition to RPM control.

- DEBYMA = Desired airflow through the ISC actuator (ppm).

- DESMAF = Total desired idle air flow, ppm. Calculated as the sum of

predicted air flow (DESMAF\_PRE), dashpot air flow (DASPOT), integral air

flow (IPSIBR) and KAM correction (ISCKAMn).

- DESMAF\_PRE = Predicted desired idle air flow, ppm. This is the open loop

air flow prediction which is required to idle, calculated as a function

of ECT and time since start and including A/C, power steering and heated

windshield adders. It does not include any closed loop or KAM

corrections.

- DSDRPM = Desired RPM. Used as the control speed for closed loop RPM

control.

- FLOW\_RUNNING = Purge flow monitor test is running flag; 1 -> test

running.

- IPSIBR = The closed loop integration component of total DESMAF, ppm.

Designed to provide integral feedback, IPSIBR adjusts the value of DESMAF

to correct for sustained changes in idle load. An increase or decrease

in IPSIBR results in a corresponding change to bypass valve duty cycle.

- ISC\_A\_DER = Derivative control term used to modify DESMAF. Contains the

output of FN851A.

- ISC\_A\_PROP = Proportional control term used to modify DESMAF. Contains

the output of FN852A.

- ISCKAM = Adaptive correction for each load condition.

- ISCPSI = The quantity of air which is added to IPSIBR each background

pass.

- ISLAST = Register which tracks the state of engine load from the previous

background pass. Used in determining when it is necessary to increment

the filtered air mass (FAM) and clip the C/L idle speed integrator to a

minimum value.

- RPMERR = RPMERR(DESIRED RPM - N) for spark feedback.

- RPMERR\_A = Filtered value of RPMERR, time constant TCBPA.

- RPMERR\_DAO = Old value of RPMERR\_DA, for input to FN851A.

- RUNUPTMR = Time since runup rpm exceeded (0.125 secs).

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IDLE SPEED CONTROL, IPSIBR CALCULATION - CDAN2

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Bit Flags:

- CTPTFG = Closed throttle to Part/Wide Open Throttle transition flag; 1 ->

Transition occurred.

- IAC\_ERR1 = IAC error flag used for malfunction detection - overspeed.

- IAC\_ERR2 = IAC error flag used for malfunction detection - underspeed.

- ISCFLG = ISC MODE Flag; -1 -> Dashpot mode, 0 -> Dashpot Preposition

mode, 1 -> RPM Control mode, 2 -> RPM Control Lockout mode.

- ISFLAG = Idle load indicator, set according to the current state of the

A/C (on or off) and of the transmission (neutral or drive).

- LPCOMP\_ENA = State of PCOMP\_ENA last background pass.

- PCOMP\_ENA = PCOMP strategy enabled flag.

- PDL\_ERROR = PRNDL error detected and verified.

Calibration Constants:

- DEBYCP = Minimum value of ISC valve airflow, ppm.

- FN851A(RPMERR\_DAO - RPMERR) = Derivative control function used to modify

DESMAF.

- FN852A(RPMERR) = Proportional control function used to modify DESMAF.

- IAC\_HI\_LIM = Level of RPMERR\_A to set fault flag IAC\_ERR1.

- IAC\_LO\_LIM = Level of RPMERR\_A to set fault flag IAC\_ERR2.

- IPSIMAX = Maximum IPSIBR clip value when in dashpot or dashpot

preposition modes.

- IPSI\_SW = Calibration switch to use IPSIMAX; 1 -> IPSIBR is clipped to

IPSIMAX in dashpot and dashpot preposition modes.

- IPSIDLY = Time delay to disable IPSIBR update, secs.

- PRG\_FLOW\_SW = Calibration switch indicating if Purge Flow test is present

- PUR\_ENA\_SW = Purge enable switch for adaptive ISC control; 0 -> ISCKAM

enabled, 1 & 2 -> Freeze ISCKAM; 1 -> Reset IPSIBR.

- PSIBRM = Maximum allowed value for IPSIBR when in normal strategy.

- PSIBRN = Minimum allowed value for IPSIBR when in normal strategy.

- TC\_OVER = Time constant used to control the integral gain (or pacing) of

the term, IPSIBR. TC\_OVER is used when RPMERR <= 0, ie when the actual

speed is higher than desired. A large value of TC\_OVER corresponds to a

small integral gain, a small value corresponds to a high gain.

- TC\_UNDER = As with TC\_OVER but for overspeed conditions, i.e RPMERR > 0.

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IDLE SPEED CONTROL, IPSIBR CALCULATION - CDAN2

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PROCESS

STRATEGY MODULE: ISC\_IPSIBR\_COM2

BEGIN: IPSIBR\_CALC

; Set integrator error flags & calculate integral update term, ISCPSI

ISCFLG <= 0 ------------------------|

;dashpot or dashpot preposition |OR --| ;do not update IPSIBR unless

| | ;in RPM Control or RPM Control

RUNUPTMR < IPSIDLY -----------------| | ;lockout.

;delay IPSIBR update after start | ISCPSI = 0

| IAC\_ERR1 = 0

| IAC\_ERR2 = 0

|

| --- ELSE ---

PDL\_ERROR = 0 ----------------------| |

| |

RPMERR\_A < IAC\_HI\_LIM --------------|AND -| IAC\_ERR1 = 1

;large overspeed error | | ;Set malf. overspeed flag.

| | ;flag used in FMEM test

DEBYMA <= DEBYCP -------------------| | ISCPSI = 0

;actuator airflow at minimum | ;actuator minimum airflow,

| ;no change to IPSIBR

|

| --- ELSE ---

RPMERR\_A >= IAC\_LO\_LIM -------------| |

;large underspeed error | |

|AND -| IAC\_ERR2 = 1

IPSIBR >= PSIBRM -------------| | | ;Set malf. underspeed flag.

;IPSIBR at limit |OR --| | which is used in FMEM test

| | ISCPSI = 0

ISCDTY > 0.99 ----------------| | ;no change to IPSIBR as

; Valve fully open | integrator at maximum

| or valve fully open

|

| --- ELSE ---

RPMERR\_A < 0 -----------------| |

;overspeed error |AND -| |

| | |

DEBYMA <= DEBYCP -------------| | |

;actuator airflow at minimum |OR --| ISCPSI = 0

| | ;actuator minimum airflow

RPMERR\_A >= 0 ----------------| | | ;or

;underspeed error | | | ;integrator at maximum

|AND -| | ;or

IPSIBR >= PSIBRM -------| | | ;Valve fully open

;IPSIBR at limit |OR --| | IAC\_ERR1 = 0

| | IAC\_ERR2 = 0

ISCDTY > 0.99 ----------| | ;clear error flags

; Valve fully open | ;rpm error limits not

| ;exceeded

|

| --- ELSE ---

|

| IAC\_ERR1 = 0

| IAC\_ERR2 = 0

| ;OK to adjust IPSIBR

| DO: ISCPSI\_CALC

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IDLE SPEED CONTROL, IPSIBR CALCULATION - CDAN2

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;Calculate minimum integrator clip

ISFLAG <> ISLAST -----------------|

(load state transition) |OR --| min\_clip := 0.0

| | ;Set IPSIBR min. clip to zero

CTPTFG = 1 -----------------------| |

(transition out of CT) |

| --- ELSE ---

|

| min\_clip := PSIBRN

| ;Set IPSIBR min clip to PSIBRN

;Calculate maximum integrator clip:

IPSI\_SW = 1 ----------------------|

;clip required |AND -| max\_clip := IPSIMAX

| |

ISCFLG <= 0 ----------------------| |

;dashpot or dashpot pre-position |

| --- ELSE ---

|

| max\_clip := PSIBRM

;Determine IPSIBR:

PRG\_FLOW\_SW = 0 --------------|

;Test not valid |OR --|

| |

FLOW\_RUNNING = 0 -------------| |

; Don't allow reset if set. |

|

IPSIBR < 0.0 -----------------------|

;reset won't cause stumble |

|

LPCOMP\_ENA = 1 ---------------------|AND -| IPSIBR := 0.0

;pcomp enabled last loop | | ;If it is non-positive,

| | ;and flow test is not

PCOMP\_ENA = 0 ----------------------| | ;running, or flow test is

;pcomp is off | | ;not valid, ..then ...

| | ;reset IPSIBR on exiting purge.

PUR\_ENA\_SW = 1 ---------------------| |

;ipsibr reset switch |

| --- ELSE ---

|

| ipsibr\_tmp := IPSIBR + ISCPSI

| IPSIBR := CLIP(ipsibr\_tmp,

| min\_clip,max\_clip)

| ; Clip IPSIBR between limits

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IDLE SPEED CONTROL, IPSIBR CALCULATION - CDAN2

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CONTINUE: IPSIBR\_CALC

;Calculate Proportional and Derivative ISC terms

ISCFLG > 0 -----------------------|

(RPM control or lockout) |AND -| ISC\_A\_PROP = FN852A(RPMERR)

| | ISC\_A\_DER =

RUNUPTMR >= IPSIDLY --------------| | FN851A(RPMERR\_DAO - RPMERR)

(delay control after runup) |

| --- ELSE ---

|

| ISC\_A\_PROP = 0

| ISC\_A\_DER = 0

;unconditionally -------------------------| desmaf\_pid := ISC\_A\_PROP +

| ISC\_A\_DER +

| IPSIBR +

| ISCKAM(ISFLAG)

;Determine DESMAF

unconditionally --------------------------| DESMAF := DESMAF\_PRE + desmaf\_pid

| + DASPOT

Set LPCOMP\_ENA flag

unconditionally --------------------------| LPCOMP\_ENA = PCOMP\_ENA

END: IPSIBR\_CALC

BEGIN: ISCPSI\_CALC

;This process is executed only when called from IPSIBR\_CALC

;Calculate ISCPSI

RPMERR\_A >= 0 ----------------------| ISCPSI = RPMERR\_A \* DESMAF\_PRE/DSDRPM \*

| BG\_TMR/TC\_UNDER

|

| --- ELSE ---

|

| ISCPSI = RPMERR\_A \* DESMAF\_PRE/DSDRPM \*

| BG\_TMR/TC\_OVER

END: ISCPSI\_CALC

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IDLE SPEED CONTROL, ISLAST AND ISFLAG LOGIC - CDAN2

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13.3.4 ISLAST And ISFLAG LOGIC (CDAL0)

OVERVIEW

This logic control the KAM update of ISC cells and which adaptive cell is

active.

DEFINITIONS

Bit Flags:

- AC\_PPM\_RQST = Flag to request an air adder to compensate for A/C load; 1

-> A/C air requested.

- DNDSUP = Delayed neutral/drive flag; 0 -> in neutral, no load, 1 -> in

drive, loaded.

- ISFLAG = Flag that indicates the degree of loading on the engine at Idle;

0 -> Drive, 1 -> Drive + A/C (WAC Relay De-Energized), 2 -> Neutral, 3 ->

Neutral + A/C (WAC Relay De-Energized).

- ISLAST = Register which indicates the engine load state from the previous

background pass.

- TRLOAD = Transmission Load Switch.

PROCESS

STRATEGY MODULE: ISC\_ISFLAG\_COM1

BEGIN: ISFLAG\_UPDATE

ISLAST:

unconditionally ------------------------| ISLAST := ISFLAG

| ; Represents the value of ISFLAG

| ; from the last program pass.

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IDLE SPEED CONTROL, ISLAST AND ISFLAG LOGIC - CDAN2

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ISFLAG:

Indicates load state. Used to determine which adaptive idle cell is active.

AC\_PPM\_RQST = 0 ------------------|

|

DNDSUP = 1 -----------------------|AND -| ISFLAG := 0

| | ; Auto in drive

TRLOAD > 3 -----------------------| |

| --- ELSE ---

AC\_PPM\_RQST = 1 ------------------| |

| |

DNDSUP = 1 -----------------------|AND -| ISFLAG := 1

| | ; Auto in drive A/C requested

TRLOAD > 3 -----------------------| |

| --- ELSE ---

AC\_PPM\_RQST = 0 ------------------| |

|AND -| ISFLAG := 2

DNDSUP = 0 -----------------| | | ; Manual or Auto in neutral

|OR --| |

DNDSUP = 1 -----------| | |

|AND -| |

TRLOAD <= 3 ----------| |

| --- ELSE ---

AC\_PPM\_RQST = 1 ------------------| |

|AND -| ISFLAG := 3

DNDSUP = 0 -----------------| | | ; Manual or Auto in neutral

|OR --| | ; A/C requested

DNDSUP = 1 -----------| |

|AND -|

TRLOAD <= 3 ----------|

END: ISFLAG\_UPDATE

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IDLE SPEED CONTROL, RPM ERROR CALCULATION - CDAN2

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13.3.5 RPM ERROR CALCULATION (CDAL0)

OVERVIEW

Three separate RPM error calculations are executed in RPMERR\_CALC. An

instantaneous value (RPMERR) is calculated as the difference between the

desired and actual RPM -- positive value of RPMERR is an engine speed below

desired, a negative value indicates engine speed above desired.

Three filtered values of the instantaneous RPMERR are then obtained with

three separate time constants:

- RPMERR\_A: For the bypass air IPSIBR calculation ... tc = TCBPA

- RPMERR\_DA: For the bypass air derivative term ...... tc = TCCBPA\_DER

In addition, RPMERR\_CALC contains the set logic for RUNUP\_FLG, which is used

to disable IPSIBR updates and feedback spark during the initial runup. The

flag is cleared in CRANK/UNDERSPEED/RUN mode selection.

DEFINITIONS

INPUTS

Registers:

- DSDRPM = Desired engine speed. See overview section for definition of

the various uses of this register.

- DSDRPM\_LST = DSDRPM last pass.

- ECTCNT = Number of times the ECT sensor input was read.

- ISCFLG = ISC mode indicator flag; -1 -> Dashpot mode, 0 -> Dashpot

Preposition Mode, 1 -> Closed Loop RPM Control Mode, 2 -> Closed Loop RPM

Control (Lock-out entry to RPM control).

- N = Engine RPM.

- RPMERR = RPMERR(DESIRED RPM - N) for spark feedback

- RPMERR\_A = Filtered rpm error for bypass air calculations.

- RPMERR\_DA = Filtered RPM for ISC\_A\_DER DERTERM.

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

- RUNUP\_FLG = Flag indicating initial runup is complete; 1 -> runup

complete.

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IDLE SPEED CONTROL, RPM ERROR CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- DSDRPM\_OFF = Offset from DSDRPM for derivative air control, rpm.

- RUNUP\_DIFF = RPM difference from DSDRPM to set RUNUP\_FLG = 1.

- RUNUP\_DIFF\_A = Alternate calibration RPM difference from DSDRPM to set

RUNUP\_FLG = 1.

- TCBPA = Time constant for RPMERR\_A.

- TCBPA\_DER = Time constant for RPMERR\_DA.

OUTPUTS

Registers:

- RPMERR = Instantaneous rpm error (DSDRPM - N).

- RPMERR\_A = See above.

- RPMERR\_DA = Filtered RPM for ISC\_A\_DER DERTERM.

- RPMERR\_DAO = Old RPMERR\_DA

Bit Flags:

- RUNUP\_FLG = See above.

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IDLE SPEED CONTROL, RPM ERROR CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ISC\_RPMERR\_COM3

BEGIN: RPMERR\_CALC

Unconditionally ----------------| RPMERR := DSDRPM - N

ALT\_CAL\_FLG = 1 ----------------| pre\_runup := RUNUP\_DIFF\_A

|

| --- ELSE ---

|

| pre\_runup := RUNUP\_DIFF

DSDRPM = DSDRPM\_LST ------|

|AND -| RPMERR\_DAO := RPMERR\_DA

N < DSDRPM + DSDRPM\_OFF --| | RPMERR\_DA := ROLAV(RPMERR,TCBPA\_DER)

|

| --- ELSE ---

|

| RPMERR\_DAO := RPMERR

| RPMERR\_DA := RPMERR

ISCFLG > 0 ---------------------| RPMERR\_A := ROLAV(RPMERR,TCBPA)

; RPM control or lockout | ; calculate RPM error for airflow control

|

| --- ELSE ---

|

| RPMERR\_A := RPMERR

END: RPMERR\_CALC

BEGIN: RUNUP\_FLG\_UPDATE

ECTCNT >= 8 --------------|

; TCSTRT OK to use |

|

N > DSDRPM + pre\_runup ---|AND -| RUNUP\_FLG := 1

; Runup RPM exceeded | | ; initial runup complete

| |

RUNUP\_FLG = 0 ------------| |

; First time this start) |

| --- ELSE ---

|

| No change to RUNUP\_FLG

END: RUNUP\_FLG\_UPDATE

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IDLE SPEED CONTROL HCAMFG LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

13.3.6 HCAMFG LOGIC (CDAL0)

OVERVIEW

This logic determines the state of the HCAMFG flag. This flag was originally

used to denote that an elevated RPM above base idle was being requested by

the ISC system, e.g cold start conditions. In these circumstances, ISCKAM

airflow correction learning is disabled via the HCAMFG flag. The status of

the flag also has implications within the adaptive fuel strategy - see HCAMSW

and the 'special idle KAM cells'.

DEFINITIONS

Registers:

- HICAM = symbol used to represent the hi-cam adders to DSDRPM.

Bit Flags:

- COOL\_FLG = Flag indicating over temperature conditions; 1 -> Over

temperature.

- HCAMFG = Flag indicating the completion of Hi-Cam; 0 -> no desired engine

speed adder exists, 1 -> an RPM adder above base idle is present. Flag

is used in the ISC adaptive update routine to disable updates when HCAMFG

= 1.

- IS\_RPM\_NCLIP = Flag indicating whether DSDRPM has been clipped to a

minimum value (Clipped = 1) - Used to set HCAMFG in order to disable

ISCKAM learning.

- POWSFG = Flag used to indicate that power steering load is high; 1 ->

power steering on.

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IDLE SPEED CONTROL HCAMFG LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ISC\_HCAMFG\_COM1

BEGIN: HCAMFG\_UPDATE

HCAMFG Logic: Flag is used to disable updates of adaptive idle cells

(ISCKAM).

HICAM <> 0 -----------------------|

; RPM adders present |

|

IS\_RPM\_NCLIP = 1 -----------------|

; DSDRPM has been min.clipped |OR --| HCAMFG := 1

| |

POWSFG = 1 -----------------------| |

;power steering on | |

| |

COOL\_FLG = 1 ---------------------| |

;Over temperature set. |

| --- ELSE ---

|

| HCAMFG := 0

END: HCAMFG\_UPDATE

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IDLE SPEED CONTROL, DESIRED MASS AIR FLOW CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

13.4 DESIRED MASS AIR FLOW CALCULATION (CDAJ0)

OVERVIEW

The predicted desired mass air flow (DESMAF\_PRE) is the airflow which is

expected to be required to provide a particular engine speed. The prediction

is a function of DSDRPM, ECT, ATMR3 (time since entering run mode), power

steering, A/C, and heated windshield. This term is later added to an

integration term (IPSIBR), a dashpot term (DASPOT), and an adaptive term

(ISCKAM), to produce the total DESMAF.

FN875N and D are functions of DSDRPM. This means that, if a DSDRPM adder is

used for powersteering or A/C, the airflow to give the rpm increase is

already accounted for in DESMAF\_PRE. AC\_PPM, PS\_PPM, and EDF\_PPM represent

only the airflow needed for the increased load, not the increased rpm.

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IDLE SPEED CONTROL, DESIRED MASS AIR FLOW CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- AC\_PPM = AC delta air mass, calculated.

- ATMR3 = Timer which counts up in run mode. (Reset to 0 only at powerup).

- CYLOFF\_PPM = Airflow compensation for cylinder cutout during fail safe

cooling.

- EAM\_ANTICIP = Requests additional idle air flow when air pump is on.

- EAM\_PPM = Airflow increment required for Secondary Air pump load.

- ECT = Engine coolant temperature, deg. F.

- EDF\_PPM = Airflow increment required when electro-drive speed fan is on.

- PS\_PPM = Airflow increment required for power steering load.

- VSBAR = Filtered vehicle speed.

Bit Flags:

- DNDSUP = Delayed neutral/drive flag; 0 -> in neutral, no load, 1 -> in

drive, loaded.

Calibration Constants:

- FN812(N) = EAM airflow adder.

- FN875D(DSDRPM) = Airflow required for closed throttle operation in drive.

Input to this function is absolute DSDRPM.

\*\* Airflow requirements must be measured as accurately as possible

over a representative population of vehicles. Data should be

collected over a range of anticipated desired speeds on a stabilized

engine for both neutral and drive (a temperature modulator (FN1862N or

FN1862D) will automatically adjust calibrated airflow to account for

increased requirements at low ambients).

A hot wire airmeter can be remotely mounted to measure airflow

directly over the desired speed range. Equipment is available at

APTL to perform this procedure.

- FN875N(DSDRPM) = Airflow required for closed throttle operation in

neutral. Input to this function is absolute DSDRPM.

- FN1862D = Drive airflow multiplier. Used to compensate for additional

friction at startup.

X = FN020C(ECT)

Y = FN018B(ATMR3)

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IDLE SPEED CONTROL, DESIRED MASS AIR FLOW CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FN1862N = Neutral airflow multiplier. Used to compensate for additional

friction at startup.

X = FN020C(ECT)

Y = FN018B(ATMR3)

- TRLOAD = Transmission Load switch:

0 -> Manual transmission, no clutch or gear switch, NDSFLG = 0

1 -> Manual trans, no clutch or gear switch

2 -> Manual trans, one clutch or gear switch

3 -> Manual trans, both switches

4 -> Automatic trans, NDS

5 -> Automatic trans, NPS

6 -> Automatic trans, 7 position PRNDL

7 -> Automatic trans, PRNDL switches (4EAT)

OUTPUTS

Registers:

- DESMAF\_PRE = Predicted desired idle air flow, ppm. This is the open loop

air flow prediction which is required to idle, calculated as a function

of

ECT and time since start and including A/C, power steering and heated

windshield adders. It does not include any closed loop or KAM

corrections,

and is NOT DISPLAYABLE.

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IDLE SPEED CONTROL, DESIRED MASS AIR FLOW CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ISC\_DESMAF\_COM1

BEGIN: DESMAF\_PRE\_CALC

;FN1862 and FN875 select logic:

TRLOAD <= 3 ------------|

|OR --| desmaf\_pre\_tmp = FN875N(DSDRPM) \*

DNDSUP = 0 -------------| | FN1862N(ECT,ATMR3)

;auto trans in neutral |

| --- ELSE ---

|

| desmaf\_pre\_tmp = FN875D(DSDRPM) \*

| FN1862D(ECT,ATMR3)

;EAM\_PPM logic:

EAM\_ANTICIP = 1 --------------| EAM\_PPM = FN812

(EAM load anticipation) |

| --- ELSE ---

|

| EAM\_PPM = 0

;Final DESMAF\_PRE determination:

unconditionally --------| Do: AC\_PPM\_CALC

| Do: EDF\_PPM\_CALC

| Do: CYLOFF\_PPM\_CALC

| Do: PS\_PPM\_CALC

| DESMAF\_PRE = desmaf\_pre\_tmp + AC\_PPM + EAM\_PPM +

| PS\_PPM + EDF\_PPM + CYLOFF\_PPM

END: DESMAF\_PRE\_CALC

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IDLE SPEED CONTROL, ACPPM CALCULATION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

13.5 ACPPM CALCULATION (CDAL0)

OVERVIEW

This module calculates the value of AC\_PPM to be used by ISC\_DESMAF\_COMx and

supports systems with or without an A/C head pressure transducer input to the

EEC.

The AC\_PPM value is zero when there is to be no adder used, ie. the AC is

off. It includes an RPM based term, to overcome the inertia of the

compressor and terms to compensate for AC Head Pressure effects (based on

either ACPRES or ACT dependent on hardware). A time function is included in

the Inertia compensation calculation.

The actual AC Pressure load on the compressor is a function of both the

differential pressure across it and the pressure level. Separate pressure

compensation terms are therefore provided for the first engagement (where the

suction and head pressures are equal) and the cycling condition.

DEFINITIONS

Registers:

- AC\_PPM = A/C delta Airmass - calculated.

- AC\_PPM\_TMR = Timer for shaping ACPPM air adder, sec.

- ACPRES = A/C head pressure, PSI.

- ACT = Air charge temperature deg. faren.

- N = RPM.

Bit Flags:

- AC\_PPM\_RQST = Request ISC Air for A/C loading.

- AC\_CYCLE\_FLG = A/C is cycling when set.

Calibration Constants:

- ACPSEN\_HP = A/C Pressure Sensor Hardware Present Switch.

- FN881 = A/C airflow as function of ACPRES.

- FN881NC = A/C airflow as function of ACPRES - Non-cycling condition.

- FN885 = A/C airflow for Compressor Inertia.

- FN885TE = Time dependent multiplier for Compressor Inertia Fn885 -

EXTENDED RANGE.

- FN887 = A/C airflow correction as function of ACT.

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IDLE SPEED CONTROL, ACPPM CALCULATION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FN887NC = A/C airflow correction as function of ACT - Non-cycling

condition.

PROCESS

STRATEGY MODULE: ISC\_DESMAF\_ACPPM\_COM3

BEGIN: AC\_PPM\_CALC

;AC\_PPM logic:

AC\_PPM\_RQST = 0 ------------------------| AC\_PPM = 0

;A/C load not requested |

| --- ELSE ---

AC\_CYCLE\_FLG = 0 -----------------| |

;A/C not cycling |AND -| AC\_PPM = FN885(N) \*

| | FN885TE(AC\_PPM\_TMR)

ACPSEN\_HP = 1 --------------------| | + FN881NC(ACPRES)

;pressure sensor present |

| --- ELSE ---

|

AC\_CYCLE\_FLG = 0 ----------------------| AC\_PPM = FN885(N) \*

;A/C not cycling - no sensor | FN885TE(AC\_PPM\_TMR)

| + FN887NC

|

| --- ELSE ---

|

ACPSEN\_HP = 1 --------------------------| AC\_PPM = FN885(N) \*

;sensor present - cycling | FN885TE(AC\_PPM\_TMR)

| + FN881(ACPRES)

|

| --- ELSE ---

|

| AC\_PPM = FN885(N) \*

| FN885TE(AC\_PPM\_TMR) +

| FN887(ACT)

| ;no pressure sensor and

| cycling

;AC\_PPM\_TMR Control:

AC\_PPM\_RQST = 0 ------------------------| AC\_PPM\_TMR = 0

;A/C load not requested |

| --- ELSE ---

|

| increment AC\_PPM\_TMR

END: AC\_PPM\_CALC

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IDLE SPEED CONTROL, EDFPPM CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

13.6 EDFPPM CALCULATION (CDAN0)

OVERVIEW

This module calculates the value of EDF\_PPM to be used by ISC\_DESMAF\_COMx.

The value is zero when there is to be no adder used, ie. the EDF is off.

DEFINITIONS

INPUTS

Registers

- FANTMR = Time since EDF requested, sec.

Bit Flags:

- EDFHP = Electro Drive Fan hardware present switch.

- LSF\_RQST = Flag indicating that the low speed fan is requested.

Calibration Constants:

- EDF\_DELAY = Time delay before adding EDFPPM to DESMAF\_PRE.

- EDFPPM = Airflow increment required when electrodrive fan is on.

OUTPUTS

Registers

- EDF\_PPM = EDF delta airmass, calculated.

PROCESS

STRATEGY MODULE: ISC\_DESMAF\_EDFPPM\_COM1

BEGIN: EDF\_PPM\_CALC

;EDF\_PPM logic:

EDFHP = 0 ------------------------------| do nothing

;No EDF Hardware |

| --- ELSE ---

LSF\_RQST = 1 ---------------------| |

|AND -| EDF\_PPM = EDFPPM

FANTMR >= EDF\_DELAY --------------| |

| --- ELSE ---

|

| EDF\_PPM = 0

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IDLE SPEED CONTROL, EDFPPM CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

END: EDF\_PPM\_CALC

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IDLE SPEED CONTROL, CYLPPM CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

13.7 CYLPPM CALCULATION (CDAJ0)

OVERVIEW

This module calculates the value of CYLOFF\_PPM to be used by ISC\_DESMAF\_COMx.

This is part of the failsafe cooling strategy and adds inlet air as a

function of the number of inoperative engine cylinders. The value is zero

under normal operating conditions.

DEFINITIONS

INPUTS

Bit Flags:

- COOL\_FLG = Flag indicating engine overheating; 1 -> Overheating.

Calibration Constants:

- FN813 = Airflow adder as a function of INJ\_ON - cylinder cutout.

OUTPUTS

Registers

- CYLOFF\_PPM = Airflow Compensation for cylinder cutout.

PROCESS

STRATEGY MODULE: ISC\_DESMAF\_CYLPPM\_COM1

BEGIN: CYLOFF\_PPM\_CALC

COOL\_FLG = 1 ---------------------------| CYLOFF\_PPM = FN813

|

| --- ELSE ---

|

| CYLOFF\_PPM = 0

END: CYLOFF\_PPM\_CALC

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IDLE SPEED CONTROL, PS\_PPM CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

13.8 PS\_PPM CALCULATION (CDAJ0)

OVERVIEW

This module calculates the value of PS\_PPM to be used by ISC\_DESMAF\_COMx. It

is for use with a Power Steering Pressure Switch. The value is zero when

there is to be no adder used, ie. the PS is off. The compensation consists

of two different calibrateable constants, dependant upon vehicle speed. When

the vehicle is stopped or moving slowly, a shaped adder is also applied based

upon the time since the PS was engaged.

DEFINITIONS

INPUTS

Registers:

- PS\_PPM = PS delta air mass.

- VSBAR = Filtered vehicle speed.

Bit Flags:

- POWSFG = Power steering flag.

Calibration Constants:

- PSPSHP = Power steering pressure switch "Hardware Present" indicator (0 =

NO, 1 = YES).

- PS\_VS = Speed below which PS PPM addition is enabled units are MPH.

OUTPUTS

Registers:

- PS\_PPM = See above.

- PSPPM = FAM delta AM for power steering load units are LB/MPH.

- PSPPM\_VS = Power steering air adder with vehicle speed moving, lb/sec.

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IDLE SPEED CONTROL, PS\_PPM CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ISC\_DESMAF\_PSPPM\_COM1

BEGIN: PS\_PPM\_CALC

;PS\_PPM logic:

PSPSHP = 0 -----------------------------| do nothing

;PSPS not present |

| --- ELSE ---

|

POWSFG = 0 -----------------------------| PS\_PPM = 0

;power steering off |

|

| --- ELSE ---

|

VSBAR < PS\_VS --------------------------| PS\_PPM = PSPPM + FN822(PSTMR)

;vehicle stationary |

| --- ELSE ---

|

| PS\_PPM = PSPPM\_VS

END: PS\_PPM\_CALC

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IDLE SPEED CONTROL, DASHPOT CALCULATIONS - CDAN2

PED-PTE, PROPRIETARY & CONFIDENTIAL

13.9 DASHPOT CALCULATIONS (CDAJ0)

OVERVIEW

Dashpot Pre-position

Logic controlling the dashpot pre-position airflow is intended to increase

the ISC duty cycle during part/WOT operation. Strategy determines the rate

at which ISC valve flow increases/decreases in part/WOT operation as well as

the maximum allowed pre-position airflow. Adequate pre-position airflow

(DASPOT) is essential prior to entering the dashpot control mode in order to

avoid HC spiking and/or deceleration stalls. The calculated pre-position

airflow increment is added to an adaptively corrected idle flow requirement

(DESMAF) prior to output of the ISC duty cycle. Pre-position airflow

(DASPOT) is a function of the difference between a filtered throttle position

(DSTPBR) and the lowest recorded throttle position (RATCH).

DSTPBR is a time dependent rolling average filter of Throttle position. It

is updated once per background loop while in RUN or Underspeed Mode. The two

time constants, TCDASU and TCDASD are calibratable. TCDASU is used when

DSTPBR is filtering UP to TP. TCDASD is used to filter DSTPBR DOWN to TP.

The DASPOT value is adjusted as TP changes to provide the desired dashpot

action to decelerations as initiated over the range of possible engine

operating conditions, using separate time constants (TCDASU/TCDASD) to

control the response of DSTPBR.

Dashpot Bleed

During Closed Throttle Mode, the DASPOT airflow is "bled off" by decrementing

it. This action smooths the transition into RPM control by gradually

eliminating the DASHPOT contribution to the Idle airflow, DESMAF. The bleed

rate is determined by FN879.

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IDLE SPEED CONTROL, DASHPOT CALCULATIONS - CDAN2

PED-PTE, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- APT = Throttle Mode Flag; -1 -> Closed Throttle, 0 -> Part Throttle,

1 -> Wide Open Throttle.

- DAS\_CTR = Lack of decel recognition counter. Used to select between

FN894H and FN894L.

- DASPOT = Dashpot contribution to idle air flow. Used to provide a

preposition air flow in Part Throttle and Wide Open Throttle Modes, which

is "bled off" after a transition to Closed Throttle. This gradual air

decrement allows a smooth transition to RPM control.

- DNDSUP = Delay neutral/drive flag; 0 -> in neutral, no load, 1 -> in

drive, load.

- DNDT\_DAS = Filtered rate of change of RPM for DASPOT.

- DSDRPM = Desired engine speed.

- DSTPBR = Time dependent rolling average filter of throttle position.

Filtered using TCDASU when filtering UP to TP, and TCDASD when filtering

DOWN to TP.

- GEAR4TMR = Time since 3-4 shift, sec.

- N = Engine revolutions, RPM.

- N\_RATCH = RPM value which only ratchets down. When not at closed

throttle, N = N\_RATCH. When at closed throttle, N\_RATCH is only allowed

to go down. N\_RATCH is an input to the minimum daspot clip. N\_RATCH

ratchets down to prevent rpm flares after a declutch.

- RATCH = Closed throttle position, counts

- TP = Throttle position sensor.

- VSBAR = Vehicle speed, MPH.

Bit Flags:

- FLG\_DASCLP4 = FN894H dashpot minimum clip is not applied in PT/WOT when

clear and DASCLP\_4INH is set.

- FLG\_DASMNQ = VSBAR flip-flop flag for minimum DASPOT clip.

- GEAR4TH = 4TH gear flag; 1 -> 4th gear.

- ISCFLG = ISC mode indicator flag; -1 -> Dashpot Mode, 0 -> Dashpot

Preposition Mode, 1 -> Closed Loop RPM Control Mode, 2 -> Closed Loop RPM

Control (Lock-out entry to RPM control).

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IDLE SPEED CONTROL, DASHPOT CALCULATIONS - CDAN2

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Calibration Constants:

- BRAKE\_DNDT = Threshold for detection of vehicle braking, RPM/sec.

- DAS\_BKDLY = Time delay in 4th gear to recognize vehicle braking, sec.

- DAS\_CNT = Number of DNDT\_DAS samples above DAS\_DNDT to recognize lack of

vehicle deceleration.

- DAS\_CTDLY = Closed throttle time delay before activating the lack of

decel detection, sec.

- DAS\_DNDT = Threshold for detection of lack of vehicle deceleration,

rpm/sec.

- DASCLP\_4INH = Switch controls the FN894H min daspot clip inhibit logic.

- DASPTK = Gain associated with the desired DASPOT airflow. To calibrate

this value first determine the throttle position above RATCH at which

maximum DASPOT airflow is desired. Subtract FN830 from DASMAX and divide

the result by the throttle delta between RATCH and this maximum dashpot

airflow to determine the DASPTK value.

- DELHYS = Closed to part throttle hysteresis in TP counts. DELHYS should

be set equal to DELTA + HYSTS (closed throttle breakpoint). This starts

the dashpot calculation relative to the C.T./P.T. breakpoint to prevent

changes in dashpot when leaving closed throttle.

- DPNEU\_MUL = Neutral DASPOT reduction multiplier. Used to reduce minimum

DASPOT during shift of manual transmission.

- FN830 = Dashpot preposition offset.

- FN879 = A background driven decrement to the dashpot preposition airflow

register (DASPOT) as a function of DASPOT. FN879 can be calibrated to

achieve an exponentially decaying dashpot which is useful in decaying the

large DASPOT values used to control over-rich tip out conditions.

- FN882A(N - DSDRPM) = Maximum dashpot clip as a function of the RPM delta

above desired rpm. (N - DSDRPM) is clipped to 0 as a minimum.

- FN891(VSBAR) = Dashpot maximum clip as a function of vehicle speed. Used

in automatic transmission vehicles at higher vehicle speeds to prevent

harsh backout shifts by limiting large values of dashpot.

- FN894(N\_RATCH - DSDRPM) = Minimum DASPOT airflow clip for 1st, 2nd, and

3rd gears, ppm. For manual transmissions, FN894 can be used to prevent

declutch stalls. The input is N\_RATCH which only ratchets down after the

declutch. This is done to prevent the rpm from hanging up if it flares

after the declutch.

- FN894H(N\_RATCH - DSDRPM) = Minimum DASPOT airflow clip for 4th gear when

vehicle deceleration rate is acceptable, ppm.

- FN894L(N\_RATCH - DSDRPM) = Minimum DASPOT airflow clip for 4th gear when

lack of vehicle deceleration is detected, ppm.

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IDLE SPEED CONTROL, DASHPOT CALCULATIONS - CDAN2

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- TCDASD = Time constant used when TP is less than or equal to the filtered

TP value. Should be calibrated such that part throttle backouts where

closed throttle is not entered do not exhibit a run-on feel. Too fast a

filter can have the effect of greatly reducing dashpot airflow prior to

entry into dashpot control.

- TCDASU = Filter constant used when TP is greater than the filtered TP

value (DSTPBR). The larger the time constant the more slowly

pre-position airflow will be available to respond to tip in/tip out

actions. Fast response can also be obtained by use of the offset value

FN830 without the potential runaway feel that may come with too fast a

filter constant/airflow gain (DASPTK) combination.

OUTPUTS

Registers:

- DASPOT = See above.

- DSTPBR = See above.

CALIBRATION INFORMATION

Typical values are supplied for the following calibration constants:

- DASPTK = 0.002 ppm/TP count

- FN879 = (0,0.001) (0.1,0.002) (0.3,0.006) (0.75,0.05) (2.00,0.10)

- TCDASD = 0.75 sec.

- TCDASU = 3.3 sec.

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IDLE SPEED CONTROL, DASHPOT CALCULATIONS - CDAN2

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PROCESS

STRATEGY MODULE: ISC\_DASPOT\_COM5

BEGIN: DASHPOT\_EXECUTION\_PROCESS

This is the root chart for the ISC\_DASPOT\_COM5 module. It controls execution

of the strategy processes defined in the remainder of the module. The entry

logic to this process is executed in the ISC overview chapter and is repeated

here for clarity only.

MFMFLG = 0 -----------------------|

;MAF sensor function ok |OR -| ; In normal ISC. See ISC\_OVERVIEW

| | \_COM module

TFMFLG = 0 -----------------------| |

;TP function ok | DO: NO\_DECEL\_COUNTER

| DO: DSTPBR\_CALC

| DO: BASE\_DASHPOT\_CALCULATION

| DO: DASHPOT\_MIN\_CLIP

|

| --- ELSE ---

|

| NO ACTION

END: DASHPOT\_EXECUTION\_PROCESS

BEGIN: NO\_DECEL\_COUNTER

LACK OF DECEL COUNTER LOGIC

GEAR4TH = 0 -----------------------|

(1st, 2nd, or 3rd gear) |OR --| DAS\_CTR = 0

| |

CTTMR <= DAS\_CTDLY ----------------| |

(minimum dashpot time) |

| --- ELSE ---

GEAR4TH = 1 -----------------------| |

(4th gear) | |

| |

CTTMR > DAS\_CTDLY -----------------|AND -| Increment DAS\_CTR

(minimum dashpot time) | | (clip to 255 maximum)

| |

DNDT\_DAS > DAS\_DNDT ---------------| |

(no decel) |

| --- ELSE ---

|

| Freeze DAS\_CTR

END: NO\_DECEL\_COUNTER

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IDLE SPEED CONTROL, DASHPOT CALCULATIONS - CDAN2

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BEGIN: DSTPBR\_CALC

DSTPBR is the rolling average of throttle position used to calculate Dashpot

in pre-position mode. Separate time constants are used for opening and

closing throttle conditions.

TP > DSTPBR ----------------| DSTPBR = rolav(TP,TCDASU)

|

| --- ELSE ---

|

| DSTPBR = rolav(TP,TCDASD)

END: DSTPBR\_CALC

BEGIN: BASE\_DASHPOT\_CALCULATION

While at PT or WOT, airflow is added to the DASPOT term to prepare for a

deceleration. At closed throttle, the airflow which was previously added to

the DASPOT term is bled away.

APT >= 0 ---------------------| DASPOT = DASPTK \* (DSTPBR - (RATCH + DELHYS))

;PT or WOT, | + FN830(N-DSDRPM)

Dashpot Pre-position |

mode. | DO: DASPOT\_PREPOS\_CLIP\_MAX

|

| --- ELSE ---

|

| DASPOT = DASPOT - FN879(DASPOT)

| ;Dashpot mode

END: BASE\_DASHPOT\_CALCULATION

BEGIN: DASPOT\_PREPOS\_CLIP\_MAX

(FN882A(N-DSDRPM) \*

FN891(VSBAR)) < 1.99 --------| Clip DASPOT to (FN822A(N-DSDRPM) \*

;(N-DSDRPM) is clipped | FN891(VSBAR)) as a maximum.

to zero min. |

| --- ELSE ---

|

| Clip DASPOT to 1.99 as a maximum

END: DASPOT\_PREPOS\_CLIP\_MAX

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IDLE SPEED CONTROL, DASHPOT CALCULATIONS - CDAN2

PED-PTE, PROPRIETARY & CONFIDENTIAL

BEGIN: DASHPOT\_MIN\_CLIP

MINIMUM DASPOT CLIP LOGIC

The minimum value for DASPOT can come from one of three functions, or it can

be zero (no clip). All three functions use relative rpm above DSDRPM as an

input. One function, FN894, is used for all gears except 4th. 4th gear has

two unique functions which are designed to allow the calibrator to optimize

tip-in/out clunk feel while still having acceptable run-on feel. The two

functions, FN894H & FN894L (for high & low), are intended to be calibrated

such that FN894H gives good clunk control, (close to the zero driveline

torque line), while FN894L is lower, to eliminate vehicle run-on feel. When

a decel is begun in 4th gear, FN894H is always used first. If the logic

detects a lack of deceleration, the minimum clip is dropped to FN894L. Once

the clip has been dropped to FN894L, it does not go back to FN894H until

reset by a part throttle or a downshift. FN894 is always used in 1st, 2nd,

and 3rd gears. Certain special conditions will cause the dashpot to bleed

all the way down to zero (no clip). The flag FLG\_DASCLP4 is used to prevent

the application of a high minimum daspot clip from FN894H when exiting closed

throttle in fourth gear and is provided to overcome interaction concerns with

the cruise control system.

Manual transmission packages do not use FN894H and FN894L. In this case,

FN894 is intended to be used to prevent de-clutch stalls.

APT >= 0 ----------|

; Part or Wide |

Open throttle |AND ------|S Q-| FLG\_DASCLP4

| |

DASPOT >= FN894H --| |

|

APT = -1 ---------------------|C

: Closed throttle

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IDLE SPEED CONTROL, DASHPOT CALCULATIONS - CDAN2

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GEAR4TMR > DAS\_BKDLY --------|

(time since 4th gear) |AND -|

| |

DNDT\_DAS < BRAKE\_DNDT -------| |

(brakes applied) |

|

DNDSUP = 0 ------------------| |

(in neutral or clutch in) |AND -|

| |OR --| no minimum clip

TRLOAD > 3 ------------------| | |

(automatic transmission) | |

| |

TFMFLG = 1 ------------------------| |

(failed TP sensor) | |

| |

FLG\_DASMNQ = 0 --------------------| |

(low vehicle speed) | |

| |

DASCLP\_4INH = 1 - -----------| | |

;Caln switch set | | |

| | |

APT >= 0 --------------------| | |

Part or WOT |AND -| |

| |

GEAR4TH = 1 -----------------| |

| |

FLG\_DASCLP4 = 0 -------------| |

|

|

| --- ELSE ---

GEAR4TH = 0 -----------------------| |

(1st, 2nd, or 3rd gear) | | clip DASPOT to

|OR --| FN894(N\_RATCH - DSDRPM)

TRLOAD <= 3 -----------------| | | as a minimum

(manual trans) |AND -| |

| |

DNDSUP = 1 ------------------| |

(in gear) |

| --- ELSE ---

|

TRLOAD <= 3 -----------------------------| clip DASPOT to

(Manual trans, in neutral) | FN894(N\_RATCH - DSDRPM) \*

| DPNEU\_MUL as a minimum

|

| --- ELSE ---

|

DAS\_CTR >= DAS\_CNT ----------------------| clip DASPOT to

(lack of deceleration) | FN894L(N\_RATCH - DSDRPM)

| as a minimum

|

| --- ELSE ---

|

| clip DASPOT to

| FN894H(N\_RATCH - DSDRPM)

| as a minimum

END: DASHPOT\_MIN\_CLIP

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IDLE SPEED CONTROL, MODE SELECT - CDAN2

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13.10 MODE SELECT (MODE\_SELECT) (CDAN0)

OVERVIEW

Bypass idle speed control has four modes of operation; dashpot, dashpot

preposition, RPM control, and RPM control lockout. A flag is used to

identify these modes for both calibrator convenience and required interaction

with fuel modulation and spark feedback strategies.

The mode select logic selects the mode of operation and sets a flag (ISCFLG)

which is used to adjust the total desired airflow through the air bypass

valve.

\* ISCFLG = -1 DASHPOT CONTROL

\* ISCFLG = 0 DASHPOT PRE-POSITION

\* ISCFLG = 1 CLOSED LOOP RPM CONTROL

\* ISCFLG = 2 CLOSED LOOP RPM CONTROL (Lock-out entry to RPM control)

- DASHPOT PRE-POSITION MODE (ISCFLG = 0)

In engine run/underspeed mode and when operating at part or wide open

throttle the ISC system is placed in dashpot pre-position mode. In this

mode the ISC duty cycle is incremented a calibratable amount in

anticipation of a required dashpot action. Proper dashpot operation is

essential on systems having speed density fuel controls in order to

avoid tip in/tip out stalls and HC spiking on decels.

- DASHPOT MODE (ISCFLG = -1)

In engine run/underspeed mode and having just transitioned from part to

closed throttle the system is placed in ISC dashpot control mode. The

length of time the ISC system will remain in dashpot control is both

hardware/strategy dependent (some applications have VSS; some manual

transmission applications have gear and clutch switches). Regardless of

the length of time required to enter RPM control, as long as closed

throttle operation is maintained the amount of airflow specified by the

dashpot pre-position (see dashpot pre- position logic) is decremented at

a constant rate until exhausted (until DASPOT = 0).

- CLOSED LOOP RPM CONTROL (ISCFLG = 1 OR 2)

For normal entry into C/L RPM control the following conditions must be

satisfied:

. If VSS hardware is used it must indicate a speed less than MINMPH

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IDLE SPEED CONTROL, MODE SELECT - CDAN2

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. If a manual trans. with gear/clutch switches; must indicate neutral

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IDLE SPEED CONTROL, MODE SELECT - CDAN2

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\* Note: Although the system can provide acceptable function

without the above mentioned hardware either item will increase

reliability in production. The vehicle speed sensor has

calibration benefits outside of ISC (lean cruise control, etc.)

and should be considered when specifying system assumptions for

future applications utilizing ISC.

. Regardless whether the above hardware is used, normal entry into RPM

control requires that actual engine speed be less than or equal to

(DSDRPM + RPMCTL) and that closed throttle is indicated.

The following discussion will attempt to describe entry into C/L RPM control

through the lock-out logic (ISCFLG = 2). In a normal deceleration the

dashpot bleed time will be short relative to the vehicle coastdown time. As

soon as engine speed drops low enough the ISC system should enter RPM

control. However, due to hysteresis in the bypass valve, overspecification

of idle airflow requirements prior to adaptive ISC learning, ISC learning in

an unusually high state of engine load (400 psi A/C head pressure), etc. the

ISC actuator may flow too much air at the specified idle duty cycle to allow

normal entry in RPM control. When this condition occurs the system will

remain in dashpot control until it can recognize that it should in fact be in

RPM control.

Obviously this task is easy if you happen to have a VSS or have a manual

calibration with gear/clutch switches. The problem without this hardware is

to differentiate between a deceleration condition (especially a constant rate

of speed deceleration -- as in a coast down a mountain) and a true

locked-out-of-idle condition. Most of the logic in the above-mentioned

attachment deals with this lock-out feature.

To differentiate between deceleration and idle the rate of change in RPM is

first evaluated over a calibrated period of time (ISCTM). If the speed has

remained within a specified deadband (NDIF) for this time period a second

check is performed to compare LOAD with a calibrated value (LOWLOD for A/C

off; LOWLOD + ACLOD for A/C on). The assumption is that all idle LOAD

values, including green engine/altitude effects etc., will be greater than

this value, and all true deceleration conditions, including the same

variabilities, will yield lower LOAD. It goes without saying that great care

must be taken in selecting the correct calibration for LOWLOD.

If the ISC system were locked in dashpot control and both the rate of engine

speed change and LOAD criteria were satisfied the strategy would be forced

into C/L RPM control with ISCFLG indicating 2. This state would be present

until the speed fell below the normal entry point. The adaptive ISC would

learn the required correction, assuming sufficient time at idle, and

subsequent dashpot to RPM control transitions should follow a normal entry

path.

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IDLE SPEED CONTROL, MODE SELECT - CDAN2

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DEFINITIONS

Registers:

- APT = Throttle Mode flag.

- DASCTL = Value of DASPOT, below which RPM control can begin, with any

remaining DASPOT airflow being rolled into IPSIBR.

- DASPOT = Dashpot contribution to idle air flow. Used to provide a

preposition air flow in Part Throttle and Wide Open Throttle Modes, which

is "bled off" after a transition to Closed Throttle. This gradual air

decrement allows a smooth transition to RPM control.

- DSDRPM = Desired engine speed.

- ISCFLG = ISC mode indicator flag; -1 -> Dashpot Mode, 0 -> Dashpot

Preposition Mode, 1 -> Closed Loop RPM Control Mode, 2 -> Closed Loop RPM

Control (Lock-out entry to RPM control).

- ISCTMR = RPM sample timer for lockout logic, (0.125 sec). Timer is

cleared on each RPM sample.

- LOAD = Universal LOAD as ratio of air charge over standard.

- N = Engine speed, RPM.

- NLAST = Last sampled RPM for lockout logic. NLAST is re-calculated when

ISCTMR exceeds ISCTM.

- SETTMR = RPM control entry delay timer, secs. Used to delay entry into

RPM control until manifold stabilizes.

- VSBAR = Filtered vehicle speed, mph.

Bit Flags:

- ACCFLG = A/C engaged flag; 1 -> A/C engaged, 0 -> A/C disengaged.

- DNDSUP = Delayed neutral/drive flag; 1 -> in drive, loaded.

Calibration Constants:

- ACLOD = LOWLOD modulator - A/C on decel from idle.

- ISCTM = Time interval (over which the rate of change in engine speed is

evaluated. - resolution 0.125 Sec. Value should be small enough to

avoid prolonged speed hang-ups if the ISC system were locked out of C/L

speed control but not too short such that the rate of speed change check

becomes meaningless. ..Typical value - 4 sec.

- LOWLOD = LOAD value to differentiate decel from idle.

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IDLE SPEED CONTROL, MODE SELECT - CDAN2

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- MINMPH = Minimum speed to enter C/L RPM control. Applies to systems

having VSS. Should be set below the speed at which an automatic trans.

vehicle rolls along in drive without the brakes. This is to prevent

going into RPM control during parking lot maneuvers. ..Typical value - 3

MPH

- NDIF = The deviation in engine speed allowed over the ISCTM specified

time interval. Values too small could lock the ISC system out of C/L

speed control indefinitely. Values too large invalidate the check.

..Typical value - 32 RPM

- RPMCTL = Added to DSDRPM. The total defines the engine speed threshold

below which entry into C/L RPM control is allowed. This value should be

reasonably small to avoid inadvertent entry into C/L ISC. ..Typical

value - 90 RPM

- SETLNG\_TM = Manifold stabilization time. Used to delay entry into RPM

control.

- TRLOAD = Transmission Load switch;

0 -> Manual transmission, no clutch or gear switch, NDSFLG = 0

1 -> Manual trans, no clutch or gear switch

2 -> Manual trans, one clutch or gear switch

3 -> Manual trans, both switches

4 -> Automatic trans, NDS

5 -> Automatic trans, NPS

6 -> Automatic trans, 7 position PRNDL

7 -> Automatic trans, PRNDL switches (4EAT)

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IDLE SPEED CONTROL, MODE SELECT - CDAN2

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PROCESS

STRATEGY MODULE: ISC\_MODE\_SELECT\_COM2

APT >= 0 -----------------------------| ISCFLG = 0

(not closed throttle) | NLAST = N

| ISCTMR = 0

| (in dashpot preposition mode)

|

| --- ELSE ---

VSBAR <= MINMPH ----------------| |

(vehicle stopped) | |

| |

DASPOT <= DASCTL ---------------| |

(dashpot complete) | |

| |

TRLOAD <> 3 --------------| | |

(not man trans | | |

w/both switches) | | |

|OR --|AND -| ISCFLG = 1

DNDSUP = 0 ---------------| | | (in RPM Control Mode)

(neutral) | |

| |

SETTMR > SETLNG\_TM -------------| |

(manifold stable) | |

| |

N <= DSDRPM + RPMCTL -----------| |

| --- ELSE ---

VSBAR <= MINMPH ----------------| |

(vehicle stopped) | |

| |

DASPOT <= DASCTL ---------------| |

(dashpot complete) | |

| |

TRLOAD <> 3 --------------| | |

(not manual transmission |OR --|AND -| ISCFLG = 2

w/ both switches) | | | (in RPM Control Lockout mode;

| | | same action as RPM Control mode)

DNDSUP = 0 ---------------| | |

(neutral) | |

| |

SETTMR > SETLNG\_TM -------------| |

(manifold stable) | |

| |

LOCKOUT LOGIC TRUE -------------| |

(locked out of RPM control) |

| --- ELSE ---

|

| ISCFLG = -1

| (in Dashpot mode)

NOTE: SETTMR and ISCTMR are cleared in MODE\_SELECT logic.

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IDLE SPEED CONTROL, MODE SELECT - CDAN2

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LOCKOUT LOGIC

ISCFLG >= 1 --------------------------| Lockout Logic True

| (stay in lockout until RPM falls)

| Exit Lockout Logic

|

| --- ELSE ---

|

ISCTMR < ISCTM -----------------------| Lockout Logic False

| (not time to sample RPM yet)

| Exit Lockout Logic

|

| --- ELSE ---

|

|N - NLAST| > NDIF -------------------| Lockout Logic False

| (RPM changing quickly,

| must be decel)

| NLAST = N

| ISCTMR = 0

| Exit Lockout Logic

|

| --- ELSE ---

TRLOAD >= 3 --------------------| |

(auto trans) | |

|AND -| Lockout Logic True

| | (can't be decel when in neutral)

DNDSUP = 0 ---------------------| | Exit Lockout Logic

(in neutral) |

| --- ELSE ---

ACCFLG = 1 ---------------| |

(A/C on) |AND -| |

| | |

LOAD < LOWLOD + ACLOD ----| | |

(decel LOAD) |OR --| Lockout Logic False

| | (LOAD indicates decel)

ACCFLG = 0 ---------------| | | Exit Lockout Logic

(A/C off) |AND -| |

| |

LOAD < LOWLOD ------------| |

(decel LOAD) |

| --- ELSE ---

|

| Lockout Logic True

| Exit Lockout Logic

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IDLE SPEED CONTROL, PERLOAD\_ISC CALCULATION - CDAN2

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13.11 PERLOAD\_ISC CALCULATION (CDAC0)

OVERVIEW

PERLOAD\_ISC is used by the ISC logic as the Y input to the ISCDTY table,

FN8000(DEBYMA,PERLOAD\_ISC).

DEFINITIONS

INPUTS

Registers:

- BP = Barometric pressure valve stored in KAM.

- DEBYMA = Desired mass air flow through the ISC valve, ppm. This quantity

is calculated as the total desired idle air flow (DESMAF) less the air

flow through the throttle plate, and is corrected for altitide using

FN890(BP).

- LOAD = Normalized air meter air mass flow, unitless. Equal to: air

mass/(N\*ENGCYL\*SARCHG).

- PERLOAD\_ISC = Used by ISC logic as the Y input to FN8000. 0-1.0 scale,

Unitless.

Calibration constants:

- FN035(N) = Peak load at sea level as a function of RPM.

- FN8000 = Characterization table for the ISC actuator;

X = FN061(DEBYMA)

Y = FN060(PERLOAD\_ISC)

OUTPUTS

Registers:

- PERLOAD\_ISC = See above.

PROCESS

STRATEGY MODULE: ISC\_PERLOAD\_ISC\_COM1

LOAD 29.9

PERLOAD\_ISC = -------- \* ----

FN035(N) BP

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IDLE AIR CONTROL, FMEM LIMITS TEST - CDAN2

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13.12 IDLE AIR FEEDBACK CONTROL LIMIT TEST (CDAN0)

OVERVIEW

The purpose of this test is to monitor the Idle Air Feedback Control Limits

of the actuator, by determining the maximum duty cycle and the adaptive

limits. The base strategy has calibratable limits which describes normal

operation. Once these limits are met or exceeded, an error is set in the

IPSIBR Calculation or the KAM UPDATE logic.

Three flags have been allocated to indicate three separate failure modes;

IAC\_ERR1 - overspeed error, IAC\_ERR2 - underspeed error and IAC\_ERR3 - for a

KAM error.

The control of IPSIBR or ISCKAM reaching the maximum or minimum limits are

determined by (PSIBRM/PSIBRN). Each time the update criteria are satisfied

both IPSIBR and ISCKAM are adjusted one bit (0.00024 ppm) in the opposite

directions until IPSIBR = 0. If correction is needed and the calibratable

limits are met for an extended period of time IAC\_ERR\* is set to the

appropriate value.

The value of IAC\_ERR\* and the amount of time at the limit will determine the

failure condition. Three separate error condition timers, IAC\_ER\_TMR(1-3),

have been allocated for the associated IAC\_ERR\* failure mode. Once failure

has been determined, the malfunction flag undergoes a 0 -> 1 transition and

the MIL control logic routine is called.

Please Note: the IAC\_ER\_TM2 must be calibrated to allow detection of a

vacuum leak in the inlet system.

Because the effect of airflow on engine speed is load related and only one

set of speed limits is provided to detect errors, a calibrateable load

comparator, IAC\_ISFL\_OBD, is provided to allow the error flags to be cleared

in low load states. This may be used to limit fault setting to the Drive

condition on auto trans vehicles. IAC\_ISFL\_OBD is compared with ISFLAG.

DEFINITIONS

Registers:

- ECT = Engine Coolant Temperature

- ER\_STATUS = Engine run status register, used to sequence the diagnostic

procedure.

- IAC\_ER\_TMR1 = Timer that runs only when an IAC\_ERR1 fault is present.

- IAC\_ER\_TMR2 = Timer that runs only when an IAC\_ERR2 fault is present.

- IAC\_ER\_TMR3 = Timer that runs only when an IAC\_ERR3 fault is present.

- IAC\_ER\_TMR = Timer that runs only when an IAC fault is present.

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IDLE AIR CONTROL, FMEM LIMITS TEST - CDAN2

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- IAC\_MON\_TMR = Timer used to set OBDII monitor flags for completion of

Idle test

- ISFLAG = Flag that indicates the degree of loading on the engine at idle;

0 -> Drive, 1 -> Drive and A/C (WAC Relay De-Energized), 2 -> Neutral, 3

-> Neutral and A/C (WAC Relay De-Energized).

- RUNUPTMR = Time since runup RPM exceeded.

- USPD\_RUN\_TMR = Time in underspeed or run mode.

Bit Flags:

- APT = Throttle Mode flag.

- CCM\_IAC\_MON = Monitor flag for IAC; 1 -> all IAC fault have been

monitored at least once since power-up.

- CCM\_TST\_ENA = Idle air test enable switch; 1 -> enable malfunction logic.

- FFG\_ECT = OBDII system FMEM flag for ECT - 1 -> ECT is currently

unreliable.

- FFG\_TP = OBDII system FMEM flag for TP - 1 -> TP is currently unreliable.

- IAC\_ERR1 = Base strategy IAC error flag used for overspeed malfunction

detection.

- IAC\_ERR2 = Base strategy IAC error flag used for underspeed malfunction

detection.

- IAC\_ERR3 = Base strategy IAC error flag used for ISCKAM malfunction

detection.

- ISCFLG = Idle air mode indicator flag; -1 -> Dashpot Mode, 0 -> Dashpot

Preposition Mode, 1 -> Closed Loop RPM Control Mode, 2 -> Closed Loop RPM

Control Lock-out Mode.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II scan tool

reset message.

- PxxxxMALF = OBD-II malfunction flag for xxxx; 1-> a malfunction currently

exist for fault xxxx.

- VSFMFLG = Vehicle speed sensor FMEM flag.

Calibration Constants:

- CO\_ST\_ECT = Cold Start ECT value for ISC.

- IPSIDLY = Time delay to disable IPSIBR update, sec.

- IAC\_ER\_TM1 = Minimum amount of time for an overspeed fault to be present

before setting an IAC fault is present code.

- IAC\_ER\_TM2 = Minimum amount of time for an underspeed fault to be present

before setting an IAC fault is present code.

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IDLE AIR CONTROL, FMEM LIMITS TEST - CDAN2

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- IAC\_ER\_TM3 = Minimum amount of time for ISCKAM fault to be present before

setting an IAC fault is present code.

- IAC\_ISFL\_OBD = ISFLAG comparator to limit operation of IAC OBDII error

flags settings.

- IAC\_MON\_TM = Minimum amount of time before setting an IAC fault monitor

code.

- IAC\_RUN\_TM = Minimum time since leaving crank to do IAC fault setting -

compared with USPD\_RUN\_TMR.

- ISC\_LO\_CHECK = Value for ER\_STATUS when performing ISC low rpm test.

- V\_IAC\_TST = IAC test type enable switch; 1 -> enable minimum

airflow/maximum duty cycle test, 2 -> enable ISCKAM clips.

OTHER

- malfunction(ccm,Pxxxx) = Public procedure updating the MIL control status

provided by the MIL Control module.

- ccm\_codes = Set of (P1505,P1506,P1507). The set of OBD-II fault codes

that relate to the ccm monitor.

- P1505 = Inlet Air Control system is at the adaptive clip.

- P1506 = Inlet Air Control system duty cycle is lower than expected.

- P1507 = Inlet Air Control system duty cycle is higher than expected.

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IDLE AIR CONTROL, FMEM LIMITS TEST - CDAN2

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PROCESS

STRATEGY MODULE: ISC\_FMEM\_COM1

BEGIN: IAC\_FAULT\_SET

;Malfunction code setting logic:

CCM\_TST\_ENA = 0 ------------|

;CCM test disabled |AND -|

| |

ER\_STATUS <> ISC\_LO\_CHECK --| |

;not doing KOER low RPM test |

|

ECT < CO\_ST\_ECT ------------------|

;Too cold for test |

|OR --| IAC\_ERR1 = 0

V\_IAC\_TST = 0 --------------------| | IAC\_ERR2 = 0

;IAC tests disabled | | IAC\_ERR3 = 0

| |

FFG\_ECT = 1 ----------------------| |

| |

VSFMFLG = 1 ----------------------| |

| |

FFG\_TP = 1 -----------------------| |

| |

OBDII\_RESET = 1 ------------------| |

| |

USPD\_RUN\_TMR < IAC\_RUN\_TM --------| |

;not running long enough | |

| |

ISFLAG > IAC\_ISFL\_OBD ------------| |

;error setting not required in |

this load state |

|

| --- ELSE ---

|

| NO ACTION

IAC\_ERR1 = 1 --------------------|

|AND -| malfunction(ccm,P1506)

IAC\_ER\_TMR1 > IAC\_ER\_TM1 ---------| | IAC\_ERR1 = 0

;Fault present long enough |

| --- ELSE ---

|

| clear\_malf(P1506)

IAC\_ERR2 = 1 --------------------|

|AND -| malfunction(ccm,P1507)

IAC\_ER\_TMR2 > IAC\_ER\_TM2 ---------| | IAC\_ERR2 = 0

;Fault present long enough |

| --- ELSE ---

|

| clear\_malf(P1507)

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IDLE AIR CONTROL, FMEM LIMITS TEST - CDAN2

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V\_IAC\_TST = 2 --------------------|

|

IAC\_ERR3 = 1 --------------------|AND -| malfunction(ccm,P1505)

| | IAC\_ERR3 = 0

IAC\_ER\_TMR3 > IAC\_ER\_TM3 ---------| |

| --- ELSE ---

|

| clear\_malf(P1505)

;Error timers setting logic:

IAC\_ERR1 = 0 ---------------------------| IAC\_ER\_TMR1 = 0

|

| --- ELSE ---

|

| Increment IAC\_ER\_TMR1

IAC\_ERR2 = 0 ---------------------------| IAC\_ER\_TMR2 = 0

|

| --- ELSE ---

|

| Increment IAC\_ER\_TMR2

IAC\_ERR3 = 0 ---------------------------| IAC\_ER\_TMR3 = 0

|

| --- ELSE ---

|

| Increment IAC\_ER\_TMR3

;IAC monitor logic:

IAC\_MON\_TMR > IAC\_MON\_TM ---------------| CCM\_IAC\_MON = 1

;IAC\_MON\_TMR - time in idle:

IAC\_MON\_TMR measures the time since enter closed loop Idle. The timer is

used to set OBDII monitor flags for completion of Idle test.

APT = -1 -------------------------|

|

RUNUPTMR > IPSIDLY ---------------|AND -| Increment IAC\_MON\_TMR

| |

ISCFLG > 0 -----------------------| |

| --- ELSE ---

|

| IAC\_MON\_TMR = 0

END: IAC\_FAULT\_SET

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IDLE SPEED CONTROL, ISC DUTY CYCLE CALCULATION - CDAN2

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13.13 ISC DUTY CYCLE CALCULATION (ISCDTY\_CALC) (CDAF0)

OVERVIEW

The ISC duty cycle is calculated in ISCDTY\_CALC. The mass air flow through

the ISC actuator (DEBYMA) is calculated as the desired mass air flow at idle

(DESMAF) less the flow through the throttle plate etc, corrected for

altitude.

The desired duty cycle is calculated as follows:

Once the desired mass flow value is finalized, the appropriate duty cycle is

calculated and output. The final DESMAF value is calculated in IPSIBR\_CALC.

The calibrated leakage term (ITHBMA) and the calculated purge airflow

(PG\_AIR) are subtracted from DESMAF, to obtain the actual flow required from

the ISC actuator (DEBYMA). DEBYMA and PERLOAD\_ISC are the inputs to the ISC

duty cycle transfer function (FN8000). Output from FN8000 is the specified

ISC duty cycle.

The final value of ISCDTY includes an offset and a multiplier (IDCOFS and

IDCMUL) used primarily as calibration tools.

DEFINITIONS

INPUTS

Registers:

- BP = Barometric pressure, " Hg.

- DEBYMA = Desired mass air flow through the ISC valve, ppm. This quantity

is calculated as the total desired idle air flow (DESMAF) less the air

flow through the throttle plate, and is corrected for altitide using

FN890(BP).

- DESMAF = Total desired idle air flow, ppm. Calculated as the sum of

predicted air flow (DESMAF\_PRE), dashpot air flow (DASPOT), integral air

flow (IPSIBR) and KAM correction (ISCKAMn).

- ISCDTY = Idle speed control valve duty cycle, fraction of fully open.

Calculated as a transfer function (FN8000) of the desired mass flow

(DEBYMA) through the ISC valve, and the load (PERLOAD\_ISC).

- PERLOAD\_ISC = Used by ISC logic as the Y input to FN8000. 0-1.0 scale,

unitless.

- PG\_AIR = Calculated airflow through purge sytem.

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IDLE SPEED CONTROL, ISC DUTY CYCLE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- IDCMUL = ISCDTY multiplier, no units.

- IDCOFS = ISCDTY adder, fraction of fully open.

- ITHBMA = Throttle body idle mass air flow with throttle plate at idle

screw stop and 0% ISC duty cycle. This is any airflow which does not go

through the bypass air solenoid, i.e. throttle plate, PCV system, intake

leakage, etc.

- DEBYCP = Minimum allowed airflow through the ISC actuator. This is a

clip on DEBYMA.

- FN060(PERLOAD\_ISC) = Row normalizing function for FN8000.

- FN061(DEBYMA) = Column normalizing function for FN8000.

- FN890(BP) = ISC duty cycle altitude compensation subtractor. Required to

offset the effect with altitude of a varying pressure drop across the ISC

actuator, which affects its air flow.

- FN8000 = Characterization table for the ISC actuator;

X = FN061(DEBYMA)

Y = FN060(PERLOAD\_ISC)

OUTPUTS

Registers:

- DEBYMA = See above.

- ISCDTY = See above.

PROCESS

STRATEGY MODULE: ISC\_ISCDTY\_COM2

unconditionally ---| iscdty = IDCMUL \* FN8000(DEBYMA,PERLOAD\_ISC) + IDCOFS

| Do: substitute(0,iscdty)

| ISCDTY = iscdty

| (output state control override)

where

DEBYMA = [DESMAF - FN890(BP) - (ITHBMA + PG\_AIR)] \* 29.92 / BP

- DEBYMA is clipped to DEBYCP as a minimum.

- ISCDTY is clipped to 1.0 as a maximum.

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IDLE SPEED CONTROL, IAC SCCD OUTPUT - CDAN2

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13.14 IAC (IDLE SPEED CONTROL) SCCD OUTPUT (CDAL0)

OVERVIEW

This routine determines the idle speed output for the Switching Constant

Current Driver (SCCD) hardware. The Strategy I/O map will dictate the SCCD

channel used. The ISCDTY is converted from duty cycle to a value of current.

Sccf is the current conversion function. This module also includes the logic

to translate the SCCD driver fault bit information to OBDII code setting.

DEFINITIONS

Registers:

- IAC\_ER\_TMR4 = Timer for P1504 fault code setting.

- ISCDTY = Idle speed control duty cycle.

- ISC\_CURRENT = SCCD percent current register.

Bit Flags:

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled.

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag. (1 =>

test enabled).

- IAC\_NO\_CUR = 1 -> IAC (ISC-BPA) output driver fault - open circuit or

short to ground.

- IAC\_OVER\_CUR = 1 -> IAC (ISC-BPA) output driver fault - over current.

Shorted load or shorted to VPWR when driver is on.

- IAC\_TM4\_FLG = Control flag for IAC\_ER\_TMR4 timer - IAC driver fault.

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IDLE SPEED CONTROL, IAC SCCD OUTPUT - CDAN2

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Calibration Constants:

- IAC\_ER\_TM4 = Minimum time for IAC (ISC output) driver fault to be present

before setting the fault code.

- IAC\_OT\_REQ = 1-> Do IAC output driver test.

- ISC\_PRD\_DT = DUCE Normal ISC period in duce\_ticks.

- IAC\_TST\_DC = Minimum dutycycle for reliable driver over current test

(P1504).

OTHER

P1504 = Idle Air Control Circuit Malfunction

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IDLE SPEED CONTROL, IAC SCCD OUTPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ISC\_DTY\_CONV\_COM2

Begin: iac\_output

Execute this process each background loop.

always -----------------| ISC\_CURRENT := sccf(ISCDTY)

| ;sccf is the SCCD Current Conversion Function

| ;as defined by the SCCD specification and is

| ;defined only in software implementation

SCCD IAC DRIVER DIAGNOSTICS

The SCCD/DARC I/O chips provide idle speed control valve (IAC) driver fault

status to the strategy. The states of over current and under current are

diagnosed. PIDs are separately defined but both faults will set the same

OBDII fault code (P1504). It is not possible to detect an over current

condition when ISCDTY is zero. The associated error timer is therefore

frozen when the ISC dutycycle is below a calibrateable level and the open

load/ground short fault bit (IAC\_NO\_CUR) is not set.

IAC\_OT\_REQ = 1 ---------------|

;test required |

|AND -| DO: iac\_osm\_test

CCM\_TST\_ENA = 1 --------| | |

| | |

CCM\_ER\_ENA = 1 ---------|OR --| |

| |

CCM\_EO\_ENA = 1 ---------| |

| --- ELSE ---

|

| clear\_malf (P1504)

End: iac\_output

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IDLE SPEED CONTROL, IAC SCCD OUTPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Begin: iac\_osm\_test

Execute this process only when called (from iac\_output).

ISCDTY <= IAC\_TST\_DC ---------|

;dutycycle below minimum |AND -| IAC\_TM4\_FLG = 0

| | ;freeze IAC\_ER\_TMR4

IAC\_NO\_CUR = 0 ---------------| | output too low for reliable

;no open circuit/ground | detection of overcurrent

short fault | condition.

|

| --- ELSE ---

|

IAC\_NO\_CUR = 1 ---------------| | IAC\_TM4\_FLG = 1

|OR --| ;there is a fault

IAC\_OVER\_CUR = 1--------------| | allow IAC\_ER\_TMR4 timer

| to upcount.

|

| --- ELSE ---

|

| IAC\_TM4\_FLG = 0

| IAC\_ER\_TMR4 = 0

| ;no fault, clear timer

Fault Code Setting:

IAC\_ER\_TMR4 > IAC\_ER\_TM4 -----------| malfunction(ccm,P1504)

|

| --- ELSE ---

|

| clear\_malf(P1504)

End: iac\_osm\_test

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IDLE SPEED CONTROL, TIMERS CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

13.15 TIMER SUMMARY (CDAN0)

OVERVIEW

The timers described here are for use within the idle speed control logic.

For general purpose timers see the Utility area.

.---------------------------------------------------.

| TIMER | DESCRIPTION | INTERVAL |

|==========+=============================+==========|

| ISCTMR | RPM sample/KAM update timer | 0.125 sec|

|----------+-----------------------------+----------|

| RUNUPTMR | Time since runup | .125 sec |

`---------------------------------------------------'

DEFINITIONS

Registers:

- APT = Throttle mode flag: -1 = closed, 0 = part, 1 = wide open throttle

mode.

- DASPOT = Desired mass air flow for dashpot (PPM).

- ISCFLG = Current mode of the Idle Speed control system.

- ISCTMR = Time at closed throttle (APT = -1) (0.125 seconds).

- N = Engine RPM

- NLAST = Previous value of Engine RPM

- RPMERR\_A = Filtered RPM error (desired rpm - N).

- RUNUPTMR = time since initial runup (seconds).

- SETTMR = settling time for entering closed loop RPM control (seconds).

Bit Flags:

- RUNUP\_FLG = status of runup: 0 = not complete, 1 = complete.

Calibration Constants:

- DASCTL = lower dashpot limit to allow rpm control (PPM)

- ISCTM = Pacing to evaluate rate of change of engine speed.

- NDIF = Time dependent RPM limit to differentiate decel from idle

(seconds).

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IDLE SPEED CONTROL, TIMERS CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- RPMDED = RPM deadband for closed loop idle speed control.

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IDLE SPEED CONTROL, TIMERS CDAN2

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PROCESS

STRATEGY MODULE: ISC\_TIMERS\_COM1

;RUNUPTMR - TIME SINCE RUNUP (.125 sec)

RUNUPTMR measures the time since the runup rpm was first exceeded. The timer

is used to disable IPSIBR update for a time period following initial RUNUP.

For setting of RUNUP\_FLG see idle speed control chapter.

RUNUP\_FLG = 0 -------------------------| RUNUPTMR := 0

| ; Clear timer

|

| --- ELSE ---

|

| ; Increment free

| ; running RUNUPTMR

SETTMR - RPM CONTROL ENTRY DELAY TIMER (.125 sec)

SETTMR is used to delay entry into RPM control for a time

which corresponds to the manifold stabilization time. SETTMR is

cleared in Idle Speed Control MODE\_SELECT.

In mode select ------------------|

|

APT >= 0 ------------------| |

;not closed throttle | |AND -| SETTMR := 0

| | | ; Clear timer

APT = -1 ------------| | | |

|AND -|OR --| |

DASPOT > DASCTL -----| | |

;daspot too large | |

| |

RUNUP\_FLG = 0 -------------| |

; RUNUP not complete |

| --- ELSE ---

|

| ;Increment free

| ; running SETTMR

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IDLE SPEED CONTROL, TIMERS CDAN2

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;ISCTMR - RPM SAMPLE / KAM UPDATE DELAY TIMER (0.125 Sec.)

This timer is used for two separate purposes in the normal idle speed control

strategy. It is always cleared in dashpot-preposition mode.

- In rpm control mode, it is used to prevent ISCKAM updates while

RPMERR\_A is outside the deadband allowed for ISCKAM learning.

- In dashpot mode, it is used to pace the rate of change of RPM checks

in order to determine whether or not to go to lockout mode.

; The following piece of logic is actually implemented in three distinct

; groupings. This is reflected in the comments below each of the groups,

; below;

APT >= 0 ---------------------------|

; Not at closed throttle. |

; Above condition is actioned |

; within the Mode Select logic |

|

ISCFLG = 1 -------------------| |

; Close loop RPM control |AND -|

| |

|RPMERR\_A| > RPMDED ----------| |OR --| ISCTMR := 0

;outside deadband | | ;Clear Timer

; Above AND gate is actioned | |

; within the ISCKAM update | |

; logic | |

| |

ISCFLG < 1 -------------------| | |

;not rpm control or lockout | | |

| | |

ISCTMR >= ISCTM --------------|AND -| |

;time to check RPM | |

| |

|N - NLAST| > NDIF -----------| |

;RPM changing too fast |

| --- ELSE ---

|

| ; Increment free

| ; running ISCTMR

; Above AND gate is actioned within

; the Lockout logic

13-90

CHAPTER 14

A/C CLUTCH STRATEGY

14-1

A/C CLUTCH STRATEGY

14.1 FEATURE: AIR CONDITIONING CONTROL STRATEGY (ACC) - V2.3\_ACC (CDAN0)

14.1.1 A/C CLUTCH INPUT (CDAN0)

OVERVIEW

This strategy module is for use in applications that have the A/C input going

high when A/C is selected, and do NOT have the Heated Front Windshield

multiplexed on the same input as the A/C.

OBDII code P1464 is set when the A/C is requested during KOER or KOEO

selftest. Seperate logic prevents the A/C from being engaged during on

demand testing.

DEFINITIONS

Registers:

- ACSW = A/C switch input status; 1 -> A/C on.

- P1464\_TMR = Time A/C requested during selftest mode.

Bit Flags:

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled flag.

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled flag.

Calibration Constants:

- P1464\_TM\_LMT = Time required to set code for A/C requested during

selftest.

OTHER

- P1464 = A/C demand out of Self test range.

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A/C CLUTCH STRATEGY, A/C CLUTCH INPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ACC\_INPUT\_COM3

accs = 1 -------------------------------| ACSW := 1

| ;A/C input "on"

|

| --- ELSE ---

|

| ACSW := 0

| ;A/C input "off"

ACSW = 0 -------------------------|

;A/C input off |

|OR --| P1464\_TMR := 0

CCM\_EO\_ENA = 0 -------------| | | Do: Clear\_malf(P1464)

|AND -| |

CCM\_ER\_ENA = 0 -------------| | ;Either switch is "off"

;Testing is disabled | ;or Engine off and Engine

| ;running sleftest disabled

|

| --- ELSE ---

|

P1464\_TMR > P1464\_TM\_LMT ---------------| Do: Store\_code(P1464)

|

| --- ELSE ---

|

| NO ACTION

| ;Allow P1464\_TMR to increment

14-3

A/C CLUTCH STRATEGY, A/C CLUTCH CONTROL - CDAN2

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14.1.2 A/C CLUTCH CONTROL (CDAN0)

FEATURE MEMBERSHIP : ACC

EXECUTION CONTEXT : Background

FUNCTIONAL REQUIREMENTS :

This module controls the A/C request flag. This flag is passed to the module

ACC\_OUTPUT for control of the A/C air and the clutch.

FUNCTIONAL DESCRIPTION :

The A/C clutch control strategy disengages the air conditioning clutch when

compressor operation is undesirable. Control is achieved through the use of

an EEC controlled, normally closed relay or solid state switch in the A/C

compressor clutch circuit.

The strategy requests that the A/C clutch be disengaged when any of the

following conditions are met.

1. Time since start is less than a calibration value (5 second maximum).

2. Throttle position is greater than a calibration value (at least 90% of

the "low limit" TP\_REL at full throttle travel) and the time since

disabling due to throttle position is less than a calibration value.

3. Engine coolant temperature is greater than an "overheat" calibration

value. (248 deg F minimum, maximum 10 deg F hysterisis) or if CFMFLG is

set. This means that the ECT reading is not valid.

4. Engine RPM is less than a near stall value (at least 100 RPM under base

idle; re-enabled no less than 50 RPM under base idle).

5. Engine RPM is above the RPM that could cause damage to the A/C compressor

(value depends on compressor type and pulley ratio).

6. A DIS Coil failure has occurred.

7. On demand self test mode is active.

8. The power steering flag has been triggered at the same time as the A/C is

requested. This will delay the A/C clutch for a calibratable time.

9. High A/C head pressure.

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A/C CLUTCH STRATEGY, A/C CLUTCH CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The A/C clutch will be requested when all of the following conditions are

met:

1. None of the above disabling conditions are true.

2. The A/C panel switch is closed indicating driver demand for A/C.

3. The cycling pressure switch in the A/C system is closed.

4. The A/C clutch has been disengaged for a minimum time. Used to prevent

rapid cycling (2.0 - 2.5 seconds).

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* NOTE \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* \*

\* CLIMATE CONTROL DIVISION MUST BE APPRISED OF ANY \*

\* DEVIATIONS FROM THE CALIBRATION GUIDELINES. \*

\* \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* NOTE \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

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A/C CLUTCH STRATEGY, A/C CLUTCH CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- ACIOTMR = A/C OFF delay timer.

- ACTPOFF\_TMR = A/C wide open throttle cutoff timer.

- ACTPTMR2 = Not at high throttle angle timer for A/C clutch control, sec.

Used to delay A/C re-enable after TP decreases below the high TP disable

condition.

- ATMR1 = Time since Start up, sec.

- ECT = Engine Coolant Temperature, deg. F.

- N = Engine speed, rpm.

- PSTMR = Power steering transient airflow timer.

- TP\_REL = Relative Throttle Position (TP - RATCH), counts.

Bit Flags:

- ACCFLG = A/C Engaged flag; 1 -> A/C engaged, 0 -> A/C disengaged.

- ACC\_KAM\_FLG = KAM flag to signify that AC has been engaged.

- ACSW = Flag that indicates the state of the AC input.

- ACECT\_FLG = A/C ECT flip flop.

- ACNLO\_FLG = A/C RPM low flag.

- ACNHI\_FLG = A/C RPM high flag.

- ACPRES\_FLG = High A/C pressure flag.

- ACRQST = A/C requested flag; 1 -> request.

- ACTP\_FLG = A/C throttle position flag.

- ACTPOFF\_RQST = A/C wide open throttle cutout requested.

- DEMAND\_MODE = Flag set when an On-Demand self test mode is active.

- DIS\_FMEM = Flag indicating that a primary side failure has occurred on a

DIS system and that an alternate strategy has been requested.

- POWSFG = Power steering flag.

- KAM\_ERROR = KAM error flag, 1 -> KAM data invalid.

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A/C CLUTCH STRATEGY, A/C CLUTCH CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- AC\_NEW\_RPM = Max RPM to enable a new AC compressor to be engaged.

- ACECT\_CL = Minimum ECT to disable A/C clutch, deg. F. Guideline; not

lower than ACECT\_SH minus 10 deg. F.

- ACECT\_SH = Maximum ECT to enable A/C clutch, deg. F. Guideline; not

lower than 248 deg. F.

- AC\_MN\_DT = Minimum disable time for A/C clutch.

- ACMNDT\_TP = Time delay to keep A/C disabled after leaving high throttle

angle, sec.

- ACNHI\_CL = RPM below which WAC based RPM cutout is cleared.

- ACNHI\_SH = Maximum RPM to enable A/C clutch, rpm. Guideline; depends on

compressor type and pulley ratio.

- ACNLO\_CH = Maximum RPM to disable A/C clutch, rpm. Guideline; not higher

than "base idle rpm - 50".

- ACNLO\_SL = Minimum RPM to enable A/C clutch, rpm. Guideline; not higher

than "base idle rpm - 100".

- ACPSTM = A/C delay time for PS stabilisation.

- ACSTRD = Time delay after start up before enabling the A/C, sec.

Guideline: not more than 5 secs.

- ACTP\_SH = Maximum TP\_REL to enable A/C clutch, counts. Guideline; at

least 90% of minimum TP\_REL at full throttle travel.

- WOTCOT = Maximum time to disable A/C at high TP, sec. Guideline; not

more than 25 seconds.

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A/C CLUTCH STRATEGY, A/C CLUTCH CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ACC\_CONTROL\_COM2

Temperature Limiting:

ECT > ACECT\_SH -------------|

;overheated |OR --|S Q -| ACECT\_FLG

| |

CFMFLG = 1 -----------------| |

;ECT Sensor failed |

|

ECT < ACECT\_CL -------------| |

|AND -|C

CFMFLG = 0 -----------------|

RPM limiting:

N < ACNLO\_SL ---------------------|S Q -| ACNLO\_FLG

;near stall |

|

N > ACNLO\_CH ---------------------|C

N > ACNHI\_SH ---------------------|S Q -| ACNHI\_FLG

;high rpm |

|

N < ACNHI\_CL ---------------------|C

Wide Open Throttle cutout logic:

TP\_REL > ACTP\_SH -----------------|S Q -| ACTPOFF\_RQST

;high throttle angle | | ;Cutout requested

|

ACTPTMR2 > ACMNDT\_TP -------------|C

;at low TP for a time

ACTPOFF\_TMR < WOTCOT -------------|

;WOT cutout timer less than |

;requested |AND -| ACTP\_FLG := 1

| | ;disable A/C

ACTPOFF\_RQST = 1 -----------------| |

;WOT cutout requested |

| --- ELSE ---

|

| ACTP\_FLG := 0

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A/C CLUTCH STRATEGY, A/C CLUTCH CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

KAM flag control:

KAM\_ERROR = 1 --------------------------| ACC\_KAM\_FLG := 0

;KAM data invalid, initialize | ; Initialize KAM flag

|

| --- ELSE ---

ACCFLG = 1 -----------------------| |

;A/C on |AND -| ACC\_KAM\_FLG := 1

| | ;Store AC on in KAM

ACRQST = 1 -----------------------| |

;A/C requested |

| --- ELSE ---

|

| NO ACTION

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A/C CLUTCH STRATEGY, A/C CLUTCH CONTROL - CDAN2

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ACC\_KAM\_FLG = 0 ------------|

;AC has not been on yet |AND -|

| |

N > AC\_NEW\_RPM -------------| |

;RPM not low |

|

DIS\_FMEM = 1 ---------------------|

;DIS failure |

|

DEMAND\_MODE = 1 ------------------|

;On-Demand self test |

|

ACSW = 0 -------------------------|

;A/C switch "off" |

|

ACIOTMR < AC\_MN\_DT ---------| |

;minimum off time |AND -|

| |

ACRQST = 0 -----------------| |

;A/C not requested |OR --| ACRQST := 0

| | ;A/C not requested

ATMR1 < ACSTRD -------------------| |

;start up delay | |

| |

ACPRES\_FLG = 1 -------------------| |

| |

ACECT\_FLG = 1 --------------------| |

| |

ACNLO\_FLG = 1 --------------------| |

| |

ACNHI\_FLG = 1 --------------------| |

| |

ACTP\_FLG = 1 ---------------------| |

| |

ACRQST = 0 -----------------| | |

;A/C not requested | | |

| | |

POWSFG = 1 -----------------|AND -| |

;Power Steering ON | |

| |

PSTMR < ACPSTM -------------| |

;PS On for short time |

| --- ELSE ---

|

| ACRQST := 1

| ;A/C requested

14-10

A/C CLUTCH STRATEGY, A/C CLUTCH CONTROL TIMERS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

14.1.3 A/C CLUTCH CONTROL TIMERS (CDAN0)

OVERVIEW

This module comprises the timers for the A/C Control strategy.

DEFINITIONS

Registers:

- ACIOTMR = A/C OFF delay timer, for ISC.

- ACITMR = A/C clutch idle turn on delay timer.

- ACTPTMR2 = Not at high throttle angle timer for A/C clutch control, sec.

Used to delay A/C re-enable after TP decreased below the high TP disable

condition.

- ACTPOFF\_TMR = A/C wide open throttle cutout timer.

- TP\_REL = Relative Throttle Position (TP - RATCH), counts.

Bit Flags:

- ACRQST = A/C requested flag; 1 -> request.

- ACTPOFF\_RQST = A/C Wide open throttle cutout requested.

- AC\_EN\_TRANS = Flag used to delay A/C activation process; 0 -> delay.

Calibration Constants:

- ACTP\_CL = Maximum TP\_REL to increment ACTPTMR2, counts. Provides TP

hystersis for high throttle angle A/C disable. Should be less than

ACTP\_SH.

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A/C CLUTCH STRATEGY, A/C CLUTCH CONTROL TIMERS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ACC\_TIMER\_COM1

A/C CLUTCH CONTROL TIMERS

ACTPOFF\_TMR - WIDE OPEN THROTTLE CUTOUT TIMER. ( Resolution - 0.125 secs )

This timer is used to disable the A/C clutch at high throttle angles for a

calibratable time.

ACTPOFF\_RQST = 1 -----------------------| Increment ACTPOFF\_TMR

;WOT cutout requested |

| --- ELSE ---

|

| ACTPOFF\_TMR := 0

ACTPTMR2 - NOT AT HIGH THROTTLE ANGLE TIMER ( Resolution - 0.125 secs )

This timer is used in conjunction with the ACTPOFF\_TMR timer to provide a

means of keeping the A/C clutch disabled when leaving high throttle angles

momentarily to shift gears. Note: If WOTCOT is calibrated to zero, this

timer has no effect on the A/C clutch.

TP\_REL < ACTP\_CL -----------------------| Increment ACTPTMR2

;throttle is not close to wide open |

| --- ELSE ---

|

| ACTPTMR2 := 0

ACITMR - A/C CLUTCH ENABLE DELAY TIMER ( Resolution - 0.001 secs )

This timer is used to sequence events that occur when A/C is impending.

AC\_EN\_TRANS = 1 ------------------|

|AND -| Increment ACITMR

ACRQST = 1 -----------------------| |

;A/C requested | --- ELSE ---

|

| ACITMR := 0

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A/C CLUTCH STRATEGY, A/C CLUTCH CONTROL TIMERS - CDAN2

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ACIOTMR - A/C CLUTCH DISABLE DELAY TIMER. ( Resolution - 0.001 secs )

This timer is used to sequence events that occur when A/C turn off is

impending.

ACRQST = 0 -----------------------------| Increment ACIOTMR

;A/C not requested |

| --- ELSE ---

|

| ACIOTMR := 0

14-13

A/C CLUTCH STRATEGY, A/C CLUTCH OUTPUT - CDAN2

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14.1.4 A/C CLUTCH OUTPUT (CDAN0)

OVERVIEW

This strategy module controls the A/C output for the instances where the CPU

output is low to enable A/C, and provides a delay for ISC compensation when

turning A/C on only. The strategy incorporates two separate turn-on delays.

The first, IDLCOT, is for use at start-up only, and enables a significant

time delay to be calibrated to enable the cooling fans to remove heat from

the A/C Condensor. The second, IDLCOT2, is for use when the A/C is cycling

under normal operating conditions, and does not require a delay the length of

IDLCOT. If the strategy is used such that the compressor is turned on before

the fan then IDLCOT2 should be calibrated equal to IDLCOT.

Note that there are two corresponding values for ISC compensation, ACC\_DELAY

and ACC\_DELAY2.

N.B If using the Transmission convertor clutch slip feature ensure that both

ACC\_DELAY and ACC\_DELAY2 are greater than zero to prevent premature A/C air

addition prior to clutch engagement.

DEFINITIONS

INPUTS

Registers:

- ACIOTMR = A/C off delay timer, for ISC.

- ACITMR = A/C clutch enable delay timer, sec. Used to delay A/C clutch

engagement to allow the Idle Speed Control strategy to anticipate the

compressor load application.

Bit Flags:

- ACCFLG = Flag that controls the state of A/C CPU output; 1 -> high.

- ACCFLG\_LAST = Last value of ACCFLG.

- ACRQST = A/C requested; 1 -> request.

- AC\_CYCLE\_FLG = Flag to indicate that the AC is cycling.

- ACC\_STATUS = ACC Smart Output Driver Fault Status.

- OSM\_EO\_OFF = Off state requested for OSM outputs during engine off

on-demand test.

- OSM\_EO\_ON = ON state requested for OSM outputs during engine off

on-demand test.

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A/C CLUTCH STRATEGY, A/C CLUTCH OUTPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- ACC\_DELAY = Time delay before adding air to DESMAF\_PRE.

- ACC\_DELAY2 = Second delay for adding A/C air, sec.

- AC\_MN\_FT = Minimum time to run low speed EDF after A/C clutch is

disengaged, sec.

- IDLCOT = Closed Throttle A/C enable delay time to allow ISC compensation.

- IDLCOT2 = Second delay time for A/C operation, sec.

OUTPUTS

Bit Flags:

- ACCFLG = See above.

- ACCFLG\_LAST = See above.

- ACC\_STATUS = See above.

- AC\_CYCLE\_FLG = See above.

- AC\_PPM\_RQST = Flag to request that the ISC adds air to compensate for AC

loading.

- ACR = A/C output.

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A/C CLUTCH STRATEGY, A/C CLUTCH OUTPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ACC\_OUTPUT\_COM1

ACRQST = 0 ------------------------| AC\_PPM\_RQST := 0

;A/C not requested | ;add no AC air

|

| --- ELSE ---

AC\_CYCLE\_FLG = 0 ------| |

;A/C not cycling |AND -| |

| | |

ACITMR >= ACC\_DELAY ---| | |

;delay 1 expired |OR --| AC\_PPM\_RQST := 1

| | ;add AC air

AC\_CYCLE\_FLG = 1 ------| | |

;A/C cycling |AND -| |

| |

ACITMR >= ACC\_DELAY2 --| |

;delay 2 expired |

| --- ELSE ---

|

| NO ACTION

| ;Make no change to AC\_PPM\_RQST

OSM\_EO\_ON = 0 ---------|

|AND -|

ACRQST = 0 ------------| |

;A/C not requested |OR --| ACCFLG := 0

| | ACR := 1

OSM\_EO\_OFF = 1 --------------| | ;A/C "off"

|

|

| --- ELSE ---

AC\_CYCLE\_FLG = 0 ------| |

;A/C not cycling |AND -| |

| | |

ACITMR > IDLCOT -------| | |

;delay 1 expired | |

| |

AC\_CYCLE\_FLG = 1 ------| |OR --| ACCFLG := 1

;A/C cycling |AND -| | ACR := 0

| | | ;A/C "on"

ACITMR > IDLCOT2 ------| | |

;delay 2 expired | |

| |

OSM\_EO\_ON = 1 ---------------| |

| --- ELSE ---

|

| ;Make no change to ACR and ACCFLG

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A/C CLUTCH STRATEGY, A/C CLUTCH OUTPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ACCFLG\_LAST = 1 ------|

|AND --|S Q -| AC\_CYCLE\_FLG

ACCFLG = 0 -----------| |

;AC has been ON and now OFF |

|

ACIOTMR > AC\_MN\_FT ----------|C

;AC been off for more than

;fan run-on time

unconditionally -------------------| ACCFLG\_LAST := ACCFLG

| ;store last state

| ;of ACCFLG

|

| ACC\_STATUS := output(ACR)

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A/C CLUTCH STRATEGY, ACC OUTPUT STATE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

14.1.5 ACC OUTPUT STATE MONITOR (CDAN0)

OVERVIEW

This module documents the ACC Output State Monitor. For the Smart Output

Drivers the status bit should always read Zero for no fault present.

DEFINITIONS

Registers:

- P1460\_TMR = Time ACC OSM failure detected for.

- VBAT = Battery voltage.

Bit Flags:

- ACC\_KAM\_FLG = KAM flag to signify that A/C has been engaged at least

once.

- ACC\_STATUS = ACC Smart Output Driver Fault status.

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled.

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CCM\_TST\_ENA = OBDII Comprehensive Component Test enable flag; 1 -> test.

Calibration Constants:

- P1460\_TM\_LMT = Time required to set code for ACC OSM failure.

- VBAT\_CCM\_MIN = Minimum voltage to perform OSM tests.

OTHERS

- P1460 = Fault code for ACC OSM failures.

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A/C CLUTCH STRATEGY, ACC OUTPUT STATE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ACC\_OSM\_COM1

ACC\_KAM\_FLG = 0 ------------------|

;A/C not run yet |

|

ACC\_STATUS = 0 -------------------|

;OSM status correct | |

|OR --| P1460\_TMR := 0

VBAT < VBAT\_CCM\_MIN --------------| | Do: Clear\_malf (P1460)

| | ;Either OSM testing is

CCM\_TST\_ENA = 0 ------------| | | ;disabled, the A/C system has

| | | ;not been run at least once,

CCM\_ER\_ENA = 0 -------------|AND -| | ;or there is no error.

| |

CCM\_EO\_ENA = 0 -------------| |

| --- ELSE ---

|

P1460\_TMR > P1460\_TM\_LMT ---------------| Do: Store\_code (P1460)

;Fault has been present long enough |

| --- ELSE ---

|

| NO ACTION

| ;Allow free running timer

| ;P1460\_TMR to increment

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A/C CLUTCH STRATEGY, A/C CLUTCH DIAGNOSTICS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

14.2 A/C CLUTCH DIAGNOSTICS (CDAN2)

OVERVIEW

This strategy module monitors the A/C Cycling period and sets a selftest

code, P1469, if the period is short enough that the transmission is no longer

able to slip to pre-empt A/C Clutch engagement. Note that for this strategy

to work, ACIOTMR must be actuated, to prevent it from counting up and being

reset once per background loop.

DEFINITIONS

Registers:

- ACIOTMR = A/C OFF delay timer, for ISC.

- ACIOTMR\_LAST = Last pass valuve of ACIOTMR.

- ACPERIOD = A/C Clutch cycling period.

- ACPERIOD\_TMR = A/C Cycling period timer.

| - P1469\_CNT = Number of times a short A/C cycle has been detected.

| Bit Flags:

| - CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag. (1 =>

| test enabled).

| - OBDII\_RESET = Flag used to simulate the receipt of an OBD-II scan tool

| reset message.

Calibration Constants:

- CCSLP\_MN\_PRD = Transmission CC minimum AC Period to enable slip feature.

| - P1469\_LMT = Number of short A/C cycles which must be detected before

| setting the malfunction code.

OTHER

- P1469 = Fault code for A/C cycling period too short.

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A/C CLUTCH STRATEGY, A/C CLUTCH DIAGNOSTICS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ACC\_OBD\_COM1

| CCM\_TST\_ENA = 0 --------------|

| ;continuous testing disabled | | Clear\_malf (P1469)

| |OR -| P1469\_CNT := 0

| OBDII\_RESET = 1 --------------| | ;reset counter and

| ;reset required | ;clear code, either

| | ;testing disabled or

| | ;reset required.

| |

| | --- ELSE ---

| |

| | DO: Determine\_ac\_period

| | ;determine the period and

| | ;set code if consistantly

| | ;too short

| |

| | ACIOTMR\_LAST := ACIOTMR

| | ;store last value of timer

| BEGIN : Determine\_ac\_period

| ACIOTMR < ACIOTMR\_LAST ------------| ACPERIOD := ACPERIOD\_TMR

| ;ACIOTMR has been reset | ACPERIOD\_TMR := 0

| ;end of period | ;store A/C period and

| | ;reset period timer to zero

| | ;to count new period

| |

| | DO: Test\_ac\_period

| | DO: set\_clear\_code

| |

| | --- ELSE ---

| |

| | ;increment ACPERIOD\_TMR

| END : Determine\_ac\_period

| BEGIN : Test\_ac\_period

| ACPERIOD < CCSLP\_MN\_PRD -----------| P1469\_CNT := P1469\_CNT + 1

| ;Clutch cycling period less | clip(P1469\_CNT,0,255)

| ;than minimum - error | ;cycling period too short

| | ;increment the error

| | ;counter

| |

| --- ELSE ---

|

| | P1469\_CNT := P1469\_CNT - 1

| | clip(P1469\_CNT,0,255)

| | ;no error present

| | ;decrement the counter

| END : Test\_ac\_period

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A/C CLUTCH STRATEGY, A/C CLUTCH DIAGNOSTICS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| BEGIN : set\_clear\_code

| P1469\_CNT > P1469\_LMT -------------| Store\_code (P1469)

| | ;too many short cycles

| | ;set the code

| |

| | --- ELSE ---

| |

| | Clear\_malf (P1469)

| | ;cycling ok, clear

| | ;the code

| END : set\_clear\_code

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CHAPTER 15

CANISTER PURGE STRATEGY

15-1

CANISTER PURGE STRATEGY

15.1 FEATURE: EVAPORATIVE PURGE COMPENSATION CONTROL (PCOMP) -

V1.1D\_CANP\_PCOMP (CDAN0)

15.1.1 PCOMP ENABLE (CDAM0)

OVERVIEW

The strategy alternates when PCOMP is active and when adaptive is active.

This module enables the PCOMP strategy when:

- The EEC has entered closed loop control for the first time (to allow

initial start-up vapors to be purged); or

- The EEC is in closed loop control and the adaptive system has adapted for

a maximum period of time; or

- The EEC is in closed loop control and the adaptive system has brought

LAMBSE into a calibrated window of control.

After adaptive fuel has timed-out via ADAPT\_TMR, if the filtered value of

either LAMBSE1 or LAMBSE2 shows that the commanded equivalence ratio is not

under control, PCOMP will remain disabled. In this case, PCOMP will remain

in the disable state until the filtered LAMBSE values (LAM\_BAR1 and LAM\_BAR2)

are both within the window specified by ADP\_LAM\_MIN and ADP\_LAM\_MAX, or until

the filtered KAMRF values KAM\_BAR1 and KAM\_BAR2) leave the window calibrated

by ADP\_KAM\_MIN and ADP\_KAM\_MAX.

The following conditions will keep PCOMP disabled, even after the ADAPT\_TMR

has expired (ADP\_TM). This example illustrates a Rich Engine Condition.

RICH ENGINE CONDITION

|++++++++++++++++

| ++

| ++

| ++ <-- LAM\_BARn

| - - - - - - - - - - - - -++ - - - - - - - - - - - - - ADP\_LAM\_MAX

| ++

+++++++++++++++++-------------------------------------- 1.0

| ++

| ++

| ++

| - - - - - - - - - - - - -++ - - - - - - - - - - - - - ADP\_KAM\_MIN

| ++ <-- KAM\_BARn

| ++++++++++++++++++++++++++++++

| +

| +

|+++++++++++++++++++++++++\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ PCOMP\_ENA

| ++

| ++ +

| ++ +

| ++ +

| ++ +

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CANISTER PURGE STRATEGY, PCOMP ENABLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| - - - -++ - - - - - - -+- - - - - - - - - - - - - - - ADP\_TM

| ++ +

| ++ +

|++\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_++++++++++++++++++++++++++++++ ADAPT\_TMR

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CANISTER PURGE STRATEGY, PCOMP ENABLE - CDAN2

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DEFINTIONS

Registers:

- ADAPT\_TMR = Timer that tracks how long Adaptive fuel strategy has been

enabled.

- ADPTMR = Adaptive fuel timer, seconds.

- F6K\_LST\_PS = Output value of FN6000A last background pass.

- KAMRF1/KAMRF2 = The adaptive fuel strategy F/A ratio correction factor.

- LAM\_BAR1 = Filtered equivalence ratio for HEGO11 injectors.

- LAM\_BAR2 = Filtered equivalence ratio for HEGO21 injectors.

- PCOMP\_W = Reduced range PCOMP.

- PG\_DC = Purge duty cycle, percent on.

- TCSTRT = Temperature of Engine Coolant at Cold Startup, deg F.

- TSLADPTMR = Time Since Last Adapt TiMeR. Tracks time between when Adapt

is active.

Bit Flags:

- FADPT\_READY = Flag indicating that all conditions have been met to enable

an adaptive fuel.

- FFS\_FMFLG = Flexible Fuel sensor failure mode flag.

- FRST\_ADP = Flag showing that ADAPT\_TMR has incremented at least once.

- OLFLG = Open Loop Fuel flag; 1 -> open loop, 0 -> closed loop possible.

- PCOMP\_ENA = PCOMP strategy enabled flag; 1 -> PCOMP is enabled, adaptive

fuel disabled.

- PCOMP\_FST\_PS = PCOMP first pass flag; 1 -> first pass of PCOMP has been

completed.

- PGM\_CVS\_FM = Canister vent solenoid FMEM flag; 1 -> CVS failed. Danger

exists to pull excessive vacuum on the fuel tank, disable PCOMP.

- PGM\_PG\_ON = Purge monitor command to turn PCOMP/PURGE on.

- PGM\_RUN\_LST = State of PGM\_RUNNING last pass.

- PGM\_RUNNING = Purge monitor is running flag.

Calibration Constants:

- ADAPTM = Time in ECT desired range before enabling adaptive fuel learning

in seconds.

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CANISTER PURGE STRATEGY, PCOMP ENABLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- ADP\_LAM\_MAX = If LAM\_BAR1 and LAM\_BAR2 are greater than this value, the

system will remain in adaptive fuel control after ADAPT\_TMR has expired

(if KAM\_BARn is not nearing the ADP\_KAM\_MIN limit).

- ADP\_LAM\_MIN = If LAM\_BAR1 and LAM\_BAR2 are less than than this value, the

system will remain in adaptive fuel control after ADAPT\_TMR has expired

(if KAM\_BARn is not nearing the ADP\_KAM\_MAX limit).

- ADP\_KAM\_MAX = Maximum value of KAM\_BAR1 and KAM\_BAR2 to remain in

adaptive fuel control after ADAPT\_TMR has expired.

- ADP\_KAM\_MIN = Minimum value of KAM\_BAR1 and KAM\_BAR2 to remain in

adaptive fuel control after ADAPT\_TMR has expired.

- ADP\_TM = Time in adaptive learning after which PCOMP is re-enabled if

LAMBSE within window.

- ADP\_TM\_MAX = Maximum amount of time that adaptive strategy is allowed to

be active before PCOMP is forced.

- FFS\_SW = Flexible Fuel sensor hardware present switch; 1 -> hardware

present.

- PG\_TSLADP\_TM = Value of TSLADPTMR that forces an adaptive sequence to

begin.

- PCOMP\_ECT = TCSTRT value below which adaptive fuel will be executed

first; otherwise PCOMP is executed first.

- PCOMP\_MN\_PPM = PCOMP PPM value below which the system will be allowed to

adapt.

- PG\_DC\_D\_MIN = Purge valve duty cycle disable minimum.

- PGM\_ADPT\_RST = Restart state of PCOMP; 1 -> After the purge monitor is

complete, start adaptive fuel, 0 -> After the purge monitor is complete,

start PCOMP.

- PGM\_HW\_SW = Evaporative System Monitor hardware present switch; 1 ->

hardware present.

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CANISTER PURGE STRATEGY, PCOMP ENABLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CANP\_PCOMP\_ENABLE\_COM7

BEGIN: canp\_pcomp\_enable

PGM\_RUNNING = 1 -------------------|

; purge monitor test running |AND -| PCOMP\_ENA := PGM\_PG\_ON

| | ; set PCOMP\_ENA according to

PGM\_HW\_SW = 1 ---------------------| | ; register set in purge monitor

; purge monitor present | PGM\_RUN\_LST := 1

| ADAPT\_TMR := 0

| TSLADPTMR := 0

| ; clear timers, not needed

| ; during purge monitor test.

| Exit: canp\_pcomp\_enable

|

| --- ELSE ---

|

| Do: pcomp\_timers

| Do: pcomp\_ena\_init

| PGM\_RUN\_LST := 0

END: canp\_pcomp\_enable

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CANISTER PURGE STRATEGY, PCOMP ENABLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: pcomp\_ena\_init

; Determine if the purge monitor test has just completed:

PGM\_RUNNING = 0 -------------------|

; test is not running now |

|

PGM\_RUN\_LST = 1 -------------------|AND -| pc\_restart := 1

; test was running last pass | |

| |

PGM\_HW\_SW = 1 ---------------------| |

; purge monitor present |

| --- ELSE ---

|

| pc\_restart := 0

; Initialize PCOMP\_ENA for special conditions:

TCSTRT < PCOMP\_ECT ----------|

; low ECT, adapt first |AND -|

| |

PCOMP\_FST\_PS = 0 ------------| |

; first pass |

|

PGM\_CVS\_FM = 1 --------------| |

; canister vent failure |AND -|

| |

PGM\_HW\_SW = 1 ---------------| |

; purge monitor present |

|OR --| PCOMP\_ENA := 0

FFS\_FMFLG = 1 ---------------| | | PCOMP\_FST\_PS := 1

; flex fuel sensor failure |AND -| | ; disable PCOMP

| | | ; allow adaptive

FFS\_SW = 1 ------------------| | |

; flex fuel sensor present | |

| |

pc\_restart = 1 --------------| | |

|AND -| |

PGM\_ADPT\_RST = 1 ------------| |

; purge monitor test done |

; restart with adaptive fuel |

| --- ELSE ---

PCOMP\_FST\_PS = 0 ------------------| |

; first pass | |

|OR --| PCOMP\_ENA := 1

pc\_restart = 1 --------------| | | PCOMP\_FST\_PS := 1

|AND -| | ; enable PCOMP

PGM\_ADPT\_RST = 0 ------------| |

; purge monitor test done |

; restart with PCOMP first |

| --- ELSE ---

|

| ; No change to PCOMP\_ENA

| ; due to initialization.

| Do: pcomp\_enable

END: pcomp\_ena\_init

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CANISTER PURGE STRATEGY, PCOMP ENABLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: pcomp\_enable

ADAPT\_TMR > ADP\_TM\_MAX ---------------------| PCOMP\_ENA := 1

; max adaptive time exceeded | ; enable PCOMP

| Exit: pcomp\_enable

ADAPT\_TMR > ADP\_TM -------------------|

|

LAM\_BAR1 < ADP\_LAM\_MIN ---| |

|AND -| |

KAM\_BAR1 < ADP\_KAM\_MAX ---| | |AND -| PCOMP\_ENA := 0

| | | ; disable PCOMP

LAM\_BAR1 > ADP\_LAM\_MAX ---| | | |

|AND -| | | Exit: pcomp\_enable

KAM\_BAR1 > ADP\_KAM\_MIN ---| | | |

|OR --| |

LAM\_BAR2 < ADP\_LAM\_MIN ---| | |

|AND -| |

KAM\_BAR2 < ADP\_KAM\_MAX ---| | |

| |

LAM\_BAR2 > ADP\_LAM\_MAX ---| | |

|AND -| |

KAM\_BAR2 > ADP\_KAM\_MIN ---| | --- ELSE ---

|

|

ADAPT\_TMR > ADP\_TM -------------------------| PCOMP\_ENA := 1

; min adaptive time exceeded | ; PCOMP enabled

; lambse IN acceptable window |

| --- ELSE ---

PCOMP\_W < PCOMP\_MN\_PPM ---------| |

; small PCOMP value | |

; vapor flow low | |

| |

PG\_DC > PG\_DC\_D\_MIN ------------| |

; above duty cycle disable | |

|AND -| |

F6K\_LST\_PS >= 1 ----------------| | |

; make sure that PCOMP\_W will | | |

; not be prematurely trimmed | | |

; due to high N/LOAD conditions| | |

| | |

FADPT\_READY = 1 ----------------| | |

; adaptive fuel is ready | |

|OR --| PCOMP\_ENA := 0

FRST\_ADP = 0 -------------------| | | ; disable PCOMP

; have not yet adapted |AND -| | ; allow adaptive

| | |

FADPT\_READY = 1 ----------------| | |

; adaptive fuel is ready | |

| |

TSLADPTMR > PG\_TSLADP\_TM -------| | |

; time since adapt too long |AND -| |

| |

FADPT\_READY = 1 ----------------| |

; adaptive fuel is ready |

| --- ELSE ---

(Continued on next page)

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CANISTER PURGE STRATEGY, PCOMP ENABLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(Continued from previous page)

|

| ; No change to PCOMP\_ENA

END: pcomp\_enable

BEGIN: pcomp\_timers

; Executed when called.

; this process updates the timers used by the purge strategy

; ADAPT\_TMR logic

PCOMP\_ENA = 0 ---------------------|

; PCOMP not active |

|

OLFLG = 0 -------------------| |

; in closed loop |OR --|AND -| Increment ADAPT\_TMR

| | |

FRST\_ADP = 1 ----------------| | | FRST\_ADP := 1

; adapted at least once | |

| |

ADPTMR > ADAPTM -------------------| |

; adaptive will be enabled due to |

; ECT criteria and time expired |

| --- ELSE ---

|

| ADAPT\_TMR := 0

; TSLADPTMR - Time Since Last Adapt Timer logic

PCOMP\_ENA = 1 ---------------------|

; PCOMP enabled |AND -| Increment TSLADPTMR

| |

FRST\_ADP = 1 ----------------------| |

; adapted at least once |

| --- ELSE ---

|

| TSLADPTMR := 0

END: pcomp\_timers

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CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

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15.1.2 CANISTER PURGE STRATEGY (PCOMP) (CDAN0)

System Overview:

Canister Purge refers to the vacuum-actuated valve assembly that is located

in the line between the carbon canister and the intake manifold. The EEC

operates the canister purge valve by outputting a variable duty cycle (PG\_DC)

to an Electronic Valve Regulator (EVR). The EVR responds by applying a

vacuum signal, proportional to the duty cycle, to the purge valve. When

activated, the purge valve allows fuel vapors to flow from the fuel tank and

carbon canister to the intake manifold at a rate proportional to the duty

cycle. The purge valve, the vapor management valve (VMV), is designed to

compensate for changes in manifold vacuum and will maintain a constant flow

at any given duty cycle for manifold vacuums between 5" Hg and 20" Hg.

Strategy Operation:

PCOMP strategy operation is divided into six major phases or steps. It can

be understood by the following:

PCOMP steps 1,2,3 -> deal with VAPOR FLOW calculation and usage.

PCOMP steps 4,5,6 -> deal with DUTY CYCLE calculation and output.

THE STRATEGY ENABLES CANISTER PURGE VAPOR COMPENSATION TO THE FUEL SYSTEM

ONLY DURING CLOSED LOOP ENGINE OPERATION.

IN OPEN LOOP, the output valve duty cycle is loaded from FN666 or FN667,

based on throttle mode. For no open loop purge, set FN666 and FN667's values

to zero.

IN CLOSED LOOP, a Purge Duty Cycle Multiplier (PG\_RP\_ML) is ramped up/down by

the values of PG\_RAMP1 or PG\_RAMP2 and determined by injector pulsewidth, the

value of PCOMP, and the HEGO sensor state (rich or lean). PG\_RAMP1

determines the ramp up rate based on HEGO switches during normal closed loop

operation. Every HEGO switch PG\_RP\_ML is calculated as follows:

PG\_RP\_ML(new) = PG\_RP\_ML(old) + PG\_RAMP1

PG\_RAMP2 determines a ramp up OR down rate based on background loop time.

PG\_RP\_ML is calculated every background loop as follows:

PG\_RP\_ML(new) = PG\_RP\_ML(old) - PG\_RAMP2

A variable duty cycle output (PG\_DC) is then calculated based on the desired

maximum duty cycle (PG\_DC\_DS), the above-mentioned purge duty cycle

multiplier (PG\_RP\_ML). Then, to compensate for the VMV not physically

opening until a certain offset value is seen, a purge valve offset (PG\_DC\_OF)

is added.

PG\_DC = (PG\_DC\_DS \* PG\_RP\_ML) + PG\_DC\_OF

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CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- ADP\_STATEn1 = Adaptive HEGO switchpoint algorithm state machine value.

When this value equals 1,2,or 3, the algorithm is seeking to recovery the

HEGO switchpoint. The value returns to 0 when HEGO switching resumes.

- AM = Air mass flow.

- APT = Throttle mode flag.

- ATMR4 = Time since ECT >= ECTSTABL, sec; Used with PG\_OL\_START.

- CYL\_AIR\_CHG = Current cylinder air charge.

- ER\_STATUS = State pointer that indicated current state of engine running

on demend test.

- F\_A\_RATIOn = Fuel air ratio for HEGOn1.

- FLOW\_RUNNING = Purge flow monitor test is running flag; 1 -> test

running.

- ISCDTY = Idle speed duty cycle.

- PGM\_RUNNING = Evaporative System test is running flag.

- FUELPWn = Fuel injector #n pulsewidth, clock ticks.

- F6K\_LST\_PS = Stores the output value of FN6000A for the PCOMP enabling

module.

- INJ\_TR = Ratio of the current number of cylinders onto the total number

of cylinders.

- LAMBSEn = LAMBDA equivalence ratio (HEGOn1).

- LBMF\_INJn = Fuel mass per injection for bank #n.

- LESTMR11 = Lack HEGO11 switch timer, sec.

- MINPWT = MINPW converted to clock ticks.

- N = Engine RPM.

- PCOMP\_LBM = Purge compensation fuel adder, lbs mass/cylinder.

- PCOMP\_PPM = The OUTPUT value of PCOMP in pounds per minute, ppm.

- PCOMP\_PPM\_C = The CALCULATED PCOMP in pounds per minute, ppm.

- PCOMP\_W = Reduced range PCOMP. A more stable value.

- PC\_PCOMP\_H = Maximum value of percent of pcomp allowed before purge is

decreased.

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CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PC\_PCOMP\_L = Maximum value of percent of pcomp allowed before purge is

inhibited from increasing.

- PC\_SCALE\_FN = Integrator scaling factor for PCOMP; value loaded from

either FN\_LAMT1 or FN\_LAMA1.

- PCT\_LOAD = Percent inferred LOAD (altitude independant).

- PG\_DC = Purge Duty Cycle.

- PG\_FA\_RAT = Weighted average value between F\_A\_RATIO1 and F\_A\_RATIO2

determined by PG\_BANK\_ML.

- PG\_FUELPW = Weighted average value between FUELPW1 and FUELPW2 determined

by PG\_BANK\_ML.

- PG\_LAMBSE = Weighted average value of LAMBSE1 and LAMBSE2 determined by

PG\_BANK\_ML.

- PG\_LAMAV = Filtered value of PG\_LAMBSE. Determined by TC\_PGLAM.

- PG\_LBMF = Weighted average value between LBMF\_INJ1 and LBMF\_INJ2

determined by PG\_BANK\_ML.

- PG\_PC\_PCOMP = Percent PCOMP of the total fuel flow, unitless.

- PG\_RAMP1 = Purge Duty Cycle ramp rate multiplier based on HEGO switches.

- PG\_RAMP2 = Purge Duty Cycle ramp rate multiplier based background loop

times.

- PG\_RP\_ML = Purge Duty Cycle Ramp Multiplier, unitless.

- TP\_REL = Relative TP (TP - RATCH).

Bit Flags:

- EGOSTATE1 = State of the EGO sensor 11; 1 -> rich, -1 -> lean.

- ISCFLG = Mode indicator flag, enumerated.

- LAM\_MOD\_FLG = Flag used to initiate high frequency fuel modulation for

the upstream EGO monitor.

- OLFLG = Open Loop Flag; 1 -> open loop conditions met, 0 -> closed loop

conditions met.

- PCOMP\_ENA = PCOMP strategy enabled flag; 1 -> PCOMP is enabled, adaptive

fuel disabled.

- OSM\_EO\_OFF = Off state requested for OSM outputs during engine off on

demand test.

- OSM\_EO\_ON = ON state requested for OSM outputs during engine off on

demand test.

- PC\_RESET = Canister overrich condition flag; 1 -> overrich purge reset,

ramp PG\_DC down to zero.

15-12

CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PG\_MULT\_INH = Purge multiplier inhibit flag; 1 -> inhibit multiplier

increase.

- PG\_OBD2\_HFL = Flag that indicates a OBDII test is signaling purge to HOLD

its flow and duty cycle for the duration of the test.

- PG\_OBD2\_NFL = Flag that indicates a OBDII test is signaling purge to STOP

its flow and duty cycle for the duration of the test.

- PRG\_OFF = Flag indicating that no purge flow is occuring and purge is not

enabled.

- SAIR\_TST\_ENA = OBD-II secondard air test enable flag, (1 => test

enabled).

- SWTFL11 = Bank1 upstream HEGO11 switch flag; 0 -> no HEGO11 switch, 1 ->

HEGO11 switch.

Calibration constants:

- ENGCYL = Number of pip's per engine revolution; 2 -> 4 cylinder engine (2

pip/rev), 3 -> 6 cylinder engine (3 pip/rev), 4 -> 8 cylinder engine (4

pip/rev).

- FN068(N) = Engine speed normalizing function for FN6000A.

- FN069B(PCT\_LOAD) = Load normalizing function for FN6000A.

- FN630(AM) = Purge ramp rate; PG\_RAMP1.

- FN631(AM) = Purge ramp rate; PG\_RAMP2.

- FN666 = Purge duty cycle during open loop, part throttle.

- FN667 = Purge duty cycle during open loop, wide open throttle.

- FN6000A(FN068(N),FN069B(PCT\_LOAD) = pcomp\_ppm\_new multiplier for reduced

flows at low manifold vacuums.

- FN\_LAMA1(PG\_LAMBSE) = PC\_SCALE\_FN value when LAMBSE's direction is away

from 1.0.

- FN\_LAMT1(PG\_LAMBSE) = PC\_SCALE\_FN value when LAMBSE's direction is toward

1.0.

- PC\_PCOMP\_H\_N = Maximum value of percent of PCOMP allowed before purge is

decreased at decels. % PCOMP.

- PC\_PCOMP\_H\_0 = Maximum value of percent of PCOMP allowed before purge is

decreased at accels/cruise. % PCOMP.

- PC\_PCOMP\_H\_1 = Maximum value of percent of PCOMP allowed before purge is

decreased at idle. % PCOM.

- PC\_PCOMP\_L\_N = Maximum value of percent of PCOMP allowed before purge is

increased at decels. % PCOMP.

15-13

CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PC\_PCOMP\_L\_0 = Maximum value of percent of PCOMP allowed before purge is

increased at accels/cruise. % PCOMP.

- PC\_PCOMP\_L\_1 = Maximum value of percent of PCOMP allowed before purge is

increased at idle. % PCOMP.

- PC\_PCOMP\_RS = Maximum value of percent PCOMP allowed before an overrich

condition is identified.

- PC\_TP\_R = Maximum value of relative TP to determine a canister overrich

condition.

- PG\_BANK\_ML = Calibration value (0-1.0) used to perform weighted averages

on selected purge parameters.

- PG\_DC\_DS = Maximum desired purge duty cycle. PG\_DC\_DS + PG\_DC\_OF should

equal 1.0.

- PG\_DC\_HYS = Purge Duty Cycle hysterisis term. Used with PG\_DC\_OF to ramp

down PG\_DC to zero faster without affecting the ramp up rate.

- PG\_DC\_OF = Purge Duty Cycle Offset. Purge D.C. will start at this value

when ramping on. Should be equal to the start-to-open point of the purge

valve. PG\_DC\_DS + PG\_DC\_OF should equal 1.0.

- PG\_INJ\_PW\_HI = Minimum value of Injector Pulsewidth required to increase

purge multiplier, clock ticks. One clock tick = 0.0024 msec at 15 Mhz.

- PG\_INJ\_PW\_LO = Minimum value of injector pulsewidth required; otherwise,

the purge is decreased.

- PG\_INJ\_PW\_R = Minimum value of injector pulsewidth required to determine

if a PC\_RESET condition exists.

- PG\_ISCDTY\_HI = ISCDTY below which multiplier increase is not allowed.

- PG\_ISCDTY\_LO = ISCDTY below which PG\_RP\_ML is decremented.

- PG\_LAMMAX = Maximum purge LAMBSE clip when closed loop.

- PG\_LAMMIN = Minimum purge LAMBSE clip when closed loop.

- PGM\_TCPRG = Time constant for purge duty cycle, used during VMV Flow

test.

- PG\_OL\_START = Minimum time before allowing open loop purge, sec.

- PG\_TSLE = Time Since Last HEGO switch while at its clip, sec.

- PRG\_FLOW\_SW = Calibration switch indicating if Purge Flow test is

present.

- TC\_PGLAM = Time constant for PG\_LAMAV.

- TCPRG = Time constant for purge duty cycle.

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CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

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CALIBRATION INFORMATION

Typical values are supplied for the following calibration constants:

- PC\_TP\_R = 30.0.

- PG\_DC\_DS = 0.9.

- PG\_DC\_OF = 0.1.

- PG\_INJ\_PW\_HI = 1042 clock ticks.

- PG\_INJ\_PW\_LO = 833 clock ticks.

15-15

CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

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PROCESS

STRATEGY MODULE: CANP\_PCOMP\_COM10

BEGIN: pcomp\_control

; this is the main process of PCOMP control.

unconditionally ---------------------| PG\_LAMBSE := (PG\_BANK\_ML \* LAMBSE1) +

; determine engine bank dependence | ((1 - PG\_BANK\_ML) \* LAMBSE2)

; perform weighted averages |

| PG\_LAMAV := ROLAV\_TC(PG\_LAMBSE,

| TC\_PGLAM)

| ; filtered value of PG\_LAMBSE

|

| PG\_FUELPW := (PG\_BANK\_ML \* FUELPW1) +

| ((1 - PG\_BANK\_ML) \* FUELPW2)

|

| PG\_LBMF := (PG\_BANK\_ML \* LBMF\_INJ1) +

| ((1 - PG\_BANK\_ML) \* LBMF\_INJ2)

|

| PG\_FA\_RAT := (PG\_BANK\_ML \* F\_A\_RATIO1)

| + ((1 - PG\_BANK\_ML) \* F\_A\_RATIO2)

1) Determine the values of pcomp\_ppm\_new:

; PC\_SCALE selection logic

; Allows user to select a different value of PC\_SCALE\_FN depending upon if

; lambse is heading Toward 1.0 or Away from 1.0.

PG\_LAMBSE > 1.0 ---------|

; system rich |AND -|

| |

EGOSTATE1 = -1 ----------| |

; ego lean |OR --| PC\_SCALE\_FN := FN\_LAMT1(PG\_LAMBSE)

| |

PG\_LAMBSE < 1.0 ---------| | |

; system lean |AND -| |

| |

EGOSTATE1 = 1 -----------| |

; ego rich |

| --- ELSE ---

|

| PC\_SCALE\_FN := FN\_LAMA1(PG\_LAMBSE)

15-16

CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

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OLFLG = 1 ---------------|

; open loop |AND -|

| |

PG\_OBD2\_HFL = 0 ---------| |

; not trying to hold |

|OR \_\_| ; zero flow value

PC\_RESET = 1 ------------------| | pcomp\_ppm\_new := 0

; canister overrich | |

| |

PCOMP\_ENA = 0 -----------------| |

; PCOMP not enabled |

| --- ELSE ---

PG\_FUELPW < MINPWT ------| |

; low injector flow |AND -| |

| | | ; hold flow value

PG\_LAMBSE > 1.0 ---------| |OR --| pcomp\_ppm\_new := PCOMP\_PPM

; system is rich | |

| |

PG\_OBD2\_HFL = 1 ---------------| |

; a OBD2 test needs purge held |

; at a steady value for duration |

; of the test. |

| --- ELSE ---

|

| ; calculate new flow value

|

| pcomp\_ppm\_new := (PCOMP\_PPM\_C +

| PC\_SCALE\_FN \* [(PG\_LAMBSE - 1.0)

| \* (CYL\_AIR\_CHG \* PG\_FA\_RAT)]

| \* N \* ENGCYL)

|

| ; Clip pcomp\_ppm\_new to zero as min

|

| F6K\_LST\_PS := FN6000A(N,PCT\_LOAD)

2) Determine the value of percent of PCOMP of total fuel:

unconditionally ---------------------| PG\_PC\_PCOMP :=

| PCOMP\_LBM /(PG\_LBMF +

| PCOMP\_LBM)

| ; Clip to zero as a min

3) Determine if canister purge flow is in an overrich condition:

; load % vapor flow limits

ISCFLG = -1 -------------------------| PC\_PCOMP\_L := PC\_PCOMP\_L\_N

;closed throttle - decels | PC\_PCOMP\_H := PC\_PCOMP\_H\_N

|

| --- ELSE ---

|

ISCFLG = 0 --------------------------| PC\_PCOMP\_L := PC\_PCOMP\_L\_0

;part throttle - accels and cruise | PC\_PCOMP\_H := PC\_PCOMP\_H\_0

|

| --- ELSE ---

|

ISCFLG > 0 --------------------------| PC\_PCOMP\_L := PC\_PCOMP\_L\_1

;closed throttle - idle | PC\_PCOMP\_H := PC\_PCOMP\_H\_1

15-17

CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

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PG\_PC\_PCOMP > PC\_PCOMP\_RS --|

; % vapor reset level |AND -|

| |

TP\_REL < PC\_TP\_R -----------| |

; throttle demand low |

|OR --| ; Overich condition exists

LESTMR11 > PG\_TSLE ---------------| | PC\_RESET := 1

; time since last ego while |

; at its clip too long |

|

PG\_FUELPW < PG\_INJ\_PW\_R ----------|

; fuel pulse width reset level

4) Determine the state of the multiplier inhibit flag:

ADP\_STATE11 >= 1 --------|

|AND -| ;In switchpoint recovery mode for HEGO11

ADP\_STATE11 <= 3 --------| | ;(adaptive switchpoint algorithm)

|

|

ADP\_STATE21 >= 1 --------| |

|AND -| ;In switchpoint recovery mode for HEGO21

ADP\_STATE21 <= 3 --------| |

|

PG\_FUELPW < PG\_INJ\_PW\_HI ------|

; injector fuel flow low |

|

PG\_PC\_PCOMP > PC\_PCOMP\_L ------|

; % vapor at inhibit level |

|OR --| PG\_MULT\_INH := 1

ISCDTY < PG\_ISCDTY\_HI ---------| | ; multiplier increase not allowed

; idle air at inhibit level | |

| |

PG\_LAMAV > PG\_LAMMAX ----------| |

| |

PG\_LAMAV < PG\_LAMMIN ----------| |

; lambse in inhibit areas |

| --- ELSE ---

|

| PG\_MULT\_INH := 0

| ; multiplier increase allowed

15-18

CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

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5) Determine the ramp multiplier value:

unconditionally ---------------------| ; load appropriate ramp values

| PG\_RAMP1 := FN630(AM)

| PG\_RAMP2 := FN631(AM)

OLFLG = 1 ---------------|

; open loop |AND -|

| |

PG\_OBD2\_HFL = 0 ---------| |

; not trying to hold |

|

PCOMP\_ENA = 0 -----------------|

; PCOMP not enabled |OR --| ; zero multiplier

| |

PC\_RESET = 1 ------------------| | PG\_RP\_ML := 0

; canister overrich | |

| |

PG\_OBD2\_NFL = 1 ---------------| |

; a OBD2 test needs no purge |

| --- ELSE ---

PG\_FUELPW < PG\_INJ\_PW\_LO ------| |

; low fuel injector flow | |

|OR --| ; decrease multiplier by PG\_RAMP2

PG\_PC\_PCOMP > PC\_PCOMP\_H ------| |

; % vapor too high | | PG\_RP\_ML := PG\_RP\_ML - PG\_RAMP2

| | ; Clip to zero as a minimum

ISCDTY < PG\_ISCDTY\_LO ---------| |

; idle air too low |

| --- ELSE ---

SWTFL11 = 1 -------------------| |

; HEGO11 switched this | |

background |AND -| ; increase multiplier by PG\_RAMP1

| |

PG\_MULT\_INH = 0 ---------------| | PG\_RP\_ML := PG\_RP\_ML + PG\_RAMP1

; multiplier increase allowed | ; Clip to 1.0 as a maximum

|

| --- ELSE ---

|

| No change to PG\_RP\_ML

15-19

CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

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6) Calculate and output the final purge duty cycle and flow values:

unconditionally ---------------------| ; PCOMP OBDII overide logic

| Do: pg\_obd2\_ovrd

PG\_OBD2\_NFL = 1 ---------------------| pg\_dc\_calc := 0

; a OBD2 test needs no purge |

| --- ELSE ---

|

OLFLG = 0 ---------------------------| ; closed loop purge

; in closed loop | pg\_dc\_calc := PG\_DC\_DS \* PG\_RP\_ML

|

| --- ELSE ---

APT = 0 -----------------------| |

; at part throttle |AND -| ; part throttle open loop purge

| | pg\_dc\_calc := FN666(AM)

ATMR4 > PG\_OL\_START -----------| |

; delay open loop purge |

| --- ELSE ---

APT = 1 -----------------------| |

; WOT |AND -| ; wide open throttle open loop purge

| | pg\_dc\_calc := FN667(AM)

ATMR4 > PG\_OL\_START -----------| |

; delay open loop purge |

| --- ELSE ---

|

| pg\_dc\_calc := 0

; NOTE: For no open loop purge, set FN666 and FN667's values to zero.

; a OBD2 purge test is running, use a different ramp constant

FLOW\_RUNNING = 1 --------------|

|OR --| pg\_dc\_new := ROLAV\_TC((pg\_dc\_calc +

PGM\_RUNNING = 1 ---------------| | PG\_DC\_OF),PGM\_TCPRG)

|

| --- ELSE ---

|

| pg\_dc\_new := ROLAV\_TC((pg\_dc\_calc +

| PG\_DC\_OF),TCPRG)

15-20

CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

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PG\_OBD2\_HFL = 1 ---------------------| pg\_dc\_old := PG\_DC

; a OBD2 test needs purge held | pg\_dc\_new := pg\_dc\_old

; at a steady value for duration |

; of the test. | ; output the vapor flow values

| PCOMP\_PPM\_C := pcomp\_ppm\_new

| PCOMP\_PPM := PCOMP\_PPM\_C \*

| FN6000A(N,PCT\_LOAD)

| PCOMP\_LBM := PCOMP\_PPM / (N\*ENGCYL)

|

| --- ELSE ---

pg\_dc\_calc = 0 ----------------| |

|AND -| ; purge valve being ramped closed

PG\_DC > (PG\_DC\_OF + PG\_DC\_HYS)-| |

; valve is still flowing | pg\_dc\_old := PG\_DC

| pg\_factor := (pg\_dc\_new - PG\_DC\_OF)/

| (pg\_dc\_old - PG\_DC\_OF)

| ; Clip pg\_factor to 1.0 as max

|

| ; output the vapor flow values

| pcomp\_ppm\_calc\_old := PCOMP\_PPM\_C

| PCOMP\_PPM\_C := pcomp\_ppm\_calc\_old

| \* pg\_factor

| PCOMP\_PPM := PCOMP\_PPM\_C \*

| FN6000A(N,PCT\_LOAD)

| PCOMP\_LBM := PCOMP\_PPM / (N\*ENGCYL)

|

| --- ELSE ---

|

pg\_dc\_calc = 0 ----------------------| ; purge valve closed

|

| PCOMP\_PPM\_C := 0

| PCOMP\_PPM := 0

| PCOMP\_LBM := 0

| PC\_RESET := 0

| pg\_dc\_new := 0

|

| --- ELSE ---

|

| ; normal purge valve operation

|

| pg\_dc\_old := PG\_DC

| pg\_dc\_new := pg\_dc\_calc + PG\_DC\_OF

| ; Clip pg\_dc\_new to 99.99% as max

| pg\_factor := (pg\_dc\_new - PG\_DC\_OF) /

| (pg\_dc\_old - PG\_DC\_OF)

| ; Clip pg\_factor to 1.0 as max

|

| ; output the vapor flow values

| PCOMP\_PPM\_C := pcomp\_ppm\_new \*

| pg\_factor

| PCOMP\_PPM := PCOMP\_PPM\_C \*

| FN6000A(N,PCT\_LOAD)

| PCOMP\_LBM := PCOMP\_PPM / (N\*ENGCYL)

15-21

CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

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unconditionally ---------------------| PCOMP\_W := PCOMP\_PPM

| ; reduced range version of PCOMP.

| ; does not overflow.

|

| Do: substitute(9,pg\_dc\_new)

| PG\_DC := pg\_dc\_new

| ; output state control override.

|

| Do: pg\_output\_test

| ; output test mode override

; Signal to other features that no purge flow is occuring.

PG\_DC < PG\_DC\_OF --------------|

; valve is closed - no flow |AND -| PRG\_OFF := 1

| |

PCOMP\_ENA = 0 -----------------| |

; PCOMP not enabled |

| --- ELSE ---

|

| PRG\_OFF := 0

END: pcomp\_control

BEGIN: pg\_obd2\_ovrd

; this process is executed only when called.

; this process contains the logic that interfaces with several OBDII tests

; and determines how purge should function during the duration of each test.

PRG\_FLOW\_SW = 0 -------------------------| FLOW\_RUNNING := 0

; flow test not present

INJ\_TR <> 1.0 ---------------------|

; injector cutout scheduled |OR --| ; turn purge off, stop flow

| |

FLOW\_RUNNING = 1 ------------| | | PG\_OBD2\_NFL := 1

; purge flow test active |AND -| |

| |

PRG\_FLOW\_SW = 1 -------------| |

; flow test present |

| --- ELSE ---

|

| PG\_OBD2\_NFL := 0

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CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

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ER\_STATUS = EGO\_ER\_INIT -----------|

; KOER EGO test active |

|

LAM\_MOD\_FLG = 1 -------------------|OR --| ; hold purge, steady flow

; EGO monitor active | |

| | PG\_OBD2\_HFL := 1

SAIR\_TST\_ENA = 1 ------------------| |

; SAIR test active |

| --- ELSE ---

|

| PG\_OBD2\_HFL := 0

END: pg\_obd2\_ovrd

BEGIN: pg\_output\_test

; This process overides normal purge logic when the output ; test logic

commands.

OSM\_EO\_OFF = 1 --------------------------| PG\_DC := 0.0 ; outputs commanded

off

OSM\_EO\_ON = 1 ---------------------------| PG\_DC := 1.0 ; outputs commanded

on

END: pg\_output\_test

15-23

CANISTER PURGE STRATEGY, CANISTER PURGE COMPENSATION - CDAN2

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15.2 FEATURE: RUNNING LOSS OBD-II EVAPORATIVE SYSTEM MONITOR. -

V1.9A\_CANP\_MONITOR (CDAN2)

15.2.1 TANK PRESSURE SENSOR INPUT AND SELF TEST (CDAJ0)

OVERVIEW

This module reads and converts the tank pressure sensor input. The A/D is

read and the raw counts (TPR\_CNTS) are converted into engineering units

(TPR\_ENG). TPR\_ENG is the value used when performing any input testing.

And, it is this value that will be reported to the scan tool. Next, the

TPR\_ENG value is tested for "out of range" or other failure conditions. The

parameter TPR will be modified by any FMEM. If a failure is present for a

sufficient amount of time, the appropriate malfunction flag (PxxxMALF) is

set. Finally, a timer is checked to see if the component has been

sufficiently monitored for this "trip".

DEFINITIONS

INPUTS

Registers:

- TPR\_CNTS = Raw A/D counts from sensor.

- TPR\_ENG = Engineering units value before any FMEM action. Used for FMEM

testing and output to scan tool.

- TPR\_ER\_TMR = Timer that runs when a fault is present.

- TPR\_FM\_TMR = Timer that is reset when the failure conditions for FMEM

mode are met, seconds.

- PUTMR = Time since power up, seconds.

Bit Flags:

- PURG\_TST\_ENA = OBDII purge test enable flag ( 1 -> test enabled ).

- CCM\_TST\_ENA = OBDII Comprehesive Component test ( CCM ) enable flag.

- CCM\_ER\_ENA = On demand test for CCM enable flag.

- PxxxMALF = OBDII malfunction flag for fault xxx; 1 -> a malfunction

currently exists for fault xxx.

- PxxxMON = OBDII monitor flag for fault xxx; 1 -> fault xxx has been

monitored at least once since power-up.

Calibration Constants:

- FN610(TPR\_CNTS) = Function to convert from A/D counts to engineering

units. (Note: Since the failure mode testing is done in engineering

units, the sensor transfer function MUST be calibrated from 0 to 1023

counts.)

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CANISTER PURGE STRATEGY, TANK PRESSURE SENSOR INPUT AND SELF TEST - CDAN2

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- TC\_TPR = Time constant for tank pressure.

- TPR\_FMEM = FMEM value used when TPR\_ENG is out of range, inches of water.

- TPR\_ER\_TM = Time with failure present required to set code, seconds.

- TPR\_FM\_TM = Minimum time in FMEM mode once initiated, seconds.

- TPR\_HI\_ER = Maximum acceptable value for TPR, inches of water.

- TPR\_LO\_ER = Minimum acceptable value for TPR, inches of water.

- TPR\_MON\_TM = Time required to indicate that a "trip" is complete for this

sensor, seconds.

OUTPUTS

Registers:

- PGM\_TANK\_PRS = Purge monitor tank pressure, inches of water.

- TPR\_ENG = See above.

- TPR\_ER\_TMR = See above.

- TPR\_FM\_TMR = See above.

- TPR = Engineering units value with any FMEM corrections applied. Used by

rest of strategy.

Bit Flags:

- PxxxMALF = See above.

- PxxxMON = See above.

OTHER

- purg\_codes = Set of {P0442,P0446,P0452,P0453,P1442}. The set of OBDII

fault codes that relate to purge monitor.

- malfunction(purg,Pxxx) = Logic process, imported from the MIL control

Module; Pxxx indicates the fault code. Also sets the corresponding

PxxxMALF flag.

- clear\_malf(Pxxx) = Logic process that clears the appropriate Pxxx code.

- P0452 = Fault code, fuel tank pressure sensor circuit out of range low.

- P0453 = Fault code, fuel tank pressure sensor circuit out of range high.

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CANISTER PURGE STRATEGY, TANK PRESSURE SENSOR INPUT AND SELF TEST - CDAN2

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PROCESS

STRATEGY MODULE: CANP\_INPUT\_TPR\_COM1

always -------------------------| Increment TPR\_ER\_TMR

| Increment TPR\_FM\_TMR

always -------------------------| TPR\_ENG = FN610(TPR\_CNTS)

| (read A/D, Convert to engineering units)

PURG\_TST\_ENA = 1 ---------|

|

CCM\_ER\_ENA = 1 -----------|OR --| Do: TPR\_FAILURE\_CHECK

| | (check for out of range)

CCM\_TST\_ENA = 1 ----------| | Do: TPR\_MONITORED\_CHECK

| (test for component monitored)

|

| --- ELSE ---

|

| Exit module.

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CANISTER PURGE STRATEGY, TANK PRESSURE SENSOR INPUT AND SELF TEST - CDAN2

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BEGIN: TPR\_FAILURE\_CHECK

Check for "open/short" failures and other failures as appropriate for

particular sensor. Perform FMEM action if a failure is detected. Set

malfunction flag when a malfunction has been present for a sufficient time.

TPR\_ENG > TPR\_HI\_ER ------|

(value too high) |

|

TPR\_ER\_TMR > TPR\_ER\_TM ---|AND -| Do: malfunction(purg,P0453)

(failure present long | | (update MIL and set MALF)

enough) | | TPR\_FM\_TMR = 0

| | PGM\_TPR\_FM = 1

P0453MALF = 0 ------------| | (set tank pressure sensor FMEM flag)

|

| --- ELSE ---

|

TPR\_ENG > TPR\_HI\_ER ------------| PGM\_TPR\_FM = 1

(value too high; not present | (set tank pressure sensor FMEM flag)

long enough to set | TPR\_FM\_TMR = 0

malfunction flag) |

|

| --- ELSE ---

TPR\_ENG < TPR\_LO\_ER ------| |

(value too low) | |

| |

TPR\_ER\_TMR > TPR\_ER\_TM ---|AND -| Do: malfunction(purg,P0452)

(failure present long | | (update MIL and set MALF)

enough) | | TPR\_FM\_TMR = 0

| | PGM\_TPR\_FM = 1

P0452MALF = 0 ------------| | (set tank pressure sensor FMEM flag)

|

|

|

| --- ELSE ---

|

TPR\_ENG < TPR\_LO\_ER ------------| PGM\_TPR\_FM = 1

(value too low; not present | (set tank pressure sensor FMEM flag)

long enough to set | TPR\_FM\_TMR = 0

malfunction flag) |

| --- ELSE ---

(continued on next page)

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CANISTER PURGE STRATEGY, TANK PRESSURE SENSOR INPUT AND SELF TEST - CDAN2

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(continued from previous page)

P0453MALF = 1 ------| |

|OR --| |

P0452MALF = 1 ------| |AND -| PGM\_TPR\_FM = 1

| | (Remain in FMEM mode until

TPR\_FM\_TMR < TPR\_FM\_TM ---| | it times out)

|

| --- ELSE ---

|

| PGM\_TANK\_PRS = ROLAV(TPR\_ENG,TC\_TPR)

| (no failure detected, return

| value for normal use)

| TPR\_ER\_TMR = 0

| (reset failure present timer)

| PGM\_TPR\_FM = 0

| (clear failure flags)

| Do: clear\_malf(P0452)

| Do: clear\_malf(P0453)

END: TPR\_FAILURE\_CHECK

BEGIN: TPR\_MONITORED\_CHECK

If enough time has passed since power up (or run mode, or...) assume that

enough A/D readings have been taken to assume that a hard fault, if present,

would have been detected.

PUTMR > TPR\_MON\_TM -------------| P0453MON = 1

(enough time for sufficient | P0452MON = 1

A/D readings) | (codes P0453 & P0452 monitored)

END: TPR\_MONITORED\_CHECK

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CANISTER PURGE STRATEGY, CVS FMEM - CDAN2

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15.2.2 CVS FMEM (CDAN0)

OVERVIEW

This module contains 2 processes. Each deals with the Canister Vent Valve.

[cvs\_fmem\_check] reads the tank pressure every background loop and determines

if the canister vent solenoid is erroneously stuck closed. Normally, the

canister vent solenoid should be at zero duty cycle and open, except during

the purge monitor test. If the vent solenoid is stuck closed, when the purge

monitor test is not on, then tank pressures will be dangerously low. A

FMEM/fault code will be set which will, most importantly, disable purge.

[cvs\_osm\_eo\_test] closes the CVV/CVS (which is normally OPEN) by sending a

duty cycle of 1.0 during the key on, engine off output test mode.

INPUTS/OUTPUTS

Registers:

- PG\_DC = Canister purge duty cycle.

- PGM\_TANK\_PRS = Purge monitor tank pressure, inches of water.

Bit Flags:

- PGM\_RUNNING = Purge monitor test is running flag; 1 -> running.

- PxxxMALF = OBDII malfunction flag for fault xxx; 1 -> a malfunction

currently exists for fault xxx.

- PxxxMON = OBDII monitor flag for fault xxx; 1 -> fault xxx has been

monitored at least once since power-up.

- PGM\_CVS\_FM = Canister vent solenoid FMEM flag; 1 -> CVS failed.

Calibration Constants:

- PGM\_PRS\_HI = Tank pressure which is acceptable when purge is on

(PGM\_PRS\_LO + hysteresis), inches of water.

- PGM\_PRS\_LO = Lowest tank pressure allowed when purge is on, inches of

water.

OTHER

- purg\_codes = Set of {P0442,P0446,P0452,P0453,P1442}. The set of OBDII

fault codes that relate to purge monitor.

- malfunction(purg,Pxxx) = Logic process, imported from the MIL control

Module; Pxxx indicates the fault code. Also sets corresponding MALF

flag.

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CANISTER PURGE STRATEGY, CVS FMEM - CDAN2

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- clear\_malf(Pxxx) = Logic process that clears the appropriate fault code.

- P0453 = Fault code, fuel tank pressure sensor circuit out of range high.

- P0452 = Fault code, fuel tank pressure sensor circuit out of range low.

- P0446 = Fault code, purge monitor canister vent solenoid stuck closed.

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CANISTER PURGE STRATEGY, CVS FMEM - CDAN2

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PROCESS

STRATEGY MODULE: CANP\_CVS\_FMEM\_COM1

BEGIN: cvs\_fmem\_check

PGM\_TANK\_PRS < PGM\_PRS\_LO -------|

(tank pressure is too low) |

|

PGM\_RUNNING = 0 -----------------|

(purge monitor is not running) |

|

P0453MON = 1 --------------------|

|

P0452MON = 1 --------------------|

(tank pressure sensor has been |

monitored) |AND -| PGM\_CVS\_FM = 1

| | (Canister Vent Solenoid

P0453MALF = 0 -------------------| | erroneously stuck closed)

| | Do: malfunction(purg,P0446)

P0452MALF = 0 -------------------| | (update MIL and set MALF)

(tank pressure sensor is O.K.) | | P0446MON = 1

| | (code P0446 monitored)

PG\_DC > 0 -----------------------| |

(vapor management valve is on) | |

| |

P0446MALF = 0 -------------------| |

| --- ELSE ---

PGM\_TANK\_PRS < PGM\_PRS\_LO -------| |

(tank pressure is too low) | |

| |

PGM\_RUNNING = 0 -----------------| |

(purge monitor is not running) | |

| |

P0453MALF = 0 -------------------| |

| |

P0452MALF = 0 -------------------|AND -| PGM\_CVS\_FM = 1

(tank pressure sensor is O.K.) | | (Canister Vent Solenoid

| | erroneously stuck closed)

P0453MON = 1 --------------------| |

| |

P0452MON = 1 --------------------| |

(tank pressure sensor has been | |

monitored) | |

| |

PG\_DC > 0 -----------------------| |

(VMV commanded on) |

| --- ELSE ---

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CANISTER PURGE STRATEGY, CVS FMEM - CDAN2

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PGM\_TANK\_PRS > PGM\_PRS\_HI -------| |

(tank pressure is O.K.) | |

| |

PGM\_RUNNING = 0 -----------------| |

(purge monitor is not running) | |

| |

P0453MALF = 0 -------------------| |

| |

P0452MALF = 0 -------------------|AND -| PGM\_CVS\_FM = 0

(tank pressure sensor is O.K.) | | (Canister Vent Solenoid O.K.)

| |

P0453MON = 1 --------------------| | P0446MON = 1

| | (code P0446 monitored)

P0452MON = 1 --------------------| |

(tank pressure sensor has been | | Do: clear\_malf(P0446)

monitored) | | (clear malfunction flag)

|

PG\_DC > 0 -----------------------|

(VMV commanded on)

END: cvs\_fmem\_check

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CANISTER PURGE STRATEGY, VAPOR MANAGEMENT VALVE OSM TEST LOGIC- CDAN2

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15.2.3 VAPOR MANAGEMENT VALVE OSM TEST LOGIC (CDAM0)

OVERVIEW

This module monitors the control circuitry of the vapor management valve

(VMV). The voltage across the VMV is monitored and brought into the EEC by

way of an analog channel. The EEC converts this voltage to a A/D counts

value (VMV\_OSM\_CNTS). This value is compared with two calculated expected

threshold values and this determines if the valve is functioning correctly or

not.

The VMV is a duty cycled solenoid, therefore to test it correctly, the OSM

test must be performed when the VMV is nearly completely ON (> 90% dc) or

completely OFF (0% dc). These conditions are commanded by logic in the purge

control module for the engine off on demand test. As for the other possible

tests, PG\_DC must be set to 1.0 or 0 before this test will complete.

DEFINITIONS

Registers:

- CANP\_FF = Vapor Management Valve fault filter.

- PG\_DC = Canister purge duty cycle; 1.0 -> 100%, 0 -> 0%.

- VMV\_OSM\_CNTS = VMV OSM raw analog channel input value.

- VMV\_OSM\_TMR = Timer that tracks the amount of time that the VMV has been

actively monitored.

- VBAT = Battery voltage.

- VMV\_ZDC\_MIN = Calculated expected VMV OSM counts value at 0% DC.

- VMV\_MXDC\_MAX = Calculated expected VMV OSM counts value at >90% DC.

Bit Flags:

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled.

- CCM\_ER\_ENA = On demand test for CCM enabled.

- CCM\_TST\_ENA = OBDII Comprehensive Component Test Enable Flag.

- OSM\_EO\_ON = ON state requested for OSM outputs during engine off demand.

- OSM\_EO\_OFF = OFF state requested for OSM outputs during engine off on

demand test.

- OSM\_1ST\_PS = First pass flag of the VMV OSM test; 1 -> first pass seen.

- PURG\_TST\_ENA = OBDII purge test enable flag ( 1 -> test enabled ).

- P0443MON = OBDII monitored flag for code 0443.

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CANISTER PURGE STRATEGY, VAPOR MANAGEMENT VALVE OSM TEST LOGIC- CDAN2

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Calibration Constants:

- VMV\_MXDC\_ML = Multiplier used with VMV\_MXDC\_MAX.

- VMV\_MXDC\_SUB = Subtractor used with calculation of VMV\_MXDC\_MAX .

- VMV\_ZDC\_ML = Multiplier used with VMV\_ZDC\_MIN.

- VMV\_ZDC\_SUB = Subtractor used with VMV\_ZDC\_MIN.

- TC\_CANP = Time constant used in the ROLAV filtering check of CANP\_FF.

- CANP\_THRES = Threshold used with the rolav filtering check of CANP\_FF.

- PG\_DC\_MAX = Duty cycle of the purge valve above which it is considered to

be at its maximum ON value, %.

- VMV\_OSM\_TM = Time above which the VMV is considered completely monitored.

- VBAT\_CCM\_MIN = Minimum voltage to perform OSM tests.

OTHER

- purg\_codes = Set of (P0442,P0443,P0446,P0452,P0453,P0455) OBDII fault

codes.

- P0443 = Fault code for the vapor management valve circuit malfunction.

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CANISTER PURGE STRATEGY, VAPOR MANAGEMENT VALVE OSM TEST LOGIC- CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CANP\_VMV\_OSM\_COM4

BEGIN: vmv\_osm\_check ; done once per background loop

OSM\_EO\_ON = 1 --------------|

|

OSM\_EO\_OFF = 1 ------------|

|

CCM\_ER\_ENA = 1 ------------|OR --|AND -| Do: vmv\_osm\_test.

| | |

CCM\_EO\_ENA = 1 ------------| | |

| | |

PURG\_TST\_ENA = 1 -----------| | |

| | |

CCM\_TST\_ENA = 1 ------------| | |

| |

VBAT >= VBAT\_CCM\_MIN -------------| |

| --- ELSE ---

|

| Exit vmv\_osm\_check.

END: vmv\_osm\_check

BEGIN: vmv\_osm\_test

; This routine checks to see if the first pass has been seen.

OSM\_1ST\_PS = 0 -------------------------| VMV\_OSM\_TMR := 0

; first time through | ; clear timer

| OSM\_1ST\_PS := 1

; This routine compares the actual count readings of the vapor management

; valve output state monitor (from the A/D channel) to calculated expected

; readings. Based on the comparison, the logic determines if the vapor

; management valve is functioning correctly.

; calculate the expected values from equations governing the OSM circuit

unconditionally ------------------------| VMV\_ZDC\_MIN := (VMV\_ZDC\_ML\*VBAT)

| - VMV\_ZDC\_SUB

| VMV\_MXDC\_MAX := (VMV\_MXDC\_ML\*VBAT)

| - VMV\_MXDC\_SUB

; compare the measured and the calculated expected values.

PG\_DC >= PG\_DC\_MAX ---------|

; VMV commanded on |AND -|

| |

VMV\_OSM\_CNTS > VMV\_MXDC\_MAX | |OR --| CANP\_FF := ROLAV(1,TC\_CANP)

| | ; error seen, filter to 1

PG\_DC = 0 ------------------| | |

; VMV commanded off |AND -| | Increment VMV\_OSM\_TMR.

| |

VMV\_OSM\_CNTS < VMV\_ZDC\_MIN -| |

| --- ELSE ---

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CANISTER PURGE STRATEGY, VAPOR MANAGEMENT VALVE OSM TEST LOGIC- CDAN2

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(continued from previous page)

PG\_DC >= PG\_DC\_MAX ---------| |

; VMV commanded on |AND -| |

| | |

VMV\_OSM\_CNTS < VMV\_MXDC\_MAX | |OR --| CANP\_FF := ROLAV(0,TC\_CANP)

| | ; NO error seen, filter to 0

PG\_DC = 0 ------------------| | |

; VMV commanded off |AND -| | Increment VMV\_OSM\_TMR.

| |

VMV\_OSM\_CNTS > VMV\_ZDC\_MIN -| |

| --- ELSE ---

|

| Hold CANP\_FF at current value.

| ; PG\_DC <> 1 or 0 - cannot test

|

| Hold VMV\_OSM\_TMR at current value.

CANP\_FF > CANP\_THRES -------------------| Do: malfunction(purg,P0443)

; apply threshold check to decide the |

; error status |

| --- ELSE ---

|

| Do: clear\_malf(P0443)

VMV\_OSM\_TMR > VMV\_OSM\_TM ---------------| P0443MON := 1

; check if enough time has passed |

; to say if completely monitored |

| --- ELSE ---

|

| P0443MON := 0

END: vmv\_osm\_test

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CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

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15.2.4 CANISTER PURGE MONITOR (CDAN2)

OVERVIEW

This logic describes the vacuum leak down test of the canister purge system

for compliance with CARB and EPA OBD-II requirements. The purpose of the

test is to identify any leaks in the fuel/canister purge system that would

cause vapor to escape to the atmosphere. After PCOMP has been active for

some amount of time, the test is run by closing the atmospheric vent on the

canister and applying a vacuum to the fuel system and observing if the vacuum

is held. The test passes if the system can successfully hold the vacuum for

a period of time.

o Entry Conditions:

The test will begin if all of the following entry conditions are met:

. The test has not yet been run this trip.

. Powertrain load is within the calibrated window.

. The vehicle speed is within a calibrated window.

. ACT/ECT is below a calibrated maximum value.

. Tank pressure before testing is within a calibrated window.

. Time since closed loop is greater than a calibrated minimum value.

. PG\_DC is above a calibrated value.

. PGM\_PCOMP\_W is below a calibrated value.

o Test Description:

There are six test phases in addition to a pre-test phase. The pre-test

phase is simply the time immediately preceding the beginning of the purge

monitor test when PCOMP is actively purging down the vapors in the

system. The six test phases begin at phase zero and are as follows:

. Tank vacuum application phase:

In this portion of the test, an attempt is made to achieve a vacuum of a

calibrated value in the fuel system. If the tank vacuum is ABOVE the

calibratable value, the Canister Vent Valve (CVV/CVS) is ramped closed to

atmosphere. Since the VMV is open, the engine will see vapor that is

very rich with fuel vapor. For this reason, PCOMP is still enabled to

allow the engine to consume the vapor, but the "leakage term" that

represents the unmetered air flowing through the purge system must be

forced to zero. If the tank vacuum is BELOW a calibratable value, the

VMV is closed and the vacuum is bled out of the CVS until the target is

reached. After reaching the target, the CVS is closed. If the target

vacuum is not reached in a calibrated amount of time, it must be assumed

that this is a result of a fuel system leak - the test fails and an error

code is stored. If the target vacuum is reached, the VMV, if open, is

closed and phase 1 is entered.

. Vacuum stabilization phase:

In this portion of the test, the tank vacuum is allowed to stablize for a

calibratable period of time and then enter phase 2. This compensates for

overshoots and undershoots which would interfere with the accuracy of the

vacuum bleedup reading.

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CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

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. Vacuum hold phase:

This phase tests the capability of the fuel/evap system to hold a vacuum.

Both the VMV and the Canister Vent Valve are held closed in order to hold

the vacuum for a calibrated period of time. At the end of the time

period, the change in fuel tank vacuum is calculated and this value is

compared to a calibrated maximum acceptable pressure change. The test

passes if the pressure change is below the maximum allowable value and if

it is above the maximum, the test continues to phase 3.

. Tank pressure stabilization phase:

In this portion of the test, the tank pressure is stabilized by opening

the Canister Vent Valve and closing the Vapor Management Valve. The

logic waits for a calibratable time to pass and the tank pressure to be

within limits to continue to phase 4 of the test.

. Pressure build phase:

In this portion of the test, the system is sealed by closing both the VMV

and the Canister Vent Valve. The pressure is monitored and the increase

in tank pressure is calculated over a period of time. This part of the

test will indicate the extent to which pressure is increasing in the tank

due to vapor generation. If the increase in pressure is above a

calibrated maximum value, the test results are rejected, since the "bleed

down" rate will be skewed by vapor generation. If the pressure increase

is below the calibrated maximum value, vapor generation is within reason

and this value is subtracted from the vacuum bleedup of phase 2 to

determine the true bleedup rate of a possible leak. If the bleedup is

still above the limit, a failure is indicated.

. End of test:

The final phase of the test returns the purge system to normal purge.

The Canister Vent Valve is gradually opened at a calibrated ramp rate to

the full open position. Finally, the system is allowed to return to

either purge or adaptive fuel learning, depending on which the engine

strategy is requesting at the time.

o Early Exit Conditions (no error code stored)

Over the duration of the test, a few conditions are possible that may

require the early termination of the test:

- operation out of a load window.

- operation out of the vehicle speed window.

- failure of the tank pressure sensor.

- failure of the canister vent valve.

- re-entry into open loop

- engine stall

- excessive pressure/vacuum on the tank

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CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- ACT = Air Charge Temperature, deg. F.

- CL\_TMR = Closed loop timer (actuated).

- ECT = Engine coolant temperature, deg F.

- KWUCTR = Warm up counter for Adaptive learning.

- LOAD = Universal load as a ratio of aircharge over standard.

- PCT\_LOAD = Percent inferred load (altitude independent).

- PCOMP\_W = Calculated PCOMP flow in pounds per minute.

- PGM\_PCOMP\_W = Filtered PCOMP flow in pounds per minute.

- PG\_DC = Purge duty cycle.

- PGM\_BLED\_KAM = Weighted moving average of the delta of pressures used to

determine if a small leak exists (P0442 -> unable to hold vacuum in

tank).

- PGM\_CVS\_DC = Purge monitor canister vent solenoid valve duty cycle.

- PGM\_ERROR = Present error condition of the purge monitor system.

- PGM\_FK = Filter constant used with the weighted moving average of

PGM\_BLED\_KAM. Value is either PGM\_FK\_NMAT or PGM\_FK\_MAT.

- PGM\_LOAD\_DLT = Absolute value of the difference between the filtered

PGM\_LOAD and the current value of LOAD.

- PGM\_PS0\_BEGP = Tank pressure at beginning of phase zero.

- PGM\_P0\_BEGK = Value of PGM\_PS0\_BEGP stored to KAM for SCP reporting.

- PGM\_PS2\_BEGP = Tank pressure at beginning of phase two.

- PGM\_PS2\_DLTP = Delta pressure in tank during phase 2.

- PGM\_P2\_DLTPK = Value of PGM\_PS2\_DLTP stored to KAM for SCP reporting.

- PGM\_PS4\_BEGP = Tank pressure at beginning of phase four.

- PGM\_PS4\_DLTP = Delta pressure in tank during phase 4, not caused by vapor

generation.

- PGM\_P4\_DLTPK = Value of PGM\_PS4\_DLTP stored to KAM for SCP reporting.

- PGM\_PS4\_DELP = Delta pressure in tank during phase 4, with phase 2

compensation.

- PGM\_P4\_DELPK = Value of PGM\_PS4\_DELP stored to KAM for SCP reporting.

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CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PGM\_BLD\_DLTK = Value of PGM\_BLD\_DLT stored to KAM for SCP reporting.

- PGM\_PS\_TMR = Purge monitor phase timer (free run).

- PGM\_RUN\_CTR = Purge monitor run counter, tracks how many times monitor

has been run during a single Key-ON event.

- PGM\_RST\_CTR = Purge monitor restart counter.

- PGM\_RST\_TMR = Timer that counts down time between attempts to run the

purge monitor test after a reset.

- PGM\_ST = Purge monitor state.

- PGM\_TANK\_PRS = Purge monitor tank pressure.

- PGM\_TEMP = Temperature (ECT/ACT combination) used in purge monitor.

- PGM\_TEMP\_CTR = Counter that tracks the number of times that the PGM\_TEMP

window has been entered.

- PGM\_TPR\_DLT = Absolute value of the difference between the filtered tank

pressure, PGM\_TANK\_PRS, and the current value of TPR\_ENG.

- PGM\_VBAT\_DLT = Absolute value of the difference between the filtered

PGM\_VBAT and the current value of VBAT.

- TPR\_ENG = Tank pressure converted from A/D.

- VSBAR = Vehicle speed, MPH.

- PGM\_0442\_DLP = Parameter that holds the value of the pressure change used

in PGM\_BLED\_KAM check.

- PGM\_P0\_WPEK = Peak PCOMP\_W seen during phase 0.

- FN\_PGM\_BLEED = Purge monitor's allowed bleedup pressure as function of

PGM\_P0\_WPEK.

- PGM\_BLD\_DLT = Purge monitor bleed pressure allowed before test is failed,

from FN\_PGM\_BLEED(PGM\_P0\_WPEK).

| - ER\_STATUS = State pointer that indicates current state of engine running

| on demand test.

Bit Flags:

- EGR\_MON = OBDII monitor flag for EGR systems; 1=> all EGR faults been

monitored since power-up.

- FFG\_PURG = OBDII system FMEM flag for the purge system - 1 -> purge

system is not under control reliably.

- FLG\_STALL = Indicates a stall has occurred; transition.

- KAM\_ERROR = Flag that indicates the keep alive memory (KAM) is invalid.

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CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

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- OBDII\_RESET = Flag used to simulate the receipt of an OBDII scan tool

reset message.

- OLFLG = Open loop flag; 1 -> open loop mode, 0 -> closed loop mode.

- PGM\_CVS\_FM = Canister Vent Valve FMEM flag; 1 -> CVS failed.

- PGM\_DONE = Purge monitor test is done flag; 1 -> test is done.

- PGM\_PG\_ON = Purge monitor command to turn PCOMP/PURGE on.

- PGM\_PS0\_SET = Phase zero set-up flag; 1 -> set-up complete.

- PGM\_PS1\_SET = Phase one set-up flag; 1 -> set-up complete.

- PGM\_PS2\_SET = Phase two set-up flag; 1 -> set-up complete.

- PGM\_PS3\_SET = Phase three set-up flag; 1 -> set-up complete.

- PGM\_PS4\_SET = Phase four set-up flag; 1 -> set-up complete.

- PGM\_RUNNING = Purge monitor test is running flag; 1 -> running.

- PGM\_TPR\_FM = Tank Pressure Sensor FMEM flag; 1 -> TPR failed.

- PGM\_TRG\_SEEN = Target vacuum range has been entered flag.

- PGM\_VAC\_SEEN = Specific vacuum value has been reached flag. Used with

the logic that checks for exessive vacuum.

- PGM\_TMP\_SEEN = PGM\_TEMP window has been seen this key on flag.

- PGM\_TEMP\_FLG = Flag that indicates if PGM\_TEMP\_CTR has been incremented

this Key On.

- PURG\_MON = OBDII monitor flag for evaporative purge; 1 -> all purge

faults been monitored since power-up.

- PURG\_TST\_ENA = Purge test enabled flag; 1 -> Purge test has been enabled

by the OBD-2 executive.

- PURG\_TST\_RDY = Purge test ready flag; 1 -> all local conditions have been

met, ready to run purge test.

- PxxxxMALF = OBDII malfunction flag for fault xxxx; 1 -> a malfunction

currently exists for fault xxxx.

- PxxxxMON = OBDII monitor flag for fault xxxx; 1 -> fault has been

monitored at least once since power-up.

- TRIP\_NOT\_PRG = Flag that indicates all other OBDII monitors have been

monitored, except for purge.

- OSM\_EO\_OFF = Off state requested for OSM outputs during engine off on

demand.

Calibration Constants:

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CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

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- PGM\_BLD\_INIT = Initial value of PGM\_BLED\_KAM after KAM reset.

- PGM\_CL\_TM = Time in closed loop to allow purge monitor test.

- PGM\_CVS\_DEC = Purge monitor canister vent solenoid valve duty cyle

decrement used during phase five.

- PG\_DC\_LOW = Calibratable minimum value of PG\_DC.

- PGM\_P0\_DCMIN = Calibratable minimum value of PG\_DC in phase 0. Below

which, amount of vacuum will probably be too low to run correctly.

- PGM\_FK\_NMAT = PGM\_FK value used when KAM is NOT considered mature.

- PGM\_FK\_MAT = PGM\_FK value used when KAM is considered mature.

- PGM\_KWUCNT = Maximum mumber of warm\_up cycles to use PGM\_FK\_NMAT.

- PGM\_LOAD\_MAX = Maximum PCT\_LOAD to allow purge monitor test.

- PGM\_LOAD\_MIN = Minimum PCT\_LOAD to allow purge monitor test.

- PGM\_PG\_START = Purge duty cycle above which to allow the purge monitor to

begin.

- PGM\_PPM\_WMX = Maximum value of PGM\_PCOMP\_W allowed to run the purge

monitor.

- PGM\_PS1\_TM = Allowable time in phase one to stabilize tank pressure, sec.

- PGM\_PS1\_MAX = Maximum tank pressure allowed during phase one, in water.

- PGM\_PS3\_TM = Allowable time in phase three to stabilize tank pressure,

sec.

- PGM\_PS3\_MAX = Maximum tank pressure allowed during phase three, in water.

- PGM\_PS3\_MIN = Minimum tank pressure allowed during phase three, in water.

- PGM\_PS4\_DP = Maximum allowable delta presure in phase four to allow purge

monitor test.

- PGM\_PS4\_DPML = Purge monitor delta pressure multiplier; multiplies phase

four delta pressure for compatability with phase two delta pressure.

- PGM\_PS4\_TM = Allowable time in phase four to build pressure.

- PGM\_PS0\_LO = Low tank pressure value of phase zero deadband.

- PGM\_PS0\_HI = High tank pressure value of phase zero deadband.

- PGM\_PS0\_TM = Allowable time in phase zero to allow system to pull vacuum.

- PGM\_P0\_WMX = Maximum value of PCOMP\_W allowed in phase 0.

- PGM\_PS2\_TM = Allowable time in phase two to verify vacuum is held.

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CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

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- PGM\_RUN\_CNT = Number of times purge monitor is allowed to be run per

engine key-on before a malfunction is indicated.

- PGM\_RST\_CNT = Number of times purge monitor is allowed to be tried per

engine key-on.

- PGM\_RST\_TM = Time required before Purge Monitor Test is allowed to

restart.

- PGM\_TANK\_MAX = Maximum tank pressure to allow purge monitor test.

- PGM\_TANK\_MIN = Minimum tank pressure to allow purge monitor test.

- PGM\_TEMP\_MAX = Maximum temperature to allow purge monitor test.

- PGM\_TEMP\_MIN = Minimum temperature to allow purge monitor test.

- PGM\_TEMP\_CNT = Minimum number of times that PGM\_TEMP must have entered

the proper window before PURG\_MON temp bypass is run.

- PGM\_VS\_MAX = Maximum vehicle speed to allow purge monitor test.

- PGM\_VS\_MIN = Minimum vehicle speed to allow purge monitor test.

- PGM\_LD\_DT\_MX = Maximum value of PGM\_LOAD\_DLT above which the purge test

is aborted.

- PGM\_TP\_DT\_MX = Maximum value of PGM\_TPR\_DLT above which the purge test is

aborted.

- PGM\_TC\_W = Time constant used in the rolav filtering of PGM\_PCOMP\_W.

| - PURG\_ER\_INIT = Value for state of ER\_STATUS to request the engine running

| purg

| - PURG\_ER\_DONE = Value for the state of ER\_STATUS to indicate that the

| engine ru test is complete.

OTHER

- purg\_codes = Set of {P0442,P0446,P0452,P0453,P0455,P1450}. The set of

OBDII fault codes that relate to purge monitor.

- malfunction(purg,Pxxxx) = Logic process, imported from the MIL control

Module; Pxxxx indicates the fault code.

- P0442 = Fault code, unable to hold vacuum in tank (small leak).

- P0443 = Fault code for the canister purge control circuit malfunction.

- P0446 = Fault code, purge monitor canister vent solenoid stuck closed.

- P0452 = Fault code, fuel tank pressure sensor circuit out of range low.

- P0453 = Fault code, fuel tank pressure sensor circuit out of range high.

- P0455 = Fault code, unable to pull the target vacuum in tank (gross

leak).

15-43

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- P1450 = Fault code, unable to bleed up the tank vacuum (gross vacuum).

15-44

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CANP\_MONITOR\_COM2

BEGIN: canister\_purge\_monitor

;Executed once every background loop.

unconditionally ---------------------| Do: pgm\_init\_kam\_values

| Do: pgm\_ram\_init

| | Do: pgm\_er\_bypass

| Do: pgm\_sensor\_processing

| Do: pgm\_main

| Do: pgm\_output\_substitution

| Do: pgm\_monitor\_temp\_bypass

| Do: pgm\_check\_monitored

| Do: pgm\_ffg\_purg

BEGIN: pgm\_init\_kam\_values

; Executed only when called.

KAM\_ERROR = 1 -----------------|

(KAM has been corrupted) |OR --| PGM\_BLED\_KAM := PGM\_BLD\_INIT

| | (reset to reasonable initial value)

OBDII\_RESET = 1 ---------------| | PGM\_P0\_BEGK := -64

| PGM\_P2\_DLTPK := -64

| PGM\_P4\_DELPK := -64

| PGM\_P4\_DLTPK := -64

| (reset to unreasonable values)

| PGM\_TEMP\_CTR := 0

END: pgm\_init\_kam\_values

BEGIN: pgm\_ram\_init

; Executed only when called.

RAM initialization ------------------| PGM\_ST = -1.0

| PGM\_ERROR = -1.0

| TRIP\_NOT\_PRG = 0

END: pgm\_ram\_init

| BEGIN: pgm\_er\_bypass

| ; bypass the KOER test logic

| ER\_STATUS = PURG\_ER\_INIT ---------------| ER\_STATUS := PURG\_ER\_DONE

| ; KOER test being desired | ; KOER test is complete

| END: pgm\_er\_bypass

15-45

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: pgm\_sensor\_processing

; Executed only when called.

unconditionally ---------------------| ; call process that calculates

| ; PGM\_TEMP, PGM\_VBAT\_DLT, PGM\_LOAD\_DLT

| ; logic found in CANP\_PGM\_FILT\_COMx

| Do: pgm\_filtering

|

| ; calculate change in tank pressure

| ; to determine if fuel is sloshing

| PGM\_TPR\_DLT := | TPR\_ENG

| - PGM\_TANK\_PRS |

| ; absolute value of difference

| ; between instantaneous and filtered

|

| ; calculate a filtered PCOMP\_W

| PGM\_PCOMP\_W := ROLAV(PCOMP\_W,PGM\_TC\_W)

|

| Decrement PGM\_PS\_TMR.

| ; Clip to 0.0 as a minimum

PGM\_TEMP <= PGM\_TEMP\_MAX ------|

|AND -| PGM\_TMP\_SEEN := 1

PGM\_TEMP >= PGM\_TEMP\_MIN ------| | ; temp has been seen this key on

(temperature within range)

END: pgm\_sensor\_processing

BEGIN: pgm\_main

; Executed only when called.

OLFLG = 0 ---------------------------| Increment CL\_TMR.

(closed loop) |

| --- ELSE ---

|

| Freeze CL\_TMR.

15-46

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PG\_DC > PGM\_PG\_START ----------|

(duty cycle is high enough) |

|

PGM\_PCOMP\_W < PGM\_PPM\_WMX -----|

(purge vapors not excessive) |

|

PCT\_LOAD >= PGM\_LOAD\_MIN ------|

(PCT\_LOAD within range) |

|

PCT\_LOAD <= PGM\_LOAD\_MAX ------|

(PCT\_LOAD within range) |

|

PGM\_TANK\_PRS >= PGM\_TANK\_MIN --|

(tank pressure within range) |

|

PGM\_TANK\_PRS <= PGM\_TANK\_MAX --|

(tank pressure within range) |AND -| purg\_rdy = 1

| | (purge test is ready)

PGM\_TEMP <= PGM\_TEMP\_MAX ------| |

| |

PGM\_TEMP >= PGM\_TEMP\_MIN ------| |

(temp currently within range) | |

| |

VSBAR >= PGM\_VS\_MIN -----------| |

| |

VSBAR <= PGM\_VS\_MAX -----------| |

(vehicle speed within range) | |

| |

CL\_TMR >= PGM\_CL\_TM -----------| |

(in closed loop long enough) | |

| |

PGM\_CVS\_FM = 0 ----------------| |

| |

PGM\_TPR\_FM = 0 ----------------| |

(purge monitor sensors and | |

actuators are O.K.) | |

| |

PGM\_RST\_TMR = 0 ---------------| |

(delay before restart test) | |

| |

P0443MON = 1 ------------------| |

(purge valve circuit checked) | |

| |

P0443MALF = 0 -----------------| |

(no circuit malfunction seen) |

| --- ELSE ---

|

| purg\_rdy = 0

purg\_rdy = 1 ------------------|

|OR --| PURG\_TST\_RDY = 1

PGM\_ST > -1 -------------------| |

| --- ELSE ---

|

| PURG\_TST\_RDY = 0

15-47

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PGM\_DONE = 1 ------------------------| pgm\_cvs\_dc := 0

; purge monitor complete | EXIT: pgm\_main

|

| --- ELSE ---

PGM\_RUNNING = 0 ---------------| |

(purge monitor test not | |

running) | |

| |

PGM\_ST < 0 --------------------| |

(purge monitor state less than| |

zero; test not started) |AND -| PGM\_RUNNING = 1

| | (set purge monitor running flag)

purg\_rdy = 1 ------------------| | PGM\_ST = 0

(test is ready) | | (start purge monitor at phase zero)

| | Do: PGM\_ST\_DRVR

PURG\_TST\_ENA = 1 --------------| | (call state driver subroutine)

(test enabled by OBD-2 executive) |

| --- ELSE ---

PGM\_RUNNING = 1 ---------------| |

(purge monitor test is | |

running) | |

| |

PCT\_LOAD < PGM\_LOAD\_MIN -| | |

(PCT\_LOAD is not within | | |

acceptable range) | | |

| |AND -| PGM\_ST = 5

PCT\_LOAD > PGM\_LOAD\_MAX -| | | (abort test; place test

(PCT\_LOAD is not within | | | in phase 5)

acceptable range) | | | PGM\_ERROR = 5

| | | (indicate test was aborted due to

PGM\_CVS\_FM = 1 ----------| | | load, vehicle speed, stall, open

| | | loop, sensor/ actuator criteria,

PGM\_TPR\_FM = 1 ----------| | | fuel sloshing)

(sensor or actuator | | | Do: PGM\_ST\_DRVR

failed) |OR --| | (call state driver subroutine)

| |

OLFLG = 1 ---------------| |

(in open loop) | |

| |

FLG\_STALL = 1 -----------| |

(vehicle stalled) | |

| |

PURG\_TST\_ENA = 0 --------| |

(purge test disabled by | |

OBD-2 executive) | |

| |

VSBAR < PGM\_VS\_MIN ------| |

| |

VSBAR > PGM\_VS\_MAX ------| |

(vehicle speed not in | |

the acceptable range) | |

| |

PGM\_LOAD\_DLT > | |

PGM\_LD\_DT\_MX ----| |

; LOAD change too high |

(Continued on next page)

15-48

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(Continued from previous page)

| --- ELSE ---

|

PGM\_RUNNING = 1 ---------------------| Do: PGM\_ST\_DRVR

(purge monitor test running) | (call state driver subroutine)

END: pgm\_main

BEGIN: pgm\_output\_substitution

; This process controls the Monitor Output State Control substitution:

; Executed only when called.

unconditionally ---------------------| Do: substitute(10,pgm\_cvs\_dc)

| PGM\_CVS\_DC := pgm\_cvs\_dc

; Close CVV/CVS during output test mode OFF command (OSM\_EO\_OFF = 1). This

; mode is performed with the engine off, therefore, the VMV will have no

; vacuum source to open. The evaporative system will be effectively closed.

;

; PGM\_CVS\_DC -> CVV PG\_DC -> VMV

; OSM\_EO\_OFF = 1 (1.0) (closed) (0.0) (closed)

; OSM\_EO\_ON = 1 (0.0) (open) (1.0) (open)

;

; NOTE: CVV is a normally open valve, the VMV, normally closed.

OSM\_EO\_OFF = 1 ------------------------| PGM\_CVS\_DC := 1.0

; NOTE: Unless set by the logic above or by logic contained within the

; process pgm\_output\_substitution found in the module

; CANP\_MONITOR\_COMx, PGM\_CVS\_DC should be zero at all times.

END: pgm\_output\_substitution

15-49

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: pgm\_monitor\_temp\_bypass

; This process checks to see if all other monitors have been

; monitored and counts the number of times that the PGM\_TEMP

; window has NOT been entered.

; Executed only when called.

TRIP\_NOT\_PRG = 0 -----------------|

|

CCM\_MON = 1 ----------------| |

|OR --|

CCM\_TST\_SW = 0 -------------| |

|

SAIR\_MON = 1 ---------------| |

|OR --|

SAIR\_TST\_SW = 0 ------------| |

|AND -| TRIP\_NOT\_PRG := 1

FUEL\_MON = 1 ---------------| | | ; all other monitors have

|OR --| | ; been monitored except

FUEL\_TST\_SW = 0 ------------| | | ; purge monitor

|

EGO\_MON = 1 ----------------| |

|OR --|

EGO\_TST\_SW = 0 -------------| |

|

EGR\_MON = 1 ----------------| |

|OR --|

EGR\_TST\_SW = 0 -------------| |

|

MIS\_MON = 1 ----------------| |

|OR --|

MIS\_TST\_SW = 0 -------------|

15-50

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TRIP\_NOT\_PRG = 1 -------------|

; all monitors run |

; except purge |AND -| PGM\_TEMP\_CTR := PGM\_TEMP\_CTR + 1

| | ; increment temp counter

PGM\_TMP\_SEEN = 0 --------------| |

; temp range not seen | | PGM\_TEMP\_FLG := 1

| | ; temp count incremented

PGM\_TEMP\_FLG = 0 --------------|

; count not incremented yet

END: pgm\_monitor\_temp\_bypass

BEGIN: pgm\_check\_monitored

; This process checks for monitor completeness.

; Executed only when called.

PGM\_DONE = 1 ------------------|

|OR --| PURG\_MON := 1

PGM\_TEMP\_CTR > PGM\_TEMP\_CNT ---| | ; purge has been

| ; completely monitored

| PGM\_TEMP\_CTR := 0

|

| --- ELSE ---

|

| PURG\_MON := 0

END: pgm\_check\_monitored

15-51

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

END: canister\_purge\_monitor

BEGIN: PGM\_ST\_DRVR

; Executed only when called.

PGM\_ST = 0 --------------------------| Do: phase\_zero\_test

PGM\_ST = 1 --------------------------| Do: phase\_one\_test

PGM\_ST = 2 --------------------------| Do: phase\_two\_test

PGM\_ST = 3 --------------------------| Do: phase\_three\_test

PGM\_ST = 4 --------------------------| Do: phase\_four\_test

PGM\_ST = 5 --------------------------| Do: phase\_five\_test

END: PGM\_ST\_DRVR

15-52

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: phase\_zero\_test

PGM\_PS0\_SET = 0 ---------------------| PGM\_PS\_TMR = PGM\_PS0\_TM

(zero set-up not complete) | (load phase timer with max

| phase zero time)

| PGM\_PS0\_BEGP = PGM\_TANK\_PRS

| (store beginning pressure)

| PGM\_P0\_BEGK = PGM\_PS0\_BEGP

| (load to KAM for SCP)

| PGM\_PS0\_SET = 1

| (phase zero set-up is complete)

| PGM\_TRG\_SEEN = 0

| (clear target vacuum seen flag)

| PGM\_VAC\_SEEN = 0

| (specific vacuum seen)

PCOMP\_W > PGM\_P0\_WPEK ---------------| PGM\_P0\_WPEK = PCOMP\_W

(flow larger than previous) | (track flow and store the peak value)

PGM\_TANK\_PRS >= PGM\_PS0\_LO ----------| pgm\_cvs\_dc = PGM\_CVS\_DC + PGM\_CVS\_DEC

(above target range) | ( ramp CVS closed )

| Clip to 1.0 as maximum.

PG\_DC < PGM\_P0\_DCMIN ----|

(duty cycle too low) |AND -|

| |

PGM\_TRG\_SEEN = 0 --------| |OR --| PGM\_ERROR = 5

(target vacuum not seen) | | (set error indicating test aborted)

| | PGM\_ST = 5

PCOMP\_W > PGM\_P0\_WMX ----------| | (place state monitor in phase 5)

(too much vapor)

PGM\_TANK\_PRS > PGM\_PS0\_HI -----|

(ABOVE target vacuum, |AND -| PGM\_PG\_ON = 1

apply additional vacuum) | | (command PCOMP to keep VMV ON)

| | PGM\_VAC\_SEEN = 1

PGM\_TRG\_SEEN = 0 --------------| | (specific vacuum seen)

(not entered target range yet) |

| --- ELSE ---

|

| PGM\_PG\_ON = 0

| (command PCOMP to keep VMV OFF)

| PGM\_TRG\_SEEN = 1

| (entered target range)

15-53

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PGM\_PS\_TMR = 0 ----------------|

(timer has cleared before |

tank vacuum has bled up) |

|

PGM\_TANK\_PRS < PGM\_PS0\_LO -----|AND -| (GROSS VACUUM SEEN)

(tank vacuum has not | | PGM\_ERROR = 0

bled up enough) | | (indicate test was aborted in

| | this phase)

PGM\_VAC\_SEEN = 0 --------------| | malfunction(purg,P1450)

(specific vacuum not seen) | (code P1450 malfunction)

| (update MIL)

| P1450MON = 1

| (code P1450 monitored)

| PGM\_ST = 5

| (place state monitor in phase 5)

|

| --- ELSE ---

PGM\_PS\_TMR = 0 ----------------| |

(timer has cleared before | | (GROSS LEAK SEEN)

required tank pressure has |AND -| PGM\_ERROR = 0

occurred - error) | | (indicate test was aborted in

| | this phase)

PGM\_TANK\_PRS > PGM\_PS0\_HI -----| | malfunction(purg,P0455)

(tank pressure has not | (code P0455 malfunction)

dropped enough) | (update MIL)

| P0455MON = 1

| (code P0455 monitored)

| PGM\_ST = 5

| (place state monitor in phase 5)

| PGM\_PG\_ON = 0

| (clear purge monitor command

| to turn PCOMP ON)

|

| --- ELSE ---

PGM\_TRG\_SEEN = 1 --------------| |

(entered target range) |AND -| PGM\_ST = 1

| | (continue to phase one of

PGM\_CVS\_DC = 1.0 --------------| | purge monitor)

(canister vent valve closed) | | P0455MON = 1

| | (code P0455 monitored)

PG\_DC <= PG\_DC\_LOW ------------| | P1450MON = 1

(purge valve closed) | (code P1450 monitored)

| clear\_malf(P0455)

| clear\_malf(P1450)

| (clear malfunction flags)

END: phase\_zero\_test

15-54

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: phase\_one\_test

PGM\_PS1\_SET = 0 ---------------------| PGM\_PS\_TMR = PGM\_PS1\_TM

(phase 1 set-up not complete) | (load phase timer with max

| phase one time - to stabilize

| tank vacuum)

| PGM\_PS1\_SET = 1

| (phase one set-up is complete)

PGM\_PS\_TMR = 0 ----------------|

(stabilization complete) |OR --| PGM\_ST = 2

| | (place state monitor in phase 2)

PGM\_TANK\_PRS >= PGM\_PS1\_MAX ---|

(tank pressure is high)

END: phase\_one\_test

BEGIN: phase\_two\_test

PGM\_PS2\_SET = 0 ---------------------| PGM\_PS\_TMR = PGM\_PS2\_TM

(phase two set-up not complete) | (load phase timer with max

| phase two time)

| PGM\_PS2\_BEGP = PGM\_TANK\_PRS

| (store starting tank pressure

| for phase two)

| PGM\_PS2\_SET = 1

| (phase two set-up is complete)

; use the peak flow value from phase 0 to load the appropriate bleed up

unconditionally ---------------------| PGM\_BLD\_DLT =

| FN\_PGM\_BLEED(PGM\_P0\_WPEK)

| PGM\_BLD\_DLTK = PGM\_BLD\_DLT

| ; store in KAM for SCP

PGM\_TPR\_DLT >

PGM\_TP\_DT\_MX ----------------| PGM\_ERROR = 5

; slosh event occurring | (set error indicating test aborted)

| PGM\_ST = 5

| (place state monitor in phase 5

| capability to restart test)

PGM\_PS\_TMR = 0 ----------------------| PGM\_PS2\_DLTP = PGM\_TANK\_PRS -

(phase timer expired; calculate | PGM\_PS2\_BEGP

delta pressure in the tank) | (calculate delta pressure)

| Clip PGM\_PS2\_DLTP to zero as min

|

| PGM\_P2\_DLTPK = PGM\_PS2\_DLTP

| (load to KAM for SCP)

15-55

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PGM\_PS\_TMR = 0 ----------------|

(delta pressure has |

been calculated) |AND -| PGM\_ST = 5

| | (jump to phase five

PGM\_PS2\_DLTP <= PGM\_BLD\_DLT ---| | of purge monitor)

(delta pressure small; | PGM\_ERROR = 6

vacuum held - test passed) | (indicate test has passed)

| PGM\_0442\_DLP = PGM\_PS2\_DLTP

| (load for phase five check)

|

| --- ELSE ---

PGM\_PS\_TMR = 0 ----------------| |

(delta pressure has | |

been calculated) |AND -| PGM\_ST = 3

| | (continue to phase three

PGM\_PS2\_DLTP > PGM\_BLD\_DLT ----| | of purge monitor)

(delta pressure large;

continue test)

END: phase\_two\_test

15-56

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: phase\_three\_test

PGM\_PS3\_SET = 0 ---------------------| PGM\_PS\_TMR = PGM\_PS3\_TM

(phase three set-up not completed) | (time to stabilize tank pressure

| by opening vent valve and

| closing VMV)

| pgm\_cvs\_dc = 0

| (open CVS to atmosphere)

| PGM\_PS3\_SET = 1

| (phase three set-up is complete)

|

| --- ELSE ---

PGM\_TANK\_PRS <= PGM\_PS3\_MIN ---| |

(tank pressure is too low) |AND -| PGM\_ERROR = 5

| | (set error indicating test aborted)

PGM\_PS\_TMR = 0 ----------------| | PGM\_ST = 5

| (place state monitor in phase 5 for

| capability to restart test)

|

| --- ELSE ---

PGM\_TANK\_PRS >= PGM\_PS3\_MAX ---| |

(tank pressure is too high) |AND -| PGM\_ERROR = 5

| | (set error indicating test aborted)

PGM\_PS\_TMR = 0 ----------------| | PGM\_ST = 5

| (place state monitor in phase 5 for

| capability to restart test)

|

| --- ELSE ---

|

PGM\_PS\_TMR = 0 ----------------------| PGM\_ST = 4

| (continue on to phase four of purge

| monitor)

END: phase\_three\_test

15-57

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: phase\_four\_test

PGM\_PS4\_SET = 0 ---------------------| PGM\_PS\_TMR = PGM\_PS4\_TM

(phase four set-up not completed) | (load phase timer with

| phase four max time)

| PGM\_PS4\_BEGP = PGM\_TANK\_PRS

| (store beginning pressure)

| pgm\_cvs\_dc = 1.0

| (set the canister vent valve

| to 100% duty cycle)

| PGM\_PS4\_SET = 1

| (phase four set-up is complete)

PGM\_PS\_TMR = 0 ----------------------| PGM\_PS4\_DELP = (PGM\_TANK\_PRS -

| PGM\_PS4\_BEGP) \* PGM\_PS4\_DPML

| (calculate the delta pressure

| and compensate for compatability

| with phase 2)

| Clip PGM\_PS4\_DELP to zero as a min

|

| PGM\_P4\_DELPK = PGM\_PS4\_DELP

| (load to KAM for SCP)

|

| PGM\_PS4\_DLTP = PGM\_PS2\_DLTP -

| PGM\_PS4\_DELP

| (calculate delta pressure not

| caused by vapor generation)

| Clip PGM\_PS4\_DLTP to zero as a min

|

| PGM\_P4\_DLTPK = PGM\_PS4\_DLTP

| (load to KAM for SCP)

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CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PGM\_PS\_TMR = 0 ----------------|

(phase four time has |

passed) |AND -| PGM\_ST = 5

| | (continue to phase five)

PGM\_PS4\_DLTP <= PGM\_BLD\_DLT ---| | PGM\_ERROR = 6

(net change in pressure is | (indicate test has passed)

small enough to pass test) | PGM\_0442\_DLP = PGM\_PS4\_DLTP

| (load for phase five check)

|

| --- ELSE ---

PGM\_PS\_TMR = 0 ----------------| |

|AND -| PGM\_ERROR = 5

PGM\_PS4\_DELP > PGM\_PS4\_DP -----| | (indicate test was aborted

(change in pressure is too | this phase)

large to allow test) | PGM\_ST = 5

| (place state monitor

| in phase 5)

|

| --- ELSE ---

PGM\_PS\_TMR = 0 ----------------| |

(phase four time has | |

passed) |AND -| PGM\_ST = 5

| | (continue to phase five)

PGM\_PS4\_DLTP > PGM\_BLD\_DLT ----| | PGM\_ERROR = 4

(change in pressure is not | (indicate test has failed

small enough to pass test) | in this phase of test)

| PGM\_0442\_DLP = PGM\_PS4\_DLTP

| (load for phase five check)

END: phase\_four\_test

15-59

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: phase\_five\_test

unconditionally ---------------------| pgm\_cvs\_dc = PGM\_CVS\_DC - PGM\_CVS\_DEC

| ; ramp CVS open

| ; clip PGM\_CVS\_DC to zero as a min

pgm\_cvs\_dc = 0 ----------------------| PGM\_ST := 6

| ; place state monitor in non-existant

| ; state 6; test is complete/aborted)

|

| --- ELSE ---

|

| Exit: phase\_five\_test

PGM\_ERROR = 5 -----------------------| PGM\_RST\_CTR := PGM\_RST\_CTR + 1.0

; test was aborted | ; allow test to restart

| Do: check\_pgm\_done

| PGM\_RST\_TMR := PGM\_RST\_TM

| ; load timer with time before

| ; which retry will NOT be

| ; be allowed

|

| --- ELSE ---

|

PGM\_ERROR = 4 -----------------------| PGM\_RUN\_CTR := PGM\_RUN\_CTR + 1.0

; delta pressure greater | Do: check\_for\_p0442\_malfunction

; than PGM\_BLEED | Do: check\_pgm\_done

| PGM\_RST\_TMR := PGM\_RST\_TM

| ; load timer with time before

| ; which retry will NOT be

| ; be allowed

|

| --- ELSE ---

|

PGM\_ERROR = 6 -----------------------| Do: check\_for\_p0442\_malfunction

; delta pressure smaller | Do: check\_pgm\_done

; than PGM\_BLD\_DLT |

| --- ELSE ---

|

PGM\_ERROR = 0 -----------------------| Do: check\_pgm\_done

15-60

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: check\_pgm\_done

; Executed only when called.

PGM\_ERROR = 0 -----------------|

|

PGM\_ERROR = 6 -----------------|OR --| PGM\_DONE := 1

| | ; test is done

PGM\_RUN\_CTR >= PGM\_RUN\_CNT ----| | PGM\_RUNNING := 0

; multiple test runs | | ; clear running flag

| |

PGM\_RST\_CTR >= PGM\_RST\_CNT ----| |

; exceeded resets limit | --- ELSE ---

|

| Do: reset\_pgm\_parms

| ; allow test to rerun

END: check\_pgm\_done

BEGIN: check\_for\_p0442\_malfunction

; decide which filter constant to use based on KAM warm up counter value

KWUCTR < PGM\_KWUCNT -----------------| PGM\_FK := PGM\_FK\_NMAT

; First few warm\_up cycles |

; KAM considered not mature |

| --- ELSE ---

|

| PGM\_FK := PGM\_FK\_MAT

; perform the weighted average filtering

unconditionally ---------------------| pgm\_bleed\_lst = PGM\_BLED\_KAM

| PGM\_BLED\_KAM = PGM\_FK\*PGM\_0442\_DLP +

| (1-PGM\_FK) \* pgm\_bleed\_lst

| P0442MON = 1

| (code P0442 monitored)

; check filtered value against calibrated limit

PGM\_BLED\_KAM > PGM\_BLD\_DLT ----|

; above bleedup threshold |AND -| Do: malfunction(purg,P0442)

| | ; set malfunction flag

PGM\_RUN\_CTR >= PGM\_RUN\_CNT ----| |

; multiple test runs |

| --- ELSE ---

|

| Do: clear\_malf(P0442)

| ; clear malfunction flag

END: check\_for\_p0442\_malfunction

15-61

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: reset\_pgm\_parms

; Process resets selected Evaporative monitor parameters

; Executed only when called.

unconditionally ---------------------| PGM\_ST = -1

| PGM\_RUNNING = 0

| PGM\_ERROR = -1.0

| PGM\_PS0\_SET = 0

| PGM\_PS1\_SET = 0

| PGM\_PS2\_SET = 0

| PGM\_PS3\_SET = 0

| PGM\_PS4\_SET = 0

| PURG\_TST\_RDY = 0

| ; force test ready to be low for

| ; one background loop; OBD-II

| ; executive requirement

| PGM\_PS\_TMR = 0

| PGM\_P0\_WPEK = 0

END: reset\_pgm\_parms

END: phase\_five\_test

15-62

CANISTER PURGE STRATEGY, CANISTER PURGE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: pgm\_ffg\_purg

; Tracks if any of a number of errors occurred with Evaporative Monitor.

; Set if any of the possible faults currently exist. Cleared only if no

; faults currently exist.

; Executed only when called.

P0443MALF = 1 -----------------|

; VMV circuit error |

|

P0455MALF = 1 -----------------|

; gross leak |

|

P0442MALF = 1 -----------------|

; small leak |

|

P0446MALF = 1 -----------------|

; vent valve stuck closed |

|OR --| FFG\_PURG := 1

P0452MALF = 1 -----------------| | ; EVAP faults exist

; TPR circuit low error | |

| |

P0453MALF = 1 -----------------| |

; TPR circuit high error | |

| |

P1450MALF = 1 -----------------| |

; excessive vacuum in tank |

| --- ELSE ---

P0443MALF = 0 -----------------| |

; no VMV circuit error | |

| |

P0455MALF = 0 -----------------| |

; no gross leak | |

| |

P0442MALF = 0 -----------------| |

; no small leak | |

| |

P0446MALF = 0 -----------------| |

; vent valve not stuck closed | |

|AND -| FFG\_PURG := 0

P0452MALF = 0 -----------------| | ; no EVAP faults exist

; TPR circuit not low error | |

| |

P0453MALF = 0 -----------------| |

; TPR circuit not high error | |

| |

P1450MALF = 0 -----------------| |

; not excessive vac in tank |

| --- ELSE ---

|

| No change to FFG\_PURG.

END: pgm\_ffg\_purg

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CANISTER PURGE STRATEGY, Purge Monitor Filtering - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

15.2.5 PURGE MONITOR FILTERING LOGIC (CDAL0)

OVERVIEW

This module describes the logic used by the Purge Monitor test(s) in the

calculation and filtering of selected engine parameters.

DEFINITIONS

Registers:

- ACT = Air Charge Temperature, deg. F.

- ECT = Engine coolant temperature, deg F.

- LOAD = Universal load as a ratio of aircharge over standard.

- PGM\_LOAD = Filtered value of LOAD used in the Purge Flow test.

- PGM\_LOAD\_DLT = Absolute value of the difference between the filtered

PGM\_LOAD and the current value of LOAD.

- PGM\_TEMP = Temperature (ECT/ACT combination) used in purge test.

- PGM\_VBAT = Filtered value of VBAT used in the Purge Flow test.

- PGM\_VBAT\_DLT = Absolute value of the difference between the filtered

PGM\_VBAT and the current value of VBAT.

- VBAT = Battery voltage.

Calibration Constants:

- PGM\_TC\_LOAD = Time constant used with ROLAV filtering of PGM\_LOAD.

- PGM\_TC\_VBAT = Time constant used with ROLAV filtering of PGM\_VBAT.

- PGM\_TEMP\_MUL = Purge test fractional multiplier; 1.0 -> use all ECT; 0.0

-> use all ACT.

15-64

CANISTER PURGE STRATEGY, Purge Monitor Filtering - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CANP\_PGM\_FILT\_COM1

BEGIN: pgm\_filtering

; this process is executed only when called.

unconditionally ------------------------| PGM\_TEMP := (PGM\_TEMP\_MUL \* ECT) +

| ((1 - PGM\_TEMP\_MUL) \* ACT)

|

| ; calculate current filtered values

| PGM\_VBAT := ROLAV(VBAT,PGM\_TC\_VBAT)

| PGM\_LOAD := ROLAV(LOAD,PGM\_TC\_LOAD)

|

| ; calculate steady state changes

| ; absolute value of differences

| PGM\_VBAT\_DLT := | PGM\_VBAT

| - VBAT |

| PGM\_LOAD\_DLT := | PGM\_LOAD

| - LOAD |

END: pgm\_filtering

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CANISTER PURGE STRATEGY, CANISTER PURGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

15.3 CANISTER PURGE STRATEGY (CDAM0)

OVERVIEW

Canister Purge refers to the solenoid and valve combination that is located

in the line between the intake manifold and the carbon canister. When the

solenoid is energized the valve opens, allowing the flow of vapors from the

canister to the intake manifold.

The strategy enables canister purge during various engine operating modes.

These modes are calibration items. Typical calibrations will enable purge

when these conditions are met:

1. Fuel control is in the desired mode. The calibrator can choose between

purging during closed loop only or during both open loop and closed loop.

2. The engine has warmed up.

3. The engine has not overheated.

4. The 'Not at Closed Throttle' delay has been met.

The strategy includes a feature to prevent the rich surge that may occur on

purge turn on. When the purge is enabled the output is cycled on and off at

a 10Hz frequency with a variable duty cycle. The duty cycle ramps up to

slowly introduce the canister vapors. The duty cycle ramp is determined from

FN600 \* FN602 \* FN605A \* FN627.

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CANISTER PURGE STRATEGY, CANISTER PURGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- ACT = Air charge temperature, deg. F.

- AM = Air Mass flow, lb/min.

- ATMR1 = Time since initial engine startup, secs.

- ATMR2 = Time since Engine Coolant Temp (ECT) reached TEMPFB, sec.

- ECT = Engine Coolant Temperature, deg F.

- KAMRF1 = HEGO11 adaptive fuel correction.

- KAMRF2 = HEGO21 adaptive fuel correction.

- LAMBSE1 = Desired equivalence ratio for HEGO11 injectors.

- LAMBSE2 = Desired equivalence ratio for HEGO21 injectors.

- NACTMR = Not at Closed Throttle Timer, sec.

- PFS\_CNTS = Purge flow sensor input counts.

- PGM\_CNTS = Raw purge flow sensor reading from the A/D channel, counts.

- PGM\_PG\_OFF = Purge monitor command to turn Purge off.

- PURG\_ADP\_SF = Adaptive learning safety factor; delta from minadp at which

time purge is disabled.

- TCSTRT = Temperature of Engine Coolant at Cold Startup, deg F.

- VBAT = Battery voltage.

- VSBAR = Filtered vehicle speed.

- ER\_STATUS = State pointer that indicated current state of engine running

on demand test.

Bit Flags:

- ADT1FMFLG = Adaptive table 1 failure mode.

- ADT2FMFLG = Adaptive table 2 failure mode.

- APT = Throttle mode flag.

- LAM\_MOD\_FLG = Flag used to initiate high frequency fuel modulation for

the upstream EGO monitor.

- HVQ1 = Heat valve flip flop flag; 1 -> flip flop set.

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CANISTER PURGE STRATEGY, CANISTER PURGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- LEGOFG11 = Lack of HEGO11 switching flag.

- LEGOFG21 = Lack of HEGO21 switching flag.

- LIMIT\_PURGE = Flag which indicates Purge Duty Cycle is being limited due

to LAMBSE being clipped; 1 -> limited Purge.

- OLFLG = Open loop flag; 1 -> open loop control, 2 -> closed loop control.

- DFSFLG = Indicates decel fuel shutoff; 1 -> in decel fuel shutoff mode.

- prg\_flg = Purge specification variable; 1 -> conditions required to purge

have been met, 0 -> conditions required to purge have not been met.

- prg\_nact = Flag used to signal if not at closed throttle conditions has

existed for some amount of time.

- PC\_RESET = Purge lambse reset flag; 1 -> purge requesting lambse reset.

- OSM\_EO\_ON = On state requested for OSMs during on demand test.

- OSM\_EO\_OFF = Off state requested for OSMs during on demand test.

- VSPRGFLG = Vehicle speed purge enable flag.

Calibration Constants:

- CTHIGH = Temperature of Engine Coolant (ECT) at Hot Startup, deg F.

- CTLOW = Temperature of Engine Coolant at Cold Startup, deg F.

- CTPRG = Overheat temperature to turn off purge, deg F.

- CTPRG\_SL = CTPRG - hysteresis.

- EVTDOT = Purge time delay at Part throttle or WOT.

- FN600(PRGTMR) = Canister Purge Duty Cycle Multiplier

- FN602(CPRGTMR) = Canister Purge Duty Cycle Multiplier

- FN603(ACT) = Maximum LAMBSE allowed before purge duty cycle is

decremented.

- FN605A(AM) = Canister Purge Duty Cycle vs. AM

- FN627(PRGIDLE\_TMR) = Purge duty cycle modifier as a function of

PRGIDLE\_TMR.

- MINADP = Minimum allowable correction.

- PRG\_DEC = PG\_DC decrement value used by fuel system failing logic.

- PRGMPH\_CL = PRGMPH\_SH minus hysteresis.

- PRGMPH\_SH = Minimum vehicle speed to allow purge.

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CANISTER PURGE STRATEGY, CANISTER PURGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PRGTD1 = Canister purge cold startup delay time.

- PRGTD2 = Canister purge medium temp startup delay time.

- PRGTD3 = Canister purge hot startup delay time.

- PRGTD4 = Canister purge cold startup delay time, used with ATRM2.

- PRGTD5 = Canister purge delay timer, used with ATMR2.

- PURGSW = Switch to select Open Loop Purge; 1 -> Allow Open Loop Purge.

- PFS\_H\_ER = Purge flow sensor counts value below which to allow purge.

- PFS\_L\_ER = Purge flow sensor counts value above which to allow purge.

- PGM\_DEC = Value decremented from PG\_DC when purge is being commanded off

in phase one of the purge flow test.

- VBAT\_MX = Maximum battery voltage below which to allow purging.

- EGO\_ER\_INIT = Value for state of ER\_STATUS to indicate engine running EGO

test is to be run.

- PRG\_LAM\_SW = Calibration switch to enable purge induced lambse resets.

- PRG\_LAM\_SUB = Calibration constant used as a subtractor to LAMBSEx in

FN603 logic check.

OUTPUTS

Registers:

- PRGTMR = Total Purge on time.

- CPRGTMR = Current Purge on time.

- PG\_DC = Canister Purge Duty Cycle.

- PRGIDLE\_TMR = Time at idle for purge control, sec.

Bit Flags:

- HVQ1 = See above.

- LIMIT\_PURGE = See above.

- prg\_flg = See above.

- PRGFLG = Timer control flag for PRGTMR and CPRGTMR.

- VSPRGFLG = See above.

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CANISTER PURGE STRATEGY, CANISTER PURGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CANP\_COM12

APT = -1 -------------------------------| INCREMENT PRGIDLE\_TMR.

| Clip to 255 seconds as a maximum.

|

| --- ELSE ---

|

| DECREMENT PRGIDLE\_TMR.

| Clip to zero as a minimum.

ECT < CTPRG\_SL -------------------------|S Q -| HVQ1

|

ECT > CTPRG ----------------------------|C

(Over temp. disable)

VSBAR >= PRGMPH\_SH ---------------------|S Q -| VSPRGFLG

|

VSBAR < PRGMPH\_CL ----------------------|C

(vehicle speed disable)

NACTMR >= EVTDOT -----------------------| prg\_nact = 1

|

| --- ELSE ---

|

| prg\_nact = 0

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CANISTER PURGE STRATEGY, CANISTER PURGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PGM\_PG\_OFF = 1 -------------------------------| prg\_flg = 0

(purge flow test commanding purge off) | (disable purge)

(prepare to ramp purge duty cycle) | purgdc = PG\_DC

(load previous duty cycle value) | pg\_dc = PG\_DC

|

| --- ELSE ---

HVQ1 = 1 -------------------------------| |

| |

TCSTRT >= CTHIGH -----------| | |

|AND -| | |

ATMR1 >= PRGTD3 ------------| | | |

| | |

CTLOW < TCSTRT < CTHIGH ----| | | |

|AND -|OR --| |

ATMR1 >= PRGTD2 ------| | | | |

|AND -| | | |

ATMR2 >= PRGTD5 ------| | | |

| | |

TCSTRT <= CTLOW ------------| | | |

|AND -| | |

ATMR1 >= PRGTD1 ------| | |AND -| prg\_flg = 1

|AND -| | | (enable purge)

ATMR2 >= PRGTD4 ------| | | purgdc =

| | FN600(PRGTMR) \*

prg\_nact = 1 ---------------------------| | FN602(CPRGTMR) \*

| | FN605A(AM) \*

OLFLG = 0 ------------------------| | | FN627(PRGIDLE\_TMR)

(closed loop) |OR --| | pg\_dc = PG\_DC

| | | PC\_RESET = 0

PURGSW = 1 -----------------------| | |

(to allow Open Loop Purge) | |

(continued on next page)

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CANISTER PURGE STRATEGY, CANISTER PURGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

| |

LAM\_MOD\_FLG = 0 ------------------------| |

(EGO monitor not running) | |

| |

PFS\_CNTS > PFS\_L\_ER --------------------| |

| |

PFS\_CNTS < PFS\_H\_ER --------------------| |

(flow sensor is O.K.) | |

| |

VBAT < VBAT\_MX -------------------------| |

(battery voltage acceptable) | |

| |

DFSFLG = 0 -----------------------------| |

(NOT in decel fuel shut off) | |

| |

VSPRGFLG = 1 ---------------------------| |

| |

ER\_STATUS <> EGO\_ER\_INIT ---------------| |

(KOER EGO test is NOT active) |

| --- ELSE ---

prg\_nact = 0 ---------------------------| |

| |

PRGFLG = 1 -----------------------------|AND -| PC\_RESET = 1

| | prg\_flg = 0

PC\_RESET = 0 ---------------------------| | purgdc = 0

(lambse reset has not occurred) | |

| |

PRG\_LAM\_SW = 1 -------------------------| |

(calibration switch to allow reset) | |

| |

LAMBSE1 > FN603(ACT)-PRG\_LAM\_SUB -| | |

|OR --| |

LAMBSE2 > FN603(ACT)-PRG\_LAM\_SUB -| |

| --- ELSE ---

|

| PC\_RESET = 0

| prg\_flg = 0

| (disable purge)

| purgdc = 0

| pg\_dc = 0

PURGE DUTY CYCLE DECREMENT/INCREMENT LOGIC

LIMIT\_PURGE = 0 ------------------------------| pg\_dc = purgdc

|

| --- ELSE ---

|

| Continue to Increment/

| Decrement with value

| of pg\_dc.

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CANISTER PURGE STRATEGY, CANISTER PURGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The following logic allows the reduction of the purge duty cycle (PG\_DC) when

conditions indicate that the fuel system may be failing. The purge is backed

out to prevent the continuous HEGO TESTS and adaptive fuel test from

indicating failure due to purge overload. Once a failure has been indicated

or control has been restored for one of the four areas indicated by the logic

show below purging is resumed. If subsequently another area begins

indicating failure purging will again be backed out until the appropriate

failure is verified or until the system comes back into full control.

The purge duty cycle can also be reduced if the Purge test commands to turn

off purge, decrementing the duty cycle by PGM\_DEC each pass.

PGM\_PG\_OFF = 1 -------------------------------------| pg\_dc = pg\_dc -

| PGM\_DEC

| Clip to zero as

| a minimum.

| Clip to purgdc as

| a maximum.

|

| --- ELSE ---

LAMBSE1 => FN603(ACT) ------------------| |

(HEGO11 failure condition present) |AND -| |

| | |

LEGOFG11 = 0 ---------------------------| | |

(HEGO11 failure recognition not | |

latched) | |

| |

LAMBSE2 => FN603(ACT) ------------------| | |

(HEGO21 failure condition present) |AND -| |

| | |

LEGOFG21 = 0 ---------------------------| | |

(HEGO21 failure recognition not | |

latched) |OR --| pg\_dc = pg\_dc -

| | PRG\_DEC

KAMRF1 <= MINADP + 0.5 + | | Clip to zero as a

PURG\_ADP\_SF ---------| | | minimum

(bank #1 adaptive limit imminent) |AND -| | Clip to purgdc as a

| | | maximum

ADT1FMFLG = 0 --------------------------| | |

(adaptive failure not yet recognized) | |

| |

KAMRF2 <= MINADP + 0.5 + | |

PURG\_ADP\_SF ---------| | |

(bank #2 adaptive limit imminent) |AND -| |

| |

ADT2FMFLG = 0 --------------------------| |

(adaptive failure not yet recognized) |

| --- ELSE ---

|

| pg\_dc = pg\_dc +

| PRG\_DEC

| Clip to purgdc as a

| maximum

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CANISTER PURGE STRATEGY, CANISTER PURGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

purgdc > pg\_dc -------------------------------------| LIMIT\_PURGE = 1

| (purge is being

| limited due to LAMBSE

| being at its clip or

| purge test is ramping

| the duty cycle down)

|

| --- ELSE ---

|

| LIMIT\_PURGE = 0

ON DEMAND TEST PG\_DC OVERRIDE

OSM\_EO\_ON = 1 --------------------------------------| pg\_dc = 1.0

OSM\_EO\_OFF = 1 -------------------------------------| pg\_dc = 0

unconditionally ------------------------------------| Do: substitute(9,pg\_dc)

| (output state control

| override)

| PG\_DC := pg\_dc

NOTES;

1. When purge is enabled, the purge output is cycled at 10Hz

+/- 30%

2. Set EVTDOT to 0 to Purge at Closed Throttle.

TIMER LOGIC

prg\_flg = 1 ----------------------------------|

|AND -| PRGFLG = 1

FN605A(AM) <> 0 ------------------------------| | (count up PRGTMR)

| (count up CPRGTMR)

|

| --- ELSE ---

|

| CPRGTMR = 0

| PRGFLG = 0

| (clear PRGFLG)

| (freeze PRGTMR)

| (reset and freeze

| CPRGTMR)

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CANISTER PURGE STRATEGY, PURGE FLOW SENSOR INPUT AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

15.4 PURGE FLOW SENSOR INPUT AND SELF TEST (CDAJ0)

OVERVIEW

This module reads the purge flow sensor input. The A/D is read and the raw

counts (PFS\_CNTS) are tested for "out of range" or other failure conditions.

If a failure is present for a sufficient amount of time, the appropriate

malfunction flag (PxxxMALF) is set. Finally, a timer is checked to see if

the component has been sufficiently monitored for this "trip".

DEFINITIONS

INPUTS

Registers:

- PFS\_CNTS = Raw A/D counts from sensor.

- PFS\_ER\_TMR = Timer that runs when a fault is present.

- PFS\_FM\_TMR = Timer that is reset when the failure conditions for FMEM

mode are met, seconds.

- PUTMR = Time since power up, seconds.

Bit Flags:

- PURG\_TST\_ENA = OBDII purge test enable flag ( 1 -> test enabled ).

- CCM\_TST\_ENA = OBDII Comprehesive Component test ( CCM ) enable flag.

- CCM\_ER\_ENA = On demand test for CCM enable flag.

- PxxxMALF = OBDII malfunction flag for fault xxx; 1 -> a malfunction

currently exists for fault xxx.

- PxxxMON = OBDII monitor flag for fault xxx; 1 -> fault xxx has been

monitored at least once since power-up.

Calibration Constants:

- TC\_PFS = Time constant for purge flow sensor.

- PFS\_ER\_TM = Time with failure present required to set code, seconds.

- PFS\_FM\_TM = Minimum time in FMEM mode once initiated, seconds.

- PFS\_H\_ER = Maximum acceptable value for PFS, counts.

- PFS\_L\_ER = Minimum acceptable value for PFS, counts.

- PFS\_MON\_TM = Time required to indicate that a "trip" is complete for this

sensor, seconds.

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CANISTER PURGE STRATEGY, PURGE FLOW SENSOR INPUT AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- PGM\_PFS\_FM = Purge thermistor flow sensor FMEM flag.

- PFS\_ER\_TMR = See above.

- PFS\_FM\_TMR = See above.

- PGM\_PFS = Output counts value used by rest of strategy.

Bit Flags:

- PxxxMALF = See above.

- PxxxMON = See above.

OTHER

- purg\_codes = Set of {P0442,P0446,P1444,P1445,P0452,P0453,P1442}. The set

of OBDII fault codes that relate to purge monitor.

- malfunction(purg,Pxxx) = Logic process, imported from the MIL control

Module; Pxxx indicates the fault code.

- P1445 = Fault code, Purge Flow Sensor input failed high.

- P1444 = Fault code, Purge Flow Sensor input failed low.

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CANISTER PURGE STRATEGY, PURGE FLOW SENSOR INPUT AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CANP\_INPUT\_PFS\_COM1

always -------------------------| Increment PFS\_ER\_TMR

| Increment PFS\_FM\_TMR

PURG\_TST\_ENA = 1 ---------|

|

CCM\_ER\_ENA = 1 -----------|OR --| Do: PFS\_FAILURE\_CHECK

| | (check for out of range)

CCM\_TST\_ENA = 1 ----------| | Do: PFS\_MONITORED\_CHECK

| (test for component monitored)

|

| --- ELSE ---

|

| Exit module.

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CANISTER PURGE STRATEGY, PURGE FLOW SENSOR INPUT AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: PFS\_FAILURE\_CHECK

Check for "open/short" failures and other failures as appropriate for

particular sensor. Perform FMEM action if a failure is detected. Set

malfunction flag when a malfunction has been present for a sufficient time.

PFS\_CNTS > PFS\_H\_ER ------|

(value too high) |

|

PFS\_ER\_TMR > PFS\_ER\_TM ---|AND -| malfunction(purg,P1445)

(failure present long | | (code P1445 malfunction)

enough) | | (update MIL)

| |

P1445MALF = 0 ------------| | PFS\_FM\_TMR = 0

| PGM\_PFS\_FM = 1

| (set purge flow sensor FMEM flag)

|

| --- ELSE ---

|

PFS\_CNTS > PFS\_H\_ER ------------| PGM\_PFS\_FM = 1

(value too high; not present | (set purge flow sensor FMEM flag)

long enough to set | PFS\_FM\_TMR = 0

malfunction flag) |

| --- ELSE ---

PFS\_CNTS < PFS\_L\_ER ------| |

(value too low) | |

| |

PFS\_ER\_TMR > PFS\_ER\_TM ---|AND -| malfunction(purg,P1444)

(failure present long | | (code P1444 malfunction)

enough) | | (update MIL)

| |

P1444MALF = 0 ------------| | PFS\_FM\_TMR = 0

| PGM\_PFS\_FM = 1

| (set purge flow FMEM flag)

|

| --- ELSE ---

|

PFS\_CNTS < PFS\_L\_ER ------------| PGM\_PFS\_FM = 1

(value too low; not present | (set purge flow sensor FMEM flag)

long enough to set | PFS\_FM\_TMR = 0

malfunction flag) |

| --- ELSE ---

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CANISTER PURGE STRATEGY, PURGE FLOW SENSOR INPUT AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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P1445MALF = 1 ------| |

|OR --| |

P1444MALF = 1 ------| |AND -| PGM\_PFS\_FM = 1

| | (Remain in FMEM mode until

PFS\_FM\_TMR < PFS\_FM\_TM ---| | it times out)

|

| --- ELSE ---

|

| PGM\_PFS = ROLAV(PFS\_CNTS,TC\_PFS)

| (no failure detected, return

| value for normal use)

| PFS\_ER\_TMR = 0

| (reset failure present timer)

| PGM\_PFS\_FM = 0

| (clear failure flags)

| Do: clear\_malf(P1444)

| Do: clear\_malf(P1445)

END: PFS\_FAILURE\_CHECK

BEGIN: PFS\_MONITORED\_CHECK

If enough time has passed since power up (or run mode, or...) assume that

enough A/D readings have been taken to assume that a hard fault, if present,

would have been detected.

PUTMR > PFS\_MON\_TM -------------| P1445MON = 1

(enough time for sufficient | P1444MON = 1

A/D readings) | (codes P1445 & P1444 monitored)

END: PFS\_MONITORED\_CHECK

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CANISTER PURGE STRATEGY, CANISTER PURGE SOLENOID OSM TEST LOGIC- CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

15.5 CANISTER PURGE SOLENOID FAULT TEST LOGIC (CDAJ0)

OVERVIEW

By using the Output Driver Feedback circuitry (CANP\_FAULT), this module

monitors the control circuitry of the canister purge solenoid (CANP).

CANP\_FAULT operates as such:

CANP\_FAULT = 0 (No fault detected - valve is functioning properly)

CANP\_FAULT = 1 (Fault detected - valve is NOT functioning properly)

The CANP is a duty cycled solenoid, therefore to test it correctly, this test

must be performed when the CANP is competely ON (100% dc) or completely OFF

(0% dc). Otherwise, erroneous readings and a possible false fault code could

result.

Therefore, PG\_DC must be >= to some Max duty cycle value or = 0 for the fault

logic to consider checking for a true fault. If not, the test will wait for

these conditions to exist before fully running the test.

DEFINITIONS

INPUTS

Registers:

- CANP\_FF = canister purge fault filter.

- CANP\_OSM\_TMR = Timer that tracks the amount of time that the purge valve

has been actively monitored.

- PG\_DC = CANP duty cycle; 1.0 -> 100%, 0 -> 0%.

- VBAT = Battery voltage.

Bit Flags:

- CANP\_FAULT = Fault status of canister purge valve (CANP) returned from

the driver; 0 -> no fault detected, , 1 -> a fault has been detected.

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled.

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CCM\_TST\_ENA = OBDII Comprehensive Component Test Enable Flag.

- OSM\_EO\_OFF = OFF state requested for outputs during engine off on demand

test.

- OSM\_EO\_ON = ON state requested for outputs during engine off on demand

test.

- OSM\_1ST\_PS = First pass flag of the OSM test; 1 -> first pass seen.

15-80

CANISTER PURGE STRATEGY, CANISTER PURGE SOLENOID OSM TEST LOGIC- CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PURG\_TST\_ENA = OBDII purge test enable flag; 1 -> test enabled.

Calibration Constants:

- CANP\_OSM\_TM = Time above which the purge valve is considered completely

monitored.

- CANP\_THRES = Threshold used with the ROLAV filtering check of the

CANP\_OSM.

- PG\_DC\_MAX = Duty cycle of the purge valve above which it is considered to

be at its max ON value.

- TC\_CANP = Time constant used in the ROLAV filtering check of the

CANP\_OSM.

- VBAT\_CCM\_MIN = Minimum voltage to perform CCM tests.

OUTPUTS

Registers:

- CANP\_FF = See above.

- CANP\_OSM\_TMR = See above.

- PG\_DC = See above.

Bit Flags:

- CANP\_FAULT = See above.

- OSM\_1ST\_PS = See above.

- P0443MON = OBDII monitor flag for fault 0443.

OTHER

- purg\_codes = Set of (P0442,P0443,P0446,P0452,P0453,P1442) OBDII fault

codes.

- malfunction(purg,Pxxx) = Logic process, imported from the MIL control

Module.

- clear\_malf(Pxxx) = Logic process, imported from the MIL control Module.

- P0443 = Fault code for the canister purge control circuit malfunction.

15-81

CANISTER PURGE STRATEGY, CANISTER PURGE SOLENOID OSM TEST LOGIC- CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CANP\_OSM\_TEST\_COM2

BEGIN: canp\_fault\_check ;done once per background loop

OSM\_EO\_ON = 1 --------------|

|

OSM\_EO\_OFF = 1 ------------|

|

CCM\_EO\_ENA = 1 ------------|OR --|

| |

CCM\_ER\_ENA = 1 ------------| |

| |

PURG\_TST\_ENA = 1 -----------| |AND -| Do: canp\_fault\_test

| | |

CCM\_TST\_ENA = 1 ------------| | |

| |

VBAT >= VBAT\_CCM\_MIN -------------| |

| --- ELSE ---

|

| Exit canp\_fault\_check

| ;Exit module.

END: canp\_fault\_check

15-82

CANISTER PURGE STRATEGY, CANISTER PURGE SOLENOID OSM TEST LOGIC- CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: canp\_fault\_test

OSM\_1ST\_PS = 0 -------------------------| CANP\_OSM\_TMR = 0

;first time through | ;clear timer

| OSM\_1ST\_PS = 1

;This routine checks the output driver fault status and waits until the

;proper PG\_DC conditions before deciding whether a fault exists or not.

;If the proper PG\_DC conditions are not met, the test will wait until

;they exist to run the test, holding the values of the fault filter and

;the fault present timer.

PG\_DC >= PG\_DC\_MAX --------|

;CANP on |OR --|AND -| CANP\_FF = ROLAV(1,TC\_CANP)

| | | ;error seen, filter to 1

PG\_DC = 0 ------------------| | |

;CANP off | | Increment CANP\_OSM\_TMR

| |

CANP\_FAULT = 1 -------------------| |

;fault detected |

| --- ELSE ---

PG\_DC >= PG\_DC\_MAX --------| |

;CANP on |OR --|AND -| CANP\_FF = ROLAV(0,TC\_CANP)

| | | ;no error seen, filter to 0

PG\_DC = 0 ------------------| | |

;CANP off | | Increment CANP\_OSM\_TMR

| |

CANP\_FAULT = 0 -------------------| |

;fault not detected |

| --- ELSE ---

|

| No change to CANP\_FF.

| Halt CANP\_OSM\_TMR.

| ;PG\_DC <> 1 or 0 - cannot test

CANP\_FF > CANP\_THRES -------------------| Do: malfunction(purg,P0443)

;apply threshold check to decide if |

;error has been present long enough |

| --- ELSE ---

|

| Do: clear\_malf(P0443)

CANP\_OSM\_TMR >= CANP\_OSM\_TM ------------| P0443MON = 1

;check if enough time has passed |

;to say if completely monitored |

| --- ELSE ---

|

| P0443MON = 0

END: canp\_fault\_test

15-83

CANISTER PURGE STRATEGY, CANISTER PURGE OBDII TEST SELECT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

15.6 CANISTER PURGE OBDII TEST SELECT (CDAJ0)

OVERVIEW

This module selects one of the 3 OBDII purge test strategies to be active,

based on the value of the calibration parameter PGM\_SELECT.

CANP\_THERM\_FLOW\_COMx is the system that uses the purge thermistor flow sensor

(PFS) and the ON/OFF purge valve.

CANP\_VMV\_FLOW\_COMx is the system that uses PCOMP, the VMV, and which tests

the effect of the PCOMP strategy on the Idle Speed Control to infer flow in

the Evaporative purge system.

CANP\_MONITOR\_COMx is the full RUNNING LOSS compliant system that uses PCOMP,

a tank pressure sensor (TPR), the VMV purge valve, and a canister vent

solenoid (CVS) on the atmospheric side of the canister.

DEFINITIONS

INPUTS

Calibration Constants:

- PGM\_SELECT = Purge test strategy select switch; 0 -> execute Evap.

Monitor, 1 -> execute thermistor (PFS) test, 2 -> execute VMV flow test.

PROCESS

STRATEGY MODULE: CANP\_PGM\_SELECT\_COM3

PGM\_SELECT = 1 -------------------------| Do: CANP\_INPUT\_PFS\_COMx

;thermistor flow test selected | Do: CANP\_THERM\_FLOW\_COMx

|

| --- ELSE ---

|

PGM\_SELECT = 2 -------------------------| Do: CANP\_VMV\_FLOW\_COMx

;VMV flow test selected |

|

| --- ELSE ---

|

;Evap System Monitor by default | Do: CANP\_INPUT\_TPR\_COMx

| Do: CANP\_CVS\_FMEM\_COMx

| Do: CANP\_MONITOR\_COMx

| Do: canister\_vent\_valve\_output

15-84

CANISTER PURGE STRATEGY, CANISTER PURGE SELECT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

15.7 CANISTER PURGE SELECT (CDAJ0)

OVERVIEW

This strategy selects between the standard purge strategy and the

PCOMP/RUNNING LOSS strategy.

DEFINITIONS

INPUTS Calibration Constants:

- PCOMP\_SW = PCOMP strategy select switch; 1 -> execute PCOMP strategy.

- PG\_LK\_ML = Purge valve leakage multiplier, lbs/min.

OUTPUTS

Bit Flags:

- PCOMP\_ENA = PCOMP strategy enabled flag; 1 -> PCOMP is enabled; adaptive

fuel disabled.

Registers:

- PCOMP\_LBM = Purge compensation, lbs mass/cylinder.

CALIBRATION HINTS

When PCOMP\_SW=0, set PG\_LK\_ML = 0

PROCESS

STRATEGY MODULE: CANP\_SELECT\_COM2

PCOMP\_SW = 1 -----------------| Do: VMV OSM test logic.

| (CANP\_VMV\_OSM\_COM\*)

| Do: CANISTER PURGE STRATEGY - PCOMP

| (CANP\_PCOMP\_ENABLE\_COM\*, CANP\_PCOMP\_COM\*)

| Do: vapor\_management\_valve\_output

|

| --- ELSE ---

|

| Do: ON/OFF Purge valve test logic.

| (CANP\_OSM\_TEST\_COM\*)

| Do: CANISTER PURGE STRATEGY - STANDARD

| (CANP\_COM\*)

| Do: canister\_purge\_output

|

| ;PCOMP is NOT active, therefore

| PCOMP\_ENA = 0

| PCOMP\_LBM = 0

15-85

CANISTER PURGE STRATEGY, CANISTER PURGE FLOW TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

15.8 CANISTER PURGE FLOW TEST (CDAN2)

OVERVIEW

This logic describes the thermistor based flow test of the canister purge

system for compliance with CARB and EPA OBD-II requirements. The purpose of

the test is to determine if flow is properly occuring in the Evaporative Fuel

System.

o Entry Conditions:

The test will begin if all of the following entry conditions are met:

. The test has not yet been run this trip.

. Powertrain load is within the calibrated window.

. The vehicle speed is within a calibrated window.

. ACT/ECT is below a calibrated maximum value.

. Time since closed loop is greater than a calibrated minimum value.

. PG\_DC is above a calibrated value.

. Inferred manifold vacuum is above a calibrated minimum value.

| . Relative throttle position is above a calibrated minimum value.

o Test Description:

A thermistor in-line with the purge line is used to gauge flow. The

thermistor's voltage value is read by the processor at two different

times - once when the purge valve is open and manifold vacuum is purging

down the lines and canister - and once when the purge valve has been

turned off. These values are subtracted to get a delta and this is

compared with a calibratable threshold. If the flow is occuring properly

in the system, the change in the thermistor's value should be greater

than the threshold. If not, an error exists.

DEFINITIONS

Registers:

- ACT = Air Charge Temperature, deg. F.

- CL\_TMR = Closed loop timer (actuated).

- PGM\_RDY\_TMR = Timer that tracks conditions to determine if purge flow

test is ready.

- ECT = Engine coolant temperature, deg F.

- LOAD = Universal load as a ratio of aircharge over standard.

- PGM\_FLOW\_1 = First value of PFS when PURGE is ON; counts.

- PGM\_FLOW\_2 = Second value of PFS when PURGE is OFF; counts.

15-86

CANISTER PURGE STRATEGY, CANISTER PURGE FLOW TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PGM\_RST\_CTR = Purge test restart counter.

- PGM\_TEMP = Temperature (ECT/ACT combination) used in purge test.

- VSBAR = Vehicle speed, MPH.

- PGM\_RST\_TMR = Timer that counts down time between attempts to run the

purge test after a reset.

- PG\_DC = Purge duty cycle.

- PGM\_PFS = Value of Purge flow sensor; counts.

- INF\_MVAC = Inferred Manifold Vacuum; inches Hg.

- PGM\_TMR = Timer that increments between readings of the PFS.

- PGM\_DLT\_FLOW = Difference between 2 readings of the purge flow sensor,

counts.

| - TP\_REL = Relative TP (TP - RATCH).

| - ER\_STATUS = State pointer that indicates current state of engine running

| on demand test.

Bit Flags:

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag. (1 =>

test enabled)

- FLG\_STALL = Indicates a stall has occurred; transition.

- FLOW\_RUNNING = Purge test is running flag; 1 -> running.

- OLFLG = Open loop flag; 1 -> open loop mode, 0 -> closed loop mode.

- PGM\_1ST\_PS = First pass through the PGM\_FLOW\_TEST flag when a reading is

taken; 1 -> first pass seen.

- PGM\_2ND\_PS = Second pass through the PGM\_FLOW\_TEST flag when a reading is

taken; 1 -> second pass seen.

- PGM\_DONE = Purge test is done flag; 1 -> test is done.

- PGM\_PFS\_FM = Purge thermistor flow sensor FMEM flag.

- PGM\_PG\_OFF = Flag to turn PURGE off during a portion of the purge test.

- PURG\_MON = OBDII test flag for evaporative purge; 1 -> all purge faults

been monitored since power-up.

- PURG\_TST\_ENA = Purge test enabled flag; 1 -> Purge test has been enabled

by the OBD-2 executive.

- PURG\_TST\_RDY = Purge test ready flag; 1 -> all local conditions to run

the purge test have been met.

15-87

CANISTER PURGE STRATEGY, CANISTER PURGE FLOW TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PxxxMALF = OBDII malfunction flag for fault xxx; 1 -> a malfunction

currently exists for fault xxx.

- PxxxMON = OBDII test flag for fault xxx; 1 -> fault has been monitored at

least once since power-up.

Calibration Constants:

- PGM\_CL\_TM = Time in closed loop to allow purge test.

- PGM\_LOAD\_MAX = Maximum load to allow purge test.

- PGM\_LOAD\_MIN = Minimum load to allow purge test.

- PGM\_RST\_CNT = Number of times purge test is allowed to be tried per

engine key-on.

- PGM\_TEMP\_MAX = Maximum temperature to allow purge test.

- PGM\_TEMP\_MIN = Minimum temperature to allow purge test.

- PGM\_TEMP\_MUL = Purge test fractional multiplier; 1.0 -> use all ECT; 0.0

-> use all ACT.

- PGM\_VS\_MAX = Maximum vehicle speed to allow purge test.

- PGM\_VS\_MIN = Minimum vehicle speed to allow purge test.

- PGM\_RST\_TM = Time required before Purge Test is allowed to restart.

- PGM\_PG\_START = Purge duty cycle above which to allow the purge test to

begin.

- PGM\_PG\_LO = Purge duty cycle below which to load in a value of the PFS.

- PGM\_TM = Time to delay between readings of the PFS.

- PGM\_DLT\_THRS = Threshold value of PGM\_DLT\_FLOW below which an error is

assumed.

- PGM\_MVAC\_MIN = Value of INF\_MVAC above which to run the purge flow test.

- PGM\_RDY\_TM = Time to say that conditions for test have existed long

enough.

| - PGM\_TP\_MIN = Minimum value of TP\_REL to begin the purge flow test.

| - PURG\_ER\_INIT = Value for state of ER\_STATUS to request the engine running

| purge test.

| - PURG\_ER\_DONE = Value for the state of ER\_STATUS to indicate that the

| engine running purge test is complete.

15-88

CANISTER PURGE STRATEGY, CANISTER PURGE FLOW TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OTHER

- purg\_codes = Set of {P0442, P0443, P0446, P0452, P0453, P1442, P1443,

P1444, P1445}. The set of OBDII fault codes that relate to purge test.

- malfunction(purg,Pxxx) = Logic process, imported from the MIL control

Module; Pxxx indicates the fault code.

- P1443 = Fault code, evaporative emission control system purge flow

malfunction.

15-89

CANISTER PURGE STRATEGY, CANISTER PURGE FLOW TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CANP\_THERM\_FLOW\_COM1

| ; bypass the KOER test logic

| ER\_STATUS = PURG\_ER\_INIT ------------| ER\_STATUS := PURG\_ER\_DONE

| ; KOER test being desired | ; KOER test is complete

always ------------------------------| PGM\_TEMP = (PGM\_TEMP\_MUL \* ECT) +

| ((1 - PGM\_TEMP\_MUL) \* ACT)

OLFLG = 0 ---------------------------| Increment CL\_TMR.

(closed loop) |

| --- ELSE ---

|

| Freeze CL\_TMR.

PG\_DC >= PGM\_PG\_START ---------|

(duty cycle is high enough) |

|

LOAD <= PGM\_LOAD\_MAX ----------|AND -| Increment PGM\_RDY\_TMR

(load within range) | |

| |

INF\_MVAC >= PGM\_MVAC\_MIN ------| |

(manifold vacuum above |

calibratable limit) |

| --- ELSE ---

|

| PGM\_RDY\_TMR = 0

15-90

CANISTER PURGE STRATEGY, CANISTER PURGE FLOW TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLOW\_RUNNING = 1 ------------------|

|

PGM\_PFS\_FM = 0 --------------| |

(flow sensor O.K.) | |

| |

PGM\_TEMP <= PGM\_TEMP\_MAX ----| |

| |

PGM\_TEMP >= PGM\_TEMP\_MIN ----| |

(temperature is within | |OR --| PURG\_TST\_RDY = 1

acceptable range) | | | (purge test is ready)

| | |

VSBAR >= PGM\_VS\_MIN ---------| | |

| | |

VSBAR <= PGM\_VS\_MAX ---------| | |

(vehicle speed is within | | |

acceptable range) | | |

| | |

CL\_TMR >= PGM\_CL\_TM ---------|AND -| |

(in closed loop long enough)| |

| |

P0443MON = 1 ----------------| |

(Purge valve checked) | |

| |

P0443MALF = 0 ---------------| |

(Purge valve O.K.) | |

| |

PGM\_RST\_TMR = 0 -------------| |

(delay before restart test) | |

| |

PGM\_RST\_CTR < PGM\_RST\_CNT ---| |

(below max reset tries) | |

| |

PGM\_RDY\_TMR >= PGM\_RDY\_TM ---| |

| (conditions for test have | |

| existed long enough) | |

| | |

| TP\_REL > PGM\_TP\_MIN ---------| |

| --- ELSE ---

|

| PURG\_TST\_RDY = 0

15-91

CANISTER PURGE STRATEGY, CANISTER PURGE FLOW TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PGM\_DONE = 1 ------------------------| EXIT

(purge test complete) |

| --- ELSE ---

FLOW\_RUNNING = 0 --------------| |

(purge test not running) | |

|AND -| FLOW\_RUNNING = 1

PURG\_TST\_RDY = 1 --------------| | (set purge test running flag)

(test is ready) | | Do: PGM\_FLOW\_TEST

| |

PURG\_TST\_ENA = 1 --------| | |

(enabled by executive) |OR --| |

| |

CCM\_TST\_ENA = 1 ---------| |

(comprehensive component |

test enabled) |

| --- ELSE ---

FLOW\_RUNNING = 1 --------------| |

(purge test is running) | |

| |

LOAD > PGM\_LOAD\_MAX -----| | |

| | |

LOAD < PGM\_LOAD\_MIN -----| | |

(LOAD is not within | | |

acceptable range) | | |

| |AND -| FLOW\_RUNNING = 0

PGM\_PFS\_FM = 1 ----------| | | (test was aborted due to load

(sensor or actuator | | | vehicle speed, engine stall,

failed) | | | re-entry into open loop,

| | | low manifold vacuum, sensor/

OLFLG = 1 ---------------| | | actuator criteria, OBDII

| | | executive)

FLG\_STALL = 1 -----------| | |

(vehicle stalled) |OR --| | PGM\_RST\_TMR = PGM\_RST\_TM

| | (load the reset timer with the

PURG\_TST\_ENA = 0 --| | | time to wait until retest)

|AND -| | PGM\_RST\_CTR = PGM\_RST\_CTR + 1

CCM\_TST\_ENA = 0 ---| | | (increment the reset counter)

| | PGM\_1ST\_PS = 0

| VSBAR < PGM\_VS\_MIN ------| | PGM\_2ND\_PS = 0

| | PGM\_DONE = 0

| VSBAR > PGM\_VS\_MAX ------| | PGM\_PG\_OFF = 0

(vehicle speed is not | |

in acceptable range) | |

| |

INF\_MVAC < PGM\_MVAC\_MIN -| |

(manifold vacuum is | |

too low for test) | |

| |

P0443MALF = 1 -----------| |

| (Purge valve not O.K.) | |

| | |

| TP\_REL < PGM\_TP\_MIN -----| |

| --- ELSE ---

|

FLOW\_RUNNING = 1 --------------------| Do: PGM\_FLOW\_TEST

(purge test is running) | (run the actual test)

15-92

CANISTER PURGE STRATEGY, CANISTER PURGE FLOW TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Check for test completeness:

P0443MON = 1 -------------------|

(Purge valve checked) |

|

P1443MON = 1 -------------| |

(Purge flow checked) |OR --|

| |AND -| PURG\_MON = 1

P0443MALF = 1 ------------| | | (purge has been completely

(Purge circuit error) | | monitored)

| | PGM\_DONE = 1

P1444MON = 1 -------------| | | PGM\_1ST\_PS = 0

|AND -| | PGM\_2ND\_PS = 0

P1445MON = 1 -------------| | PGM\_RST\_CTR = 0

(PFS sensor checked) | FLOW\_RUNNING = 0

|

| --- ELSE ---

|

| PURG\_MON = 0

| PGM\_DONE = 0

15-93

CANISTER PURGE STRATEGY, CANISTER PURGE FLOW TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: PGM\_FLOW\_TEST

unconditionally --------------------| Increment PGM\_TMR

PGM\_1ST\_PS = 0 ---------------------| PGM\_FLOW\_1 = PGM\_PFS

| (read in thermistor value)

| PGM\_PG\_OFF = 1

| (turn off PURGE)

| PGM\_TMR = 0

| (clear timer to count up)

| PGM\_1ST\_PS = 1

| (first pass done)

|

| --- ELSE ---

PGM\_1ST\_PS = 1 ---------------| |

| |

PG\_DC <= PGM\_PG\_LO -----------|AND -| PGM\_FLOW\_2 = PGM\_PFS

| | (read in thermistor value)

PGM\_TMR >= PGM\_TM ------------| | PGM\_DLT\_FLOW = PGM\_FLOW\_1 -

| PGM\_FLOW\_2

| (clip to 0.0 as min)

| PGM\_2ND\_PS = 1

| PGM\_PG\_OFF = 0

|

| --- ELSE ---

|

| No action.

PGM\_2ND\_PS = 1 ---------------|

|AND -| Do: malfunction(purg,P1443)

PGM\_DLT\_FLOW <= PGM\_DLT\_THRS -| | (update MIL)

|

| --- ELSE ---

|

| Do: clear\_malf(P1443)

| (clear malfunction flag)

PGM\_1ST\_PS = 1 ---------------|

|AND -| P1443MON = 1

PGM\_2ND\_PS = 1 ---------------| |

| --- ELSE ---

|

| P1443MON = 0

END: PGM\_FLOW\_TEST

15-94

CANISTER PURGE STRATEGY, VMV FLOW TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

15.9 VMV FLOW TEST (CDAN0)

OVERVIEW

This logic describes the vapor management valve (VMV) based flow test of the

canister purge system for compliance with CARB and EPA OBD-II requirements.

The purpose of the test is to determine if flow is properly occurring in the

Evaporative Fuel System.

By monitoring the effects of the canister purge strategy (PCOMP) on the Idle

Speed Control strategy and then testing those effects against expected

results, flow is inferred to be occurring in the Evaporative Fuel System.

o Entry Conditions:

The test will begin if all of the following entry conditions are met:

. The purge system shows no electrical faults.

. The test has not yet been run this trip.

. Powertrain load is within the calibrated window.

. The vehicle speed is within a calibrated window.

. ACT/ECT is within a calibrated window.

. Time since closed loop is greater than a calibrated minimum.

. PG\_DC is above a calibrated value.

. Purge vapor level is below a calibrated maximum.

. Idle speed control strategy is active.

. Air conditioning is not active.

. Steady state conditions have existed for VBAT and LOAD for a

calibrated amount of time before test.

o Test Description:

The test compares the values of Idle Speed Control parameter IPSIBR at a

high calibratable PG\_DC point when purge flow is expected to be high and

at PG\_DC = 0 when purge flow is expected to be low or nonexistant. Using

these two points, the test calculates a delta value and compares this to

an expected calibratable value. If equal or above expected, flow is

inferred to be occurring and that NO malfunction exists. If however, the

delta is below expected, flow is inferred to NOT be occurring properly

and that a malfunction exists in the Evaporative Fuel System.

The test runs as follows. If the conditions to run the test are met, the

test begins by loading in the current value of IPSIBR and turning off

PCOMP by setting FLOW\_RUNNING to 1 (which is read by the

CANP\_PCOMP\_ENABLE\_COMx module and used to disable PCOMP). After a

calibratable time (PGM\_TM), after PG\_DC has decayed down to zero, and if

NO steady state changes in VBAT or LOAD have occurred, the new current

value of IPSIBR is loaded in and used to calculate a delta value. This

value is compared to PGM\_IPS\_LIM and according to the result, a

malfunction is either set or cleared.

15-95

CANISTER PURGE STRATEGY, VMV FLOW TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- ACT = Air Charge Temperature, deg. F.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag (1 => test

enabled).

- CL\_TMR = Closed loop timer (actuated).

- ECT = Engine coolant temperature, deg F.

- ISCDTY = Idle speed control duty cycle.

- ISCFLG = ISC mode Flag; 1 -> RPM control mode.

- IPSIBR = The closed loop integration component of total DESMAF, ppm.

Designed to provide integral feedback, IPSIBR adjusts the value of

DESMAF. Changes in IPSIBR result in a corresponding change to bypass

valve duty cycle.

- KWUCTR = KAM warm\_up counter. Stores number of warm\_ups in KAM. (Reset

to zero if KAM is corrupted, battery disconnect, etc.)

- LOAD = Universal load as a ratio of aircharge over standard.

- PCOMP\_W = Value of purge vapors currently being purged, ppm (reduced

range PCOMP\_PPM).

- PG\_DC = Purge duty cycle.

- PGM\_FK = Filter factor to be used with PGM\_IPS\_KAM calculation. Value is

either PGM\_FK\_NMAT or PGM\_FK\_MAT.

- PGM\_IPS\_1 = First value of IPSIBR that is read in when PG\_DC is high.

- PGM\_IPS\_2 = Second value of IPSIBR that is read in when PG\_DC is low.

- PGM\_IPS\_DLT = Difference value between PGM\_IPS\_1 and PGM\_IPS\_2.

- PGM\_IPS\_KAM = Weighed moving average value of PGM\_IPS\_DLT.

- PGM\_LOAD = Filtered value of LOAD used in the Purge Flow test.

- PGM\_LOAD\_DLT = Absolute value of the difference between the filtered

PGM\_LOAD and the current value of LOAD.

- PGM\_SS\_TMR = Timer that tracks steady state conditions of the purge test.

- PGM\_TEMP = Temperature (ECT/ACT combination) used in purge test.

- PGM\_TMR = Timer that increments between readings of the flow test.

- PGM\_VBAT = Filtered value of VBAT used in the Purge Flow test.

- PGM\_VBAT\_DLT = Absolute value of the difference between the filtered

PGM\_VBAT and the current value of VBAT.

15-96

CANISTER PURGE STRATEGY, VMV FLOW TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PURG\_TST\_ENA = Purge test enabled flag; 1 -> Purge test has been enabled

by the OBD-2 executive.

- VSBAR = Vehicle speed, MPH.

- VBAT = Battery voltage.

Bit Flags:

- FLOW\_RUNNING = Purge test is running flag; 1 -> running.

- ISFLAG = Flag that indicates the degree of loading on the engine at idle.

- ISLAST = Register which indicates the engine load state from the previous

background loop.

- KAM\_ERROR = Indicates keep alive ram invalid.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II scan tool

reset message.

- OLFLG = Open loop flag; 1 -> open loop mode, 0 -> closed loop mode.

- FRST\_ADP = Flag indicating that the ADAPT\_TMR has incremented at least

once, therefore, have entered adaptive fuel at least once.

- PGM\_1ST\_PS = First pass through the flow test flag when a reading is

taken; 1 -> first pass seen.

- PGM\_2ND\_PS = Second pass through the flow test flag when a reading is

taken; 1 -> second pass seen.

- PGM\_DONE = Purge test is done flag; 1 -> test is done.

- PGM\_VALS\_GOT = Flag that indicates that the two sets of flow values have

been read in.

- PURG\_TST\_RDY = Purge test ready flag; 1 -> conditions have been met.

- PxxxMALF = OBDII malfunction flag for fault xxx; 1 -> a malfunction

currently exists for fault xxx.

- PxxxMON = OBDII monitor flag for fault xxx; 1 -> fault has been monitored

at least once since power-up.

- PURG\_MON = OBDII monitor flag for evaporative purge; 1 -> all purge

faults been monitored since power-up.

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CANISTER PURGE STRATEGY, VMV FLOW TEST - CDAN2

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Calibration Constants:

- PGM\_CL\_TM = Time in closed loop to allow purge test.

- PGM\_FK\_MAT = PGM\_FK value used when KAM is considered mature.

- PGM\_FK\_NMAT = PGM\_FK value used when KAM is NOT considered mature.

- PGM\_IPS\_INIT = Initial value for PGM\_IPS\_KAM if KAM is corrupted.

- PGM\_LD\_DT\_MX = Maximum value of PGM\_LOAD\_DLT above which the test is

aborted.

- PGM\_IPS\_LIM = Limit value of PGM\_IPS\_DLT below which a fault is assumed.

- PGM\_ISC\_MAX = Maximum value of ISCDTY to allow purge test above which a

possible ISC failure is assumed.

- PGM\_ISC\_MIN = Minimum value of ISCDTY to allow purge test below which a

possible ISC failure is assumed.

- PGM\_KWUCNT = Maximum mumber of warm\_up cycles to use PGM\_FK\_NMAT.

- PGM\_LOAD\_MAX = Maximum load to allow purge test.

- PGM\_LOAD\_MIN = Minimum LOAD to allow purge test.

- PGM\_PG\_START = Purge duty cycle above which to allow the purge test to

begin.

- PGM\_PPM\_WMX = Maximum value of PCOMP\_W allowed to run the purge test.

- PGM\_PPM\_WMN = Minimum value of PCOMP\_W allowed to bypass the VMV Flow

Test logic and set the PURG\_MON flag. Flow is assumed if above a

certain, sufficient level.

- PGM\_SS\_TM = Time to wait while in steady state conditions before trying

purge test.

- PGM\_TC\_LOAD = Time constant used with ROLAV filtering of PGM\_LOAD.

- PGM\_TC\_VBAT = Time constant used with ROLAV filtering of PGM\_VBAT.

- PGM\_TEMP\_MAX = Maximum temperature to allow purge test.

- PGM\_TEMP\_MIN = Minimum temperature to allow purge test.

- PGM\_TEMP\_MUL = Purge test fractional multiplier; 1.0 -> use all ECT; 0.0

-> use all ACT.

- PGM\_TM = Time to delay between readings of the flow test.

- PGM\_VB\_DT\_MX = Maximum value of PGM\_VBAT\_DLT above which the test is

aborted.

- PGM\_VS\_MAX = Maximum vehicle speed to allow purge test.

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CANISTER PURGE STRATEGY, VMV FLOW TEST - CDAN2

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OTHER

- purg\_codes = Set of {P0443,P1443}. The set of OBDII fault codes that

relate to the evaporative purge OBDII test.

- malfunction(purg,Pxxx) = Logic process, imported from the MIL control

Module; Pxxx indicates the fault code.

- P1443 = Fault code, evaporative emission control system purge flow

malfunction.

- P0443 = Fault code, evaporative emission control system purge circuit

malfunction.

- P0505 = Inlet Air Control (idle speed) system malfunction.

- P1505 = Inlet Air Control System at adaptive Clip.

- P1506 = Inlet Air Control Duty cycle is lower than expected.

- P1507 = Inlet Air Control Duty cycle is higher than expected.

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CANISTER PURGE STRATEGY, VMV FLOW TEST - CDAN2

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PROCESS

STRATEGY MODULE: CANP\_VMV\_FLOW\_COM1

BEGIN: flow\_inference\_test

; this is the main process that calls all others.

OBDII\_RESET = 1 ------------------|

|OR --| PGM\_DONE := 0

KAM\_ERROR = 1 --------------------| | PGM\_IPS\_KAM := PGM\_IPS\_INIT

; bypass the KOER test logic

ER\_STATUS = PURG\_ER\_INIT ---------------| ER\_STATUS := PURG\_ER\_DONE

; KOER test being desired | ; KOER test is complete

PGM\_DONE = 1 ---------------------------| EXIT flow\_inference\_test.

; check to see if sufficient flow is seen to bypass the test

P0443MON = 1 ---------------------|

; Purge valve checked |

|

FRST\_ADP = 1 ---------------------|AND -| PURG\_MON := 1

; Adapted at least once | | ; purge has been completely

| | ; monitored

PCOMP\_W >= PGM\_PPM\_WMN -----------| | P1443MON := 1

; Sufficient flow | ; flow monitored

| PGM\_DONE := 1

| Do: reset\_parameters

| EXIT flow\_inference\_test.

unconditionally ------------------------| Do: pgm\_filtering

| ; call process that calculates

| ; PGM\_TEMP, PGM\_VBAT\_DLT, and

| ; PGM\_LOAD\_DLT. logic found in

| ; CANP\_PGM\_FILT\_COMx

OLFLG = 0 ------------------------------| Increment CL\_TMR.

; in closed loop |

| --- ELSE ---

|

| Freeze CL\_TMR.

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CANISTER PURGE STRATEGY, VMV FLOW TEST - CDAN2

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ISCDTY > PGM\_ISC\_MIN -------------|

|

ISCDTY < PGM\_ISC\_MAX -------------|

; ISCDTY value reasonable |

|

ISCFLG = 1 -----------------------|

; in Idle speed control |

|AND -| Increment PGM\_SS\_TMR

PGM\_VBAT\_DLT < PGM\_VB\_DT\_MX ------| | ; time in steady state

; change in VBAT below max | |

| |

PGM\_LOAD\_DLT < PGM\_LD\_DT\_MX ------| |

; change in LOAD below max | |

| |

ISFLAG = ISLAST ------------------| |

; no load state change |

| --- ELSE ---

|

| PGM\_SS\_TMR := 0

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CANISTER PURGE STRATEGY, VMV FLOW TEST - CDAN2

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LOAD > PGM\_LOAD\_MIN --------------|

|

LOAD < PGM\_LOAD\_MAX --------------|

; LOAD within acceptable range |

|

PGM\_TEMP < PGM\_TEMP\_MAX ----------|

|

PGM\_TEMP > PGM\_TEMP\_MIN ----------|

; temperature is within |

; acceptable range |

|

VSBAR < PGM\_VS\_MAX ---------------|

; vehicle speed is within |

; acceptable range |

|

CL\_TMR > PGM\_CL\_TM ---------------|

; in closed loop long enough |

|

P0443MON = 1 ---------------------|

; Purge valve checked |AND -| PURG\_TST\_RDY := 1

| | ; purge test is ready

P0443MALF = 0 --------------------| |

; Purge valve O.K. | |

| |

ISCFLG = 1 -----------------------| |

; idle control is active | |

| |

PGM\_SS\_TMR > PGM\_SS\_TM -----------| |

; in steady state long enough | |

| |

P0505MALF = 0 --------------------| |

; IAC not malfunctioning | |

| |

P1505MALF = 0 --------------------| |

; IAC not at adaptive clip | |

| |

P1506MALF = 0 --------------------| |

; IAC duty cycle is not too low | |

| |

P1507MALF = 0 --------------------| |

; IAC duty cycle is not too high |

| --- ELSE ---

|

| PURG\_TST\_RDY := 0

| Do: reset\_parameters

| EXIT flow\_inference\_test.

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CANISTER PURGE STRATEGY, VMV FLOW TEST - CDAN2

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FLOW\_RUNNING = 0 ----------------|

; test not running |

|

PURG\_TST\_RDY = 1 -----------------|

; test is ready |

|

PG\_DC > PGM\_PG\_START -------------|

; duty cycle high enough |

|AND -| ; Initial conditions met.

PCOMP\_W < PGM\_PPM\_WMX ------------| | ; Begin flow test.

; purge vapors not excessive | | ; Turn off PCOMP.

| | FLOW\_RUNNING := 1

PGM\_1ST\_PS = 0 -------------------|

; phase one not done yet |

|

PURG\_TST\_ENA = 1 -----------| |

; test enabled by OBD-2 | |

; executive | |

| |

CCM\_TST\_ENA = 1 ------------|OR --|

; comprehensive component |

; test enabled |

FLOW\_RUNNING = 0 -----------------------| PGM\_TMR := 0

|

| --- ELSE ---

|

| ; allow PGM\_TMR

| ; to increment

FLOW\_RUNNING = 1 -----------------------| Do: get\_flow\_values

|

| --- ELSE ---

|

PGM\_VALS\_GOT = 1 -----------------------| Do: check\_flow\_values

|

| --- ELSE ---

|

| Do: reset\_parameters

| Exit: flow\_inference\_test.

END: flow\_inference\_test

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CANISTER PURGE STRATEGY, VMV FLOW TEST - CDAN2

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BEGIN: get\_flow\_values

; This process is called by the process: flow\_inference\_test.

; Its function is to load the flow readings when appropriate.

PGM\_1ST\_PS = 0 -------------------------| PGM\_IPS\_1 := IPSIBR

; first time through | PGM\_1ST\_PS := 1

|

| --- ELSE ---

PGM\_1ST\_PS = 1 -------------------| |

| |

PGM\_TMR > PGM\_TM -----------------|AND -| PGM\_IPS\_2 := IPSIBR

| | PGM\_2ND\_PS := 1

PGM\_2ND\_PS = 0 -------------------|

PGM\_1ST\_PS = 1 -------------------|

|AND -| PGM\_VALS\_GOT := 1

PGM\_2ND\_PS = 1 -------------------| | P1443MON := 1

| FLOW\_RUNNING := 0

|

| --- ELSE ---

|

| PGM\_VALS\_GOT := 0

| P1443MON := 0

END: get\_flow\_values

BEGIN: check\_flow\_values

; This process is called by the process: flow\_inference\_test. Its

; functions are to load the appropriate filter value, calculate the

; delta of the flow readings, perform the weighted average filtering on the

; flow delta, check this filtered value against calibrated values, and set

; or clear the appropriate fault code.

; decide which filter constant to use based on KAM warm up counter value

KWUCTR < PGM\_KWUCNT --------------------| PGM\_FK := PGM\_FK\_NMAT

; First few warm\_up cycles |

; KAM considered not mature |

| --- ELSE ---

|

| PGM\_FK := PGM\_FK\_MAT

; calculate the delta of the flow readings

; perform the weighted average filtering on the flow delta

unconditionally ------------------------| pgm\_ips\_lst := PGM\_IPS\_KAM

| PGM\_IPS\_DLT := PGM\_IPS\_2 -

| PGM\_IPS\_1

| PGM\_IPS\_KAM := PGM\_FK \* PGM\_IPS\_DLT

| + (1-PGM\_FK) \* pgm\_ips\_lst

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CANISTER PURGE STRATEGY, VMV FLOW TEST - CDAN2

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; check filtered value against calibrated limit

PGM\_IPS\_KAM < PGM\_IPS\_LIM --------------| ; Error flow indicated.

| ; Call MIL control procedure

| Do: malfunction(purg,P1443)

|

|

| --- ELSE ---

|

| ; Purge functioning properly.

| ; Flow is indicated.

| Do: clear\_malf(P1443)

; check for monitor completeness

P0443MON = 1 ---------------------|

; Purge valve checked |

|AND -| PURG\_MON := 1

P1443MON = 1 ---------------| | | ; purge has been completely

; Purge flow checked |OR --| | ; monitored

| | PGM\_DONE := 1

P0443MALF = 1 --------------| | Do: reset\_parameters

; Purge circuit error |

| --- ELSE ---

|

| PURG\_MON := 0

| PGM\_DONE := 0

END: check\_flow\_values

BEGIN: reset\_parameters

; This process is called by the process: flow\_inference\_test.

; Its function is to clear the appropriate values of the

; flow\_inference\_test if it is aborted or completed.

unconditionally ------------------------| FLOW\_RUNNING := 0

| PGM\_1ST\_PS := 0

| PGM\_2ND\_PS := 0

| PGM\_VALS\_GOT := 0

| PGM\_TMR := 0

END: reset\_parameters

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CANISTER PURGE STRATEGY, VMV FLOW TEST - CDAN2

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CHAPTER 16

ELECTRO-DRIVE FAN STRATEGY

16-1

ELECTRO-DRIVE FAN STRATEGY

16.1 FEATURE: ELECTRO-DRIVE FAN CONTROL STRATEGY (EDF) - V3.3\_EDF (CDAN0)

16.1.1 LOW SPEED FAN STRATEGY (CDAH0)

OVERVIEW

Electro-drive fan refers to an electric motor driven fan used to provide

forced air circulation through the engine coolant radiator when natural air

flow is inadequate; i.e., low vehicle speed or high engine coolant

temperature. The fan is always turned off during CRANK mode to minimize the

accessory load.

Fan control is accomplished through the use of EEC controlled relays in the

fan power supply circuit. This strategy may be used with either a

"one-speed", a "two-speed" or two single fans. The "two-speed" fan motor may

either be a dual-wound type or a single wound type with a dropping resistor

to achieve low speed operation.

This Strategy Module performs the function of requesting that the Low Speed

Fan be switched on.

When the WOT EDF cutout feature is envoked, the LSF is turned off only if it

is not required to be on for some other reason, primarily ECT (LSFECT\_FLG

being set). Therefore, if the LSF is on ONLY because AC is requested and the

vehicle speed is low, then when ACRQST is cleared because ACTP\_FLG is set,

LSF\_RQST is cleared by ACTP\_FLG being equal to 1.

Note that the flag LSF\_RQST is not cleared automatically when LSFECT\_FLG is

cleared: it relies upon one of the specific conditions documented in the

logic overleaf to clear it, typically ACIOTMR or VSBAR checks.

DEFINITIONS

INPUTS

Registers:

- ACIOTMR = A/C clutch off timer, sec. Used to prevent rapid cycling of

the A/C compressor and electro-drive fan.

- ECT = Engine Coolant Temperature, deg F.

- VSBAR = Filtered Vehicle Speed, MPH.

Bit Flags:

- ACTP\_FLG = Flag to disable EDF and A/C at high TP.

- ACRQST = Flag that is set to 1 when A/C clutch desired.

- CFMFLG = Flag indicating the ECT sensor has failed.

- CRKFLG = Flag that is set when in CRANK mode.

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ELECTRO-DRIVE FAN STRATEGY, LOW SPEED FAN STRATEGY - CDAN2

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- HSF\_RQST = Flag indicating the high speed fan is requested.

- LSFECT\_FLG = LSF ECT F/F flag.

- OSM\_EDF\_OFF = Request for EDF Off from OSM or OTM test.

- OSM\_EDF\_ON = Request for EDF on from OSM or OTM test.

Calibration Constants:

- AC\_MN\_FT = Minimum EDF on time after A/C clutch off, secs. Prevents

rapid fan cycling. (Should be > 10 seconds)

- EDFHP = Electro drive fan hardware present switch. Calibrate to "1" for

either one or two speed fan control; "0" for no fan control.

- LSFECT\_CL = Maximum ECT to turn off Low Speed Fan, deg F. (Should be 4

degrees less than LSFECT\_SH, per Car Engineering Direction)

- LSFECT\_SH = Minimum ECT to turn on Low Speed Fan, deg F. (Should be 216

deg F, per Car Engineering Direction)

- LSFVS\_CH = Minimum vehicle speed to turn off the Low Speed Fan, MPH.

(Should be 5 MPH higher than LSFVS\_SL, per Car Engineering Direction)

- LSFVS\_SL = Maximum vehicle speed to turn on Low Speed Fan because the A/C

is on, MPH. (Should be 48 MPH, per Car Engineering Direction)

OUTPUTS

Bit Flags:

- LSF\_RQST = Flag indicating Low Speed Fan is requested.

- LSFECT\_FLG = See above.

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ELECTRO-DRIVE FAN STRATEGY, LOW SPEED FAN STRATEGY - CDAN2

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PROCESS

STRATEGY MODULE: EDF\_LSF\_CONTROL\_COM1

EDFHP = 1 ------------------------------------|

|AND -|S Q -| LSFECT\_FLG

ECT > LSFECT\_SH ------------------------------| |

(hot engine) |

|

EDFHP = 1 ------------------------------------| |

|AND -|C

ECT < LSFECT\_CL ------------------------------|

EDFHP = 1 ------------------------------------|

(EDF hardware present) |

|

OSM\_EDF\_OFF = 0 ------------------------------|

(OSM NOT forced off) |

|AND -|S Q -| LSF\_RQST

OSM\_EDF\_ON = 1 -------------------------| | |

| | |

CRKFLG = 0 -----------------------| |OR --| |

(not in crank mode) | | |

| | |

CFMFLG = 1 -----------------| |AND -| |

(ECT sensor failed) | | |

| | |

HSF\_RQST = 1 ---------------| | |

|OR --| |

LSFECT\_FLG = 1 -------------| |

| |

ACRQST = 1 -----------| | |

(A/C on) |AND -| |

| |

VSBAR < LSFVS\_SL -----| |

(vehicle speed low) |

|

EDFHP = 0 ------------------------------------| |

(EDF hardware not present) | |

| |

CRKFLG = 1 -----------------------------------| |

(in crank mode) | |

| |

VSBAR > LSFVS\_CH -----------------------------|OR --|C

(vehicle speed high) |

|

ACIOTMR >= AC\_MN\_FT --------------------------|

(fan turn off delay) |

|

ACTP\_FLG = 1 ---------------------------------|

(WOT A/C Cutout invoked) |

|

OSM\_EDF\_OFF = 1 ------------------------------|

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ELECTRO-DRIVE FAN STRATEGY - CDAN2

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16.1.2 HIGH SPEED FAN STRATEGY (CDAN0)

FEATURE MEMBERSHIP : EDF

EXECUTION CONTEXT : Background

FUNCTIONAL REQUIREMENTS :

This module controls the setting and clearing of the flag HSF\_RQST. This

indicates that the High speed fan has been requested. The request flag is

passed to the module EDF\_CONTROL\_COM to allow the correct sequencing of the

outputs.

If an A/C medium pressure switch is to be used the module INPUT\_ACPSW\_COM

controls the flag ACPSW, otherwise it remains at it's base value of zero. If

an A/C pressure transducer is fitted the module INPUT\_ACPRES\_COM controls

the flag ACPRES\_HSF, otherwise the base value of zero is maintained.

FUNCTIONAL DESCRIPTION :

This module performs the function of requesting the high speed fan.

The High speed fan can be requested by any of the following conditions:

- Very high ECT

- ECT sensor failure

- High A/C head pressure (Transducer)

- Medium A/C head pressure switch tripped

- High RPM and Load with low Vehicle speed ( Grade load )

- Output state control forces ON state

The high speed fan request will be cleared when none of the above request

conditions are true and :

- Low ECT and Low A/C head pressure for a sufficient time

However the fan will be forced off by any of the following :

- Output state control forces it off

- HEDF Output State Monitor failure

- Engine in CRANK mode

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ELECTRO-DRIVE FAN STRATEGY - CDAN2

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DEFINITIONS

INPUTS

Registers:

- ECT = Engine Coolant Temperature, deg F.

- HSF\_ACP\_OTMR = HSF AC Pressure Off timer.

- LOAD = Normalized aircharge parameter (CYLARC\_BG/SARCHG), unitless.

- N\_BYTE = Byte RPM.

- VSBAR = Filtered Vehicle Speed, MPH.

Bit Flags:

- ACPRES\_HSF = Flag indicating that the high speed fan is required for high

A/C head pressure.

- ACPSW = AC Medium Pressure Switch Input; 1 -> AC Pressure high.

- CFMFLG = Flag indicating the ECT sensor has failed.

- CRKFLG = Engine Mode Flag; 1 -> Crank Mode, 0 -> not in Crank Mode.

- OSM\_HEDF\_OFF = Request for HEDF Off from OSM or OTM test.

- OSM\_HEDF\_ON = Request for HEDF On from OSM or OTM test.

- P1479MALF = HEDF OSM fault malfunction flag.

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ELECTRO-DRIVE FAN STRATEGY - CDAN2

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Calibration Constants:

- HEDFHP = Two speed fan hardware present switch. Calibrate to "1" for

two speed fan control; "0" for one speed or no fan control.

- HSF\_ACP\_ROTM = HSF AC Pressure Run on time.

- HSFECT\_CL = Maximum ECT to turn off High Speed Fan, deg F.

- HSFECT1\_SH = Minimum ECT to turn on High Speed Fan for Grade Load, deg F.

- HSFECT2\_SH = Minimum ECT to turn on High Speed Fan normally, deg F.

- HSFLOD = Minimum LOAD to turn on High Speed Fan for Grade Load.

- HSFRPM = Minimum RPM to turn on High Speed Fan for Grade Load, rpm.

- HSFVS = Maximum vehicle speed to turn on High Speed Fan for Grade Load,

mph.

OUTPUTS

Bit Flags:

- HSF\_RQST = Flag indicating requested status of HSF.

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ELECTRO-DRIVE FAN STRATEGY - CDAN2

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PROCESS

STRATEGY MODULE: EDF\_HSF\_CONTROL\_COM4

HEDFHP = 1 -----------------------------------|

;HSF hardware present |

|

OSM\_HEDF\_OFF = 0 -----------------------------|

;OSM NOT forced off |AND -|S Q -| HSF\_RQST

| |

OSM\_HEDF\_ON = 1 ------------------------| | |

| | |

P1479MALF = 0 --------------------| | | |

| | | |

CRKFLG = 0 -----------------------| | | |

;not in Crank mode | |OR --| |

| | |

ACPRES\_HSF = 1 -------------| | | |

;AC Pressure high | | | |

| |AND -| |

ACPSW = 1 ------------------| | |

;AC Med. Pres. Sw. tripped | | |

| | |

CFMFLG = 1 -----------------| | |

;ECT sensor failed | | |

|OR --| |

ECT >= HSFECT2\_SH ----------| |

;higher temp. turn on | |

| |

N\_BYTE >= HSFRPM -----| | |

;high RPM | | |

| | |

LOAD >= HSFLOD -------| | |

;high load |AND -| |

| |

VSBAR <= HSFVS -------| |

;low veh. speed | |

| |

ECT >= HSFECT1\_SH ----| |

;lower temp. turn on |

|

HEDFHP = 0 -----------------------------------| |

;HSF hardware not present | |

| |

ECT < HSFECT\_CL ------------------------| | |

;HSF turn off temperature |AND -| |

| |OR --|C

HSF\_ACP\_OTMR > HSF\_ACP\_ROTM ------------| |

;low AC Pressure for a time |

|

OSM\_HEDF\_OFF = 1 -----------------------------|

|

P1479MALF = 1 --------------------------------|

|

CRKFLG = 1 -----------------------------------|

;in crank mode

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ELECTRO-DRIVE FAN STRATEGY - CDAN2

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ACPSW = 1 ------------------------|

;Medium pressure switch tripped |

|OR --| HSF\_ACP\_OTMR := 0

ACPRES\_HSF = 1 -------------------| |

;High A/C head pressure | --- ELSE ---

|

| ;increment HSF\_ACP\_OTMR

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ELECTRO-DRIVE FAN STRATEGY, ELECTRO-DRIVE FAN CONTROL STRATEGY - CDAN2

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16.1.3 ELECTRO-DRIVE FAN CONTROL STRATEGY (CDAN0)

OVERVIEW

This Strategy Module takes the requests for fan operation and sequences the

fan outputs using calibratable time delays.

In order to provide anticipatory Idle Speed compensation with any combination

of relays and hardware time delays, two software time delays are provided.

The first, EDF\_DELAY, delays Idle Speed action (see Desired RPM logic in

ISC), and the second, FAN\_DELAY, delays EDF activation. If a hardware

activation delay causes the fan to energize too long after ISC compensation

(i.e., RPM flare), set FAN\_DELAY = 0 and increase EDF\_DELAY. If the fan

energizes too soon (i.e., RPM dip), set EDF\_DELAY = 0 and increase FAN\_DELAY.

To prevent engine overheating if the EEC enters HLOS (when the EDF/HEDF

outputs are "off"), the fan power supply circuit must energize the fan unless

the EEC output is energized to turn the fan off. That is, the EDF relay must

be a "normally closed" relay, or a logic inverter is needed between the EEC

and a "normally open" relay. The Integrated Relay Controller Module (IRCM)

uses a "normally open" relay with an inverter for the EDF circuit.

This, however, creates another condition that may damage the relay contacts.

Everytime the processor is powered-up or during a "reset", the EDF output is

off (fan on) for approximately 100 milliseconds before the output is turned

on (fan off). This will cause relay contact arcing due to the very high

current flowing at that time. The relay must be rated for opening at peak

current, or a hardware delay may be used to delay closing a "normally open"

relay immediately when the EDF output is de-energized.

MLI modules have a hardware delay only in HLOS mode, and have no delay

present during normal operation. MLII modules have a hardware delay of

between 110 - 590 milliseconds dependant on tolerance, with a typical value

being 400 milliseconds. This delay occurs every time the EDF is energized.

The IRCM uses a hardware delay of approximately 550 milliseconds to bridge

the initialization time. This delay also occurs every time the EDF is

energized.

CONFIGURATION

If an electro-drive fan is not used, set both EDFHP and HEDFHP = 0.

To control a "one-speed" fan, set EDFHP = 1 and HEDFHP = 0.

To control a "two-speed" dual-wound fan, set both EDFHP and HEDFHP = 1 and

DWFHP = 1.

To control either a "two-speed" fan with a series resistor, or two separate

fans set both EDFHP and HEDFHP = 1 and DWFHP = 0.

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ELECTRO-DRIVE FAN STRATEGY, ELECTRO-DRIVE FAN CONTROL STRATEGY - CDAN2

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DEFINITIONS

INPUTS

Registers:

- FANTMR = Time since electro-drive fan was requested, sec.

Bit Flags:

- LSF\_FLG = Flag indicating the status of the Low Speed Fan.

- HSF\_FLG = Flag indicating the status of the High Speed Fan.

- LSF\_RQST = Flag indicating that the low speed fan is requested.

- HSF\_RQST = Flag indicating that the high speed fan is requested.

Calibration Constants:

- DWFHP = Flag indicating that Dual-Wound Fan hardware is present.

- EDFHP = Electro drive fan hardware present switch; 1 -> either one or two

speed fan control, 0 -> no fan control.

- FAN\_DELAY = Time delay before energizing EDF output, sec.

- HEDFHP = Two speed fan hardware present switch; 1 -> two speed fan

control, 0 -> one speed or no fan control.

- HSFAN\_DELAY = Time delay before energising HEDF.

- LSF\_RLY\_PRCT = Time to delay turn-off of LSF after it is requested, to

prevent relay damage.

OUTPUTS

Registers:

- FANTMR = See above.

Bit Flags:

- LSF\_FLG = See above.

- HSF\_FLG = See above.

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ELECTRO-DRIVE FAN STRATEGY, ELECTRO-DRIVE FAN CONTROL STRATEGY - CDAN2

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PROCESS

STRATEGY MODULE: EDF\_CONTROL\_COM1

EDFHP = 1 ------------------------------|

;EDF hardware present |

|

LSF\_RQST = 1 ---------------------------|

|AND -|S Q -| LSF\_FLG

FANTMR > FAN\_DELAY ---------------------| |

| |

DWFHP = 0 ------------------------| | |

|OR --| |

HSF\_FLG = 0 ----------------------| |

|

EDFHP = 1 ------------------------------| |

| |

FANTMR > LSF\_RLY\_PRCT ------------------| |

;Time delay for LSF Relay protection | |

| |

HSF\_FLG = 1 ----------------| |AND -|C

|AND -| |

DWFHP = 1 ------------------| | |

|OR --|

LSF\_RQST = 0 ---------------------|

HEDFHP = 1 -----------------------------|

;HEDF hardware present |

|AND -|S Q -| HSF\_FLG

HSF\_RQST = 1 ---------------------------| |

| |

FANTMR > HSFAN\_DELAY -------------------| |

|

HSF\_RQST = 0 ---------------------------| |

|AND -|C

HEDFHP = 1 -----------------------------|

16-12

ELECTRO-DRIVE FAN STRATEGY, ELECTRO-DRIVE FAN CONTROL STRATEGY - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FANTMR - TIME SINCE LSF REQUESTED

Timer used to provide the proper time delay between ISC compensation and EDF

electrical load application. (See EDF OVERVIEW and DESIRED RPM CALCULATION)

FANTMR increments when a fan is requested, and is only reset once the fans

are turned off. It is used for 3 purposes (In chronological order):

1. To provide a delay to enable ISC Compensation before turning on the

Low Speed Fan. (FAN\_DELAY)

2. To ensure that once the Low Speed Fan is turned on, it stays on for

a minimum period, (FANTMR > LSF\_RLY\_PRCT) to ensure that the relay is

not required to open while passing the high surge currents that are

associated with the first couple of seconds of EDF operation.

3. To delay the turn on of the High Speed Fan (FANTMR > HSFAN\_DELAY) in

order that the Engine may have stabilised and the LSF reached its

minimum electrical loading. Note: In previous strategy levels this

function was provided by a separate timer, EDFTMR, and a Cal. Const.

EDFTM. As a starting point, set HSFAN\_DELAY = FAN\_DELAY + EDFTM.

HSFAN\_DELAY should be > LSF\_RLY\_PRCT.

LSF\_RQST = 0 ---------------------------------|

|

HSF\_RQST = 0 ---------------------------------|

|AND -| FANTMR := 0

LSF\_FLG = 0 ----------------------------------| |

| |

HSF\_FLG = 0 ----------------------------------| |

| --- ELSE ---

|

| ;Increment FANTMR

16-13

ELECTRO-DRIVE FAN STRATEGY, EDF OUTPUT STATE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

16.1.4 FAN OUTPUT STATE MONITOR (CDAJ0)

OVERVIEW

This module documents the Output State Monitor for MLII Smart Output Drivers.

The status bits, EDF\_STATUS and HEDF\_STATUS should always be zero if there is

no fault present.

DEFINITIONS

INPUTS

Registers:

- P1474\_TMR = Time that EDF OSM fault has been present.

- P1479\_TMR = Time which HEDF OSM fault has been present.

- VBAT = Battery voltage.

Bit Flags:

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled.

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CCM\_TST\_ENA = OBDII Comprehensive Component test enable flag; 1 -> test.

- EDF\_STATUS = EDF Smart Output Driver fault status flag.

- HEDF\_STATUS = HEDF Smart Output Driver fault status flag.

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ELECTRO-DRIVE FAN STRATEGY, EDF OUTPUT STATE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration constants:

- EDFHP = Fan hardware present switch.

- HEDFHP = Two speed fan output present.

- VBAT\_CCM\_MIN = Minimum battery voltage to enable OSM testing.

- P1474\_TM\_LMT = Time that EDF OSM fault must be present before setting

code.

- P1479\_TM\_LMT = Time that HEDF OSM fault must be present before code is

set.

OUTPUTS

Others:

- P1474 = EDF OSM Malfunction code.

- P1479 = HEDF OSM Malfunction flag.

16-15

ELECTRO-DRIVE FAN STRATEGY, EDF OUTPUT STATE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EDF\_OSM\_COM1

VBAT < VBAT\_CCM\_MIN --------------|

|

CCM\_TST\_ENA = 0 ------------| |OR --|

| | | NO ACTION

CCM\_EO\_ENA = 0 -------------|AND -| | ;Do not perform OSM

| | ;tests.

CCM\_ER\_ENA = 0 -------------| |

| --- ELSE ---

|

| ;Perform OSM tests where

| ;hardware present

| DO: EDF\_TESTS

| DO: HEDF\_TESTS

BEGIN: EDF\_TESTS

EDFHP = 0 ------------------------|

|OR --| P1474\_TMR := 0

EDF\_STATUS = 0 -------------------| | DO: Clear\_malf (P1474)

| ;Correct state, clear

| ;error code

|

| --- ELSE ---

|

P1474\_TMR > P1474\_TM\_LMT ---------------| DO: Store\_code (P1474)

;Fault present long enough |

| --- ELSE ---

|

| ;Fault pending, allow

| ;free running timer

| ;to increment

END: EDF\_TESTS

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ELECTRO-DRIVE FAN STRATEGY, EDF OUTPUT STATE MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: HEDF\_TESTS

HEDFHP = 0 -----------------------|

|OR --| P1479\_TMR := 0

HEDF\_STATUS = 0 ------------------| | DO: Clear\_malf (P1479)

| ;No error present

| ;clear MALF flag

|

| --- ELSE ---

|

P1479\_TMR > P1479\_TM\_LMT ---------------| DO: Store\_code (P1479)

;Fault present long enough |

| --- ELSE ---

|

| ;Fault pending, allow

| ;free running error

| ;timer to increment

END: HEDF\_TESTS

16-17

VARIABLE SPEED FAN STRATEGY, A/C FAN CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

16.1.5 A/C FAN CONTROL (CDAL0)

OVERVIEW

When A/C is demanded and vehicle speed is low the fan is turned on to control

A/C head pressure. The fan speed is proportional to the filtered head

pressure plus a fast response term if the pressure increases quickly above

the filtered value.

At very high vehicle speeds the ram air effect allows the cooling fan to be

turned off with no decrease in cooling performance. As a failsafe, if the

pressure is too high this feature is not allowed.

DEFINITIONS

Registers:

- ACIOTMR = A/C OFF delay timer, for ISC.

- ACPRES = A/C Head pressure.

- ACPRESBAR = Filtered head pressure for fast rise control, level.

- VSBAR = Filtered Vehicle Speed, MPH.

- VSF\_AC = VSF requested by A/C.

- VSF\_DPDT = Fast rise pressure term for A/C fan control.

Bit Flags:

- VSF\_AC\_FLG = Flag indicating A/C fan demand.

- VSF\_VS\_FLG = Flag indicating high vehicle speed to disable fan.

Calibration Constants:

- AC\_MN\_FT = Minimum time to run low speed EDF after A/C clutch is

disengaged, sec.

- FN641(ACPRESBAR) = Proportional fan speed fraction vs Head pressure,

level.

- FN641F(VSF\_DPDT) = Fast pressure rise adder, level.

- TCVSFPRES = Time constant for fast pressure rise adder.

- VSF\_PRES\_CL = Pressure below which vehicle speed turn off is enabled.

- VSF\_PRES\_SH = Pressure constraint on vehicle speed turn off, PSI.

- VSF\_VS\_CL = Vehicle Speed to return to normal fan control, MPH.

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VARIABLE SPEED FAN STRATEGY, A/C FAN CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- VSF\_VS\_SH = Vehicle Speed to turn off fan during A/C operation, MPH.

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VARIABLE SPEED FAN STRATEGY, A/C FAN CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EDF\_VSF\_AC\_COM1

VSBAR > VSF\_VS\_SH -------------|

|AND -|S Q -| VSF\_VS\_FLG

ACPRES < VSF\_PRES\_SH ----------| |

|

ACPRES > VSF\_PRES\_CL ----------| |

|OR --|C

VSBAR < VSF\_VS\_CL -------------|

ACRQST = 1 --------------------------|S Q -| VSF\_AC\_FLG

|

ACIOTMR > AC\_MN\_FT ------------------|C

ACPRESBAR = ROLAV(ACPRES,TCVSFPRES)

VSF\_DPDT = ACPRES - ACPRESBAR

VSF\_VS\_FLG = 1 ----------------------|

|OR --| VSF\_AC := 0

VSF\_AC\_FLG = 0 ----------------------| | ;no A/C fan required

|

| --- ELSE ---

|

| VSF\_AC := FN641(ACPRESBAR)

| + FN641F(VSF\_DPDT)

16-20

VARIABLE SPEED FAN STRATEGY, ECT FAN CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

16.1.6 ECT FAN CONTROL (CDAL0)

OVERVIEW

Shown below is the logic for the control of the engine coolant temperature

around a set point, VSF\_DESECT. FN642(ect\_error) provides proportional

control for fast response during engine overtemp conditions until the slower

integral term responds to the error. vsf\_i is initially calculated from the

last pass value of VSF\_I; then, if vsf\_i is less than the clip, it becomes

the new value.

DEFINITIONS

Registers:

- BG\_TMR = Background Time, sec.

- ECT = Engine Coolant Temperature, deg F.

- VSF\_I = Last pass value of ECT integrator, level.

Bit flags:

- CFMFLG = ECT failure mode flag; 1 -> Failure mode set.

Calibration Constants:

- FN642(ect\_error) = Proportional fan speed fraction adder for ECT, level.

- VSF\_DESECT = Desired ECT control point, deg F.

- VSF\_IK = Gain term for ect\_error integrator, level / ECT \* sec.

- VSF\_IMAX = Maximum value for integrator, Level (0-31).

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VARIABLE SPEED FAN STRATEGY, ECT FAN CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EDF\_VSF\_ECT\_COM1

ect\_error := ECT - VSF\_DESECT

vsf\_i := VSF\_I + [ect\_error \* VSF\_IK \* BG\_TMR]

When the integrator reaches full output its value is frozen until the

temperature drops below the set point. This keeps the integrator from

increasing when it is no longer in control.

vsf\_i > VSF\_IMAX ------------------| VSF\_I := VSF\_IMAX

|

| --- ELSE ----

|

vsf\_i < 0 -------------------------| VSF\_I := 0

|

| --- ELSE ----

|

| VSF\_I := vsf\_i

The final value for ECT control adds the proportional and integral terms and

checks for a good ECT Sensor:

CFMFLG = 1 ------------------------| vsf\_ect := 31

|

| --- ELSE ----

|

| vsf\_ect := FN642(ect\_error) + VSF\_I

16-22

VARIABLE SPEED FAN STRATEGY, FINAL FAN DELIVERY - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

16.1.7 FINAL FAN DELIVERY (CDAL0)

OVERVIEW

Using the VLCM module the fan voltage can be varied to control the fan RPM.

This allows closer control of ECT and A/C head pressure to their respective

desired values. EEC determines the desired fan operation level (a value from

0 to 31, proportional to voltage). This value is then communicated to the

VLCM.

The final value for VSF\_RQST\_SPD is determined by chosing the higher value of

A/C demanded speed, engine coolant temperature determined fan speed or a

value requested by Selftest, when applicable.

DEFINITIONS

Registers:

- BG\_TMR = Background Time, sec.

- DEMAND\_MODE = Flag set when an on-demand self test mode is active.

- VSF = Last pass value of VSF, level.

- VSF\_AC = VSF requested by AC, speed no.

- VSF\_RQST\_SPD = VSF requested speed.

- VSF\_WORD = VSF, increased resolution.

Bit Flags:

- CRKFLG = Engine Mode Flag; 1 -> Crank Mode, 0 <> Crank Mode.

- VSF\_MIN\_FLG = Flag indicating VSF level is greater than the minimum

required for the fan to turn.

Calibration Constants:

- FN649(VSF) = Maximum allowable rate of VSF rise, steps/sec.

- VSF\_DECAY = Desired turn off rate, level/sec.

- VSF\_MIN\_CL = Fan turn off point because of level below minimum, level.

- VSF\_MIN\_SH = Minimum required for the fan to begin turning, level.

- VSF\_RUNNING = VSF level for Key On Engine Running.

16-23

VARIABLE SPEED FAN STRATEGY, FINAL FAN DELIVERY - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EDF\_VSF\_FINAL\_COM1

VSF\_RQST\_SPD requirements can come from engine coolant temperature, A/C or

VSF\_RUNNING. This block selects the highest value for fan control.

CRKFLG = 1 --------------------------| vsf2 = 0

(in Crank) |

| --- ELSE ---

vsf\_ect > VSF\_AC --------------| |

|AND -| vsf2 = vsf\_ect

vsf\_ect > VSF\_RUNNING ---| | |

|OR --| |

DEMAND\_MODE = 0 ---------| |

| --- ELSE ---

VSF\_AC >= vsf\_ect -------------| |

|AND -| vsf2 = VSF\_AC

VSF\_AC > VSF\_RUNNING ----| | |

|OR --| |

DEMAND\_MODE = 0 ---------| |

| --- ELSE ---

|

| vsf2 = VSF\_RUNNING

Because the fan will not begin turning below a certain voltage level, the EEC

will not turn on until the fan level reaches VSF\_MIN\_SH, and will turn the

fan off when the level fall below VSF\_MIN\_CL.

vsf2 > VSF\_MIN\_SH -------------|S Q -| VSF\_MIN\_FLG

|

vsf2 < VSF\_MIN\_CL -------------|C

VSF\_MIN\_FLG = 1 ---------------------| no change to vsf2

|

| --- ELSE ---

|

| vsf2 = 0

16-24

VARIABLE SPEED FAN STRATEGY, FINAL FAN DELIVERY - CDAN2

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The logic show below provides for soft turn on/off. Separate rising and

falling rates are provided for differing on and off requirements. The rising

rate is a function of the current fan speed (VSF) to give a non-linear ramp

rate. This section uses the last pass value of VSF to determine the new

rate.

vsf2 - VSF\_WORD

---------------- > FN649(VSF) -------| vsf1 = FN649(VSF) \* BG\_TMR + VSF\_WORD

BG\_TMR |

| --- ELSE ---

VSF\_WORD - vsf2 |

---------------- > VSF\_DECAY --------| vsf1 = VSF\_WORD - VSF\_DECAY \* BG\_TMR

BG\_TMR |

| --- ELSE ---

|

| vsf1 = vsf2

Because the proportional and integral terms can total more or less than the

allowable limits the final value is must be clipped so a valid value is

delivered.

vsf1 > 31 ---------------------------| VSF\_RQST\_SPD = 31

|

| --- ELSE ---

|

vsf1 < 0 ----------------------------| VSF\_RQST\_SPD = 0

|

| --- ELSE ---

|

| VSF\_RQST\_SPD = vsf1

16-25

VARIABLE SPEED FAN STRATEGY, VLCM OUTPUT SIGNAL PROCESSING - CDAN2

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16.1.8 VLCM OUTPUT SIGNAL PROCESSING (CDAL0)

OVERVIEW

The purpose of this module is to provide a value of VSF for output to the

VLCM, and other parts of the strategy. In the case where this signal is

transferred via SCP link it checks on the requested value of Fan Speed,

VSF\_RQST\_SPD, and the status of the link, to determine what the actual Fan

Speed will be. Note that the two FMEM values, VSF\_FMEM1 and 2, should be

calibrated to be equal to those that the VLCM will generate by default if

there is a fault in the link.

DEFINITIONS

Registers:

- VSF = Variable speed fan level.

- VSF\_RQST\_SPD = VSF requested speed.

- VSF\_WORD = VSF, increased resolution.

Bit flags:

- ACRQST = A/C Requested; 1 -> request.

- FANSCP\_FMFLG = Flag indicating that the engine coolant fan status

messages are overdue (SCP link failure)

Calibration Constants:

- VSF\_FMEM1 = VSF FMEM speed for A/C off.

- VSF\_FMEM2 = VSF FMEM speed for A/C on.

- VSFOP\_HP = VSF output hardware present; 1 -> Hardware present.

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VARIABLE SPEED FAN STRATEGY, VLCM OUTPUT SIGNAL PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EDF\_VSF\_OUTPUT\_COM2

VSFOP\_HP = 0 --------------------------|

;no VSF Output hardware | VSF\_WORD := 0

|

| --- ELSE ---

FANSCP\_FMFLG = 1 ----------------| |

;Comms link down |AND -| VSF\_WORD := VSF\_FMEM1

| |

ACRQST = 0 ----------------------| |

;AC off |

| --- ELSE ---

FANSCP\_FMFLG = 1 ----------------| |

;Comms link down |AND -| VSF\_WORD := VSF\_FMEM2

| |

ACRQST = 1 ----------------------| |

;AC on |

| --- ELSE ---

|

| VSF\_WORD := VSF\_RQST\_SPD

always---------------------------------| VSF := VSF\_WORD

16-27

ENGINE COOLANT FAN OUTPUT STATUS TEST, VLCM FAULT CODE PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

16.1.9 ENGINE COOLANT FAN OUTPUT STATUS TEST (CDAN0)

OVERVIEW

This module decodes the engine coolant fan output status information sent to

the EEEC from the VLCM via SCP. Fault bits SCP\_FAN\_xxx are set by the SCP

module and are used to set the appropriate malfunction codes. Fault

filtering is done using timers which increment when the fault is present.

When the timer exceeds a calibrated level the malfunction code is set.

DEFINITIONS

Registers:

- FAN\_ER\_TMR1 = Engine coolant fan fault timer for fault P1484

- FAN\_ER\_TMR2 = Engine coolant fan fault timer for fault P1625

- FAN\_ER\_TMR3 = Engine coolant fan fault timer for fault P1473

- FAN\_ER\_TMR4 = Engine coolant fan fault timer for fault P1483

- VBAT = Battery voltage, volts.

Bit Flags:

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled.

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag; 1 ->

enabled.

- CCM\_TST\_SW = CCM test present calibration switch; 1 -> test present.

- FANSCP\_FMFLG = Flag indicating that the Engine fan status messages are

overdue (SCP link failure).

- OBDII\_RESET = Flag used to signal an OBDII reset.

- SCP\_FAN\_GND = Engine coolant fan circuit shorted to ground; 0 -> Not

shorted, 1 -> Shorted.

- SCP\_FAN\_ON = Engine coolant fan output state; 0 -> Off, 1 -> On.

- SCP\_FAN\_OPEN = Engine coolant fan circuit open; 0 -> Not open, 1 -> Open.

- SCP\_FAN\_PGND = Engine coolant fan circuit open power ground; 0 -> Not

open, 1 -> Open.

- SCP\_FAN\_OVB = Engine coolant fan circuit open Vbatt to output; 0 -> Not

open, 1 -> Open.

16-28

ENGINE COOLANT FAN OUTPUT STATUS TEST, VLCM FAULT CODE PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- FAN\_ER\_TM1 = Time delay for fan fault P1484

- FAN\_ER\_TM2 = Time delay for fan fault P1625

- FAN\_ER\_TM3 = Time delay for fan fault P1473

- FAN\_ER\_TM4 = Time delay for fan fault P1483

- VBAT\_CCM\_MIN = Minimum voltage to perform CCM testing.

- VLCM\_HP = VLCM hardware present switch; 1 -> VLCM present.

Other:

- P1473 = Fan secondary high with fan(s) off.

- P1483 = Power to fan circuit overcurrent.

- P1484 = Open power GND to VLCM.

- P1625 = B(+) supply to VLCM fan circuit failure.

16-29

ENGINE COOLANT FAN OUTPUT STATUS TEST, VLCM FAULT CODE PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FAN\_VLCM\_TST\_COM1

CCM\_EO\_ENA = 1 -------------|

; Engine OFF CCM enabled |

|

CCM\_ER\_ENA = 1 -------------|OR --|

; Engine ON CCM enabled | |

| |

CCM\_TST\_ENA = 1 ------------| |

; Continuous CCM enabled |

|AND -| Do: FAN\_VLCM\_FAULTS

CCM\_TST\_SW = 1 -------------------| | Do: SET\_FAN\_VLCM\_CODES

; CCM test required | |

| | ;Carry out VLCM testing

VBAT > VBAT\_CCM\_MIN --------------| |

; Battery voltage sufficient | |

| |

OBDII\_RESET = 0 ------------------| |

; Not a reset | |

| |

FANSCP\_FMFLG = 0 -----------------| |

; SCP link OK | |

| | --- ELSE ---

VLCM\_HP = 1 ----------------------| |

; hardware present | Clear\_malf(P1484)

| Clear\_malf(P1625)

| Clear\_malf(P1473)

| Clear\_malf(P1483)

|

| ; Hold timers to Zero

|

| FAN\_ER\_TMR1 := 0

| FAN\_ER\_TMR2 := 0

| FAN\_ER\_TMR3 := 0

| FAN\_ER\_TMR4 := 0

16-30

ENGINE COOLANT FAN OUTPUT STATUS TEST, VLCM FAULT CODE PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FAN\_VLCM\_FAULTS

SCP\_FAN\_ON = 1 -------------------|

; Coolant fan ON |

|

SCP\_FAN\_OPEN = 0 -----------------|

; Fan circuit not open |

|AND -| ;VLCM message L, DTC 1484

SCP\_FAN\_GND = 0 ------------------| | ;Allow FAN\_ER\_TMR1 to inc

; Fan circuit not shorted to Gnd | |

| | FAN\_ER\_TMR2 := 0

SCP\_FAN\_PGND = 1 -----------------| | FAN\_ER\_TMR3 := 0

; Fan circuit open power ground | | FAN\_ER\_TMR4 := 0

| |

SCP\_FAN\_OVB = 0 ------------------| |

; Fan circuit not open VBAT to output |

|

| --- ELSE ---

SCP\_FAN\_ON = 1 -------------------| |

; Coolant fan ON | |

| |

SCP\_FAN\_OPEN = 0 -----------------| |

; Fan circuit not open | |

|AND -| ;VLCM message M, DTC 1625

SCP\_FAN\_GND = 0 ------------------| | ;Allow FAN\_ER\_TMR2 to inc

; Fan circuit not shorted to Gnd | |

| | FAN\_ER\_TMR1 := 0

SCP\_FAN\_PGND = 0 -----------------| | FAN\_ER\_TMR3 := 0

; Fan circuit not open power Gnd | | FAN\_ER\_TMR4 := 0

| |

SCP\_FAN\_OVB = 1 ------------------| |

; Fan circuit open VBAT to output |

|

| --- ELSE ---

SCP\_FAN\_ON = 0 -------------------| |

; Coolant fan Off | |

| |

SCP\_FAN\_OPEN = 1 -----------------| |

; Fan circuit open | |

|AND -| ;VLCM message N, DTC 1473

SCP\_FAN\_GND = 0 ------------------| | ;Allow FAN\_ER\_TMR3 to inc

; Fan circuit not shorted to Gnd | |

| | FAN\_ER\_TMR1 := 0

SCP\_FAN\_PGND = 0 -----------------| | FAN\_ER\_TMR2 := 0

; Fan circuit not open power Gnd | | FAN\_ER\_TMR4 := 0

| |

SCP\_FAN\_OVB = 0 ------------------| |

; circuit not open VBAT to output | |

| |

CCM\_EO\_ENA = 1 -------------------| |

; Code 1473 in KOEO mode only |

(Continued on next page)

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ENGINE COOLANT FAN OUTPUT STATUS TEST, VLCM FAULT CODE PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(Continued from previous page)

| --- ELSE ---

SCP\_FAN\_ON = 1 -------------------| |

; Coolant fan ON | |

| |

SCP\_FAN\_OPEN = 0 -----------------| |

; Fan circuit not open | |

|AND -| ;VLCM message O, DTC 1483

SCP\_FAN\_GND = 1 ------------------| | ;Allow FAN\_ER\_TMR4 to inc

; Fan circuit shorted to Gnd | |

| | FAN\_ER\_TMR1 := 0

SCP\_FAN\_PGND = 0 -----------------| | FAN\_ER\_TMR2 := 0

; Fan circuit not open power Gnd | | FAN\_ER\_TMR3 := 0

| |

SCP\_FAN\_OVB = 0 ------------------| |

; Fan circuit not open VBAT to output |

|

| --- ELSE ---

|

| ; No errors hold timers

| ; to zero

| FAN\_ER\_TMR1 := 0

| FAN\_ER\_TMR2 := 0

| FAN\_ER\_TMR3 := 0

| FAN\_ER\_TMR4 := 0

END: FAN\_VLCM\_FAULTS

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ENGINE COOLANT FAN OUTPUT STATUS TEST, VLCM FAULT CODE PROCESSING - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: SET\_FAN\_VLCM\_CODES

FAN\_ER\_TMR1 > FAN\_ER\_TM1 ---------| Do: Store\_code(P1484)

; VLCM message L present | ; Fault L

; long enough | Do: Clear\_malf(P1625)

| Do: Clear\_malf(P1473)

| Do: Clear\_malf(P1483)

|

| --- ELSE ---

FAN\_ER\_TMR2 > FAN\_ER\_TM2 ---------| Do: Store\_code(P1625)

; VLCM message M present | ; Fault M

; long enough | Do: Clear\_malf(P1484)

| Do: Clear\_malf(P1473)

| Do: Clear\_malf(P1483)

|

| --- ELSE ---

FAN\_ER\_TMR3 > FAN\_ER\_TM3 ---------| Do: Store\_code(P1473)

; VLCM message N present | ; Fault N

; long enough | Do: Clear\_malf(P1484)

| Do: Clear\_malf(P1625)

| Do: Clear\_malf(P1483)

|

| --- ELSE ---

FAN\_ER\_TMR4 > FAN\_ER\_TM4 ---------| Do: Store\_code(P1483)

; VLCM message O present | ; Fault O

; long enough | Do: Clear\_malf(P1484)

| Do: Clear\_malf(P1625)

| Do: Clear\_malf(P1473)

|

| --- ELSE ---

|

| ; No errors yet, clear

| ; all codes

|

| Do: Clear\_malf(P1484)

| Do: Clear\_malf(P1625)

| Do: Clear\_malf(P1473)

| Do: Clear\_malf(P1483)

END: SET\_FAN\_VLCM\_CODES

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ELECTRO-DRIVE FAN STRATEGY, ELECTRO-DRIVE FAN OUTPUT STRATEGY - CDAN2

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16.2 ELECTRO-DRIVE FAN OUTPUT STRATEGY (CDAN0)

OVERVIEW

This module is responsible for writing to the output locations for EDF and

HEDF.

DEFINITIONS

INPUTS

Bit Flags:

- HSF\_FLG = Flag indicating the status of the High Speed Fan.

- LSF\_FLG = Flag indicating the status of the Low Speed Fan.

Calibration Constants:

- EDFHP = Fan hardware present switch.

- HEDFHP = Two speed fan output present.

- LSF\_INVRT\_HP = LSF Inverting Output Hardware Present.

OUTPUTS

Bit Flags:

- EDF\_STATUS = EDF Smart Output Driver Fault Status.

- HEDF\_STATUS = HEDF Smart Output Driver Fault Status.

- EDF = Flag for low-speed Electro-Drive Fan output pin bit.

- HEDF = Flag for High-speed Electro-Drive Fan output pin bit.

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ELECTRO-DRIVE FAN STRATEGY, ELECTRO-DRIVE FAN OUTPUT STRATEGY - CDAN2

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PROCESS

STRATEGY MODULE: EDF\_OUTPUT\_COM1

EDFHP = 0 ------------------------------| do nothing

|

| --- ELSE ---

LSF\_FLG = 1 ----------------| |

;fan on |AND -| |

| | |

LSF\_INVRT\_HP = 1 -----------| | |

;inverting output |OR --| EDF := 0

| | EDF\_STATUS := output(EDF)

LSF\_FLG = 0 ----------------| | |

;fan off |AND -| |

| |

LSF\_INVRT\_HP = 0 -----------| |

;non-inverting output |

| --- ELSE ---

|

| EDF := 1

| EDF\_STATUS := output(EDF)

HEDFHP = 0 -----------------------------| do nothing

|

| --- ELSE ---

|

HSF\_FLG = 1 ----------------------------| HEDF := 1

| HEDF\_STATUS := output(HEDF)

|

| --- ELSE ---

|

| HEDF := 0

| HEDF\_STATUS := output(HEDF)

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ELECTRO-DRIVE FAN STRATEGY, ELECTRO-DRIVE FAN OUTPUT STRATEGY - CDAN2

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CHAPTER 17

THERMACTOR AIR STRATEGY

17-1

THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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17.1 EAM AND OUTPUT STATE MONITOR CIRCUIT (MID LINE 2) (CDAN2)

OVERVIEW

Normal Operation:

The Electric Air Management (EAM) strategy controls an On/Off electric air

pump. The purpose of EAM is to control emissions during the first 20 to 120

seconds of engine operation. By forcing excess air into the exhaust

manifold, Hydocarbons and Carbon Monoxide created by running rich after start

are oxidized. This reaction will only occur when temperatures are hot enough

at the exhaust port to start the reaction, so it may be desirable to delay

pump turn on for a few seconds until the reaction temperature is reached.

The pump is typically kept on until the catalyst is lit-off and can oxidize

and reduce at stoic without excess air.

At extremely hot engine and ACT it may be necessary to force open loop. In

addition, upstream air will force open loop due to its effect on the HEGO

sensor. The Thermactor logic commands open loop during these conditions via

the CHKAIR flag.

Self-Test:

The Self-Test for the EAM systems uses the messages sent by the output driver

(SSPOD, etc.) to diagnose problems with the primary circuit, an EAM Monitor

(EAMM) to diagnose problems with the secondary circuit, and a check to detect

if some secondary air flow is detectable when the pump is on.

The EAM Monitor (EAMM) (with an internal pull up) should be held low by the

low resistance path through the air pump motor when the pump is turned off.

If it is high, there is either an open circuit between the EAMM input to the

EEC and the pump motor ground, or there is power being supplied to the pump.

This failure will force open loop fuel operation for catalyst protection. If

the EAMM is low when the pump is commanded on, there is either an open

circuit between the battery and the EAMM connection to the circuit or the

relay has failed to close and supply power.

This flow test is enabled by the OBD-II diagnostic executive after it is

determined that the HEGOs are functional and the engine is in closed loop

idle speed control. This flow test is unable to detect a particular flow

rate or a pump that is on when it should be off. It is intended to determine

if some flow can be detected when the pump is on. This is done by assuming

that if the HEGO sensor is not stuck rich for an extended period of time,

there must be some secondary air available to make it switch lean. It should

be noted that even if adequate secondary air is available to make the

aggregate air fuel ratio in the exhaust lean, the EGO sensor may not

consistently provide a lean indication.

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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Engine Off On-Demand testing:

During the Key On Engine Off Self-Test, the sequencer controls the flags

OSM\_EO\_ON and OSM\_EO\_OFF to signal the EAM system to command the output on

and off. The state of the EAMM circuit is checked along with diagnostic

messages from the output driver to determine if there is an electrical fault.

Engine Running On-Demand testing:

During the Key On Engine Running Self-Test, the sequencer sets the parameter

ER\_STATUS is set to SAIR\_ER\_INIT to indicate to the EAM system that it is

time to initiate the engine running test. This test first ramps the fuel to

achieve a slightly rich condition. Then, the air pump is commanded on. With

the pump on, the EAMM monitor and output driver are checked, and the HEGOs

are monitored to see if flow can be detected (via normal continuous test

logic). After testing with the pump on is complete, the pump is turned off

and again, the driver and EAMM monitor are checked. Note that as the test

moves through the sequence, DEMAND\_STATE is modified to point to the current

logic in use, and when the test is complete ER\_STATUS is set to SAIR\_ER\_DONE

to indicate to the sequencer that the EAM test is complete.

\*\*\*\*\*\*\*\*\*\*\*\*

..\*.. \* g

B+ \*\*\*\*\*\*\*\*x\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*x\*\*\* ..\*.. \* r

\* \* \* .. \* .. ----- o

...\*... .....\*..\*.... . PUMP . --- u

CHECK ! ) ! ! ) \* ! .. \* .. - n

VALVE ! ( ! RELAY ! ( | ! ..\*.. d

+ ! ) ! ! ) \* | ! ..\*..

SOLENOID ! ( ! ! ( \* ! \*

!..\*..! !....\*..\*...! \*

\* \* \*\*\*\*\*\*\*\*x\*\*\*\*\*\*\*

\* \* \*

\* \* \*

\*\*x\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* \*

\* \*

\* \*

......\*...............................\*.......................

! \* \* !

! driver \* !

! (SSPOD ect.) EAMM !

!(with diagnostics) (Digital input, !

! \* Pulled up) !

! ----- ECU !

! --- (EEC-IV) !

!.....-......................................................!

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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DEFINITIONS

Registers:

- ACT = Air Charge Temperature, deg F.

- ATMR1 = Time since Engine Startup, sec.

- BIAS\_G1 = Closed loop fuel bias for bank 1.

- BIAS\_G2 = Closed loop fuel bias for bank 2.

- DEMAND\_STATE = Utility state pinter that is used by on demand OBDII

tests.

- DEMAND\_TIMER = VIP state timer.

- EAM\_ANTP\_TMR = Used to time the delay in air pump activation to allow

idle speed load anticipation, seconds.

- EAMM\_TST\_TMR = Consecutive amount of time that EAMM has no errors,

seconds.

- ECT = Engine Coolant Temperature, deg F.

- ER\_EAM\_LEAN = LAMBSE at which EGOS switched lean during EAM test.

- ER\_LAM\_DSD1 = LAMBSE1 value requested by engine running on-demand test.

- ER\_LAM\_DSD2 = LAMBSE2 value requested by engine running on-demand test.

- ER\_RPM = Register that contains RPM value requested during engine running

self test.

- ER\_STATUS = State pointer that indicates current state of engine running

on demand test.

| - INFAMB\_KAM = Inferred ambient air temperature, used to initialize the

| cat. temp. model.

- ISCFLG = Mode indicator flag.

- j1979\_01\_12 = Bitmap of commanded status of secondary air system. Bit 2

set when air is dumped / off, Bit 1 is set for Downstream air, Bit 0 is

set for Upstream air.

- LAMAVE1 = Average of LAMBSE1: averages the value of LAMBSE1 at the

current EGO-1 switch and last EGO-1 switch.

- LAMAVE2 = Average of LAMBSE2: averages the value of LAMBSE2 at the

current EGO-2 switch and last EGO-2 switch.

- LAMBSE1 = Desired A/F ratio for bank 1 injectors in equivalence units.

- LAMBSE2 = LAMBDA equivalence ratio (EGO-2).

- PG\_DC = Purge duty cycle.

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SAIR\_END\_FLG = Flag used to delay ending of SAIR test when test is

aborted because engine idle is exited.

- SAIR\_END\_TMR = Timer to delay the ending of the SAIR monitor, allow EAM

pump time to spin down.

- SAIR\_HLD\_TMR = Amount of time LAMBSE at SAIR\_REQV limit.

- SAIR\_LAM\_DSD = Required lambse value for continuous secondary air test.

- SAIR\_LN\_TMR = Time that both egos are lean in secondary air flow test.

- SAIR\_PRM\_TMR = Consecutive amount of time that EAM has no errors.

- SAIR\_RCH\_TMR = Time that both egos must be rich to start continuous flow

test.

- SAIR\_TMRK1 = KAM snapshot of SAIR\_LN\_TMR at completion of upstream

thermactor flow test, sec.

- SAIR\_TMRK2 = KAM snapshot of SAIR\_LN\_TMR at completion of downstream

thermactor flow test, sec.

- SUBST\_REQ1 = Substitution Requested flag for channel 1.

- TCSTRT = Engine coolant temperature at startup, deg F.

- USPD\_RUN\_TMR = Time in underspeed or run mode, sec.

- V\_AP\_TSTTMR = Time limit for Air pump hot retest, sec.

- V\_EAMM\_TMR = Time that EAM monitor (EAMM) error.

- V\_THERM\_TMR = Time EAM circuit failure error detected.

- VEGO11 = Bank1 upstream HEGO voltage.

- VEGO11\_FIL1 = First order filtered value of bank1 upstream HEGO voltage.

- VEGO11\_FIL2 = Second order filtered value of bank1 upstream HEGO voltage.

- VEGO12\_FIL2 = Second order filtered value of bank1 downstream HEGO

voltage.

- VEGO21 = Bank2 upstream HEGO voltage.

- VEGO21\_FIL1 = First order filtered value of bank2 upstream HEGO voltage.

- VEGO21\_FIL2 = Second order filtered value of bank1 upstream HEGO voltage.

-

Bit Flags:

- CCM\_ER\_ENA = OBD-II Comprehensive Component Engine Running On Demand Test

enable flag; 1 -> test enabled.

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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- CCM\_TST\_ENA = OBD-II Comprehensive Component Continuous Test enable flag;

1 -> test enabled.

- CHKAIR = Thermactor forced open loop flag.

- DEMAND\_ABORT = Flag to indicate that the engine running on demand test is

in the process of an abort.

- EAM = Electric Air Management control flag, 1 -> Pump On.

- EAM\_ANTICIP = Requests additional idle air flow when air pump is on.

- EAM\_FAULT = Secondary Air Injection (AIR) output fault indicated.

- EAMM = State of EAM Monitor digital input. 1 -> high (pump on).

- EAM\_OLD = Last pass value of EAM.

- ER\_ACTIVE = Flag set when engine running on demand test is active.

- FFG\_SAIR = OBDII system FMEM flag for the sair system; 1 -> sair sytem is

not currently under control reliably.

- LN\_CTL\_FLG = Control actuator for SAIR\_LN\_TMR, 1 = increment timer.

- OBD\_PARM\_RST = OBDII paramter reset signal; 1-> reset parameters.

- OSM\_EO\_OFF = Off state requested for outputs during engine off on demand

test, 1 -> test off state.

- OSM\_EO\_ON = On state requested for outputs during engine off test 1 ->

test on state.

- OVERTEMP\_FLG = Overtemp flag to force open loop and bypass air.

- PSPN\_FLWTST = Postpone continuous flow until next idle period.

- PxxxMALF = Malfunction flag for code PXXX: 1 -> a malfunction currently

exists for fault PXXX.

- SAIR\_END\_TM = Maximum time to delay ending of SAIR monitor test to wait

for EAM pump to spin down.

- SAIR\_EGO\_LN = A lean state has been seen on both egos in the secondary

air test.

- SAIR\_EGO\_RC = A rich state has been seen on both sego in the secondary

air test.

- SAIR\_ER\_NOW = Indicates that engine running on demand secondary air test

is in progress.

- SAIR\_MON = OBD-II Monitor flag for secondary air: 1 -> all secondary air

faults have been monitored at least once since powerup.

- SAIR\_OFF\_MON = Secondary air EAMM off state monitored.

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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- SAIR\_ON\_MON = Secondary air on state monitored.

- SAIR\_PRM\_FLG = SAIR KOER primary circuit test complete flag, 1 =

complete.

- SAIR\_TST\_ENA = EAM flow test enabled by OBD-II diagnostic monitor.

- SAIR\_TST\_RDY = Secondary air test ready flag. 1 => local condition to

test have been met; ready to run test.

Calibration Constants:

- ATBYS = Minimum ACT to Bypass thermactor Air, deg F.

- ATBYS\_CL = ACT to reset (clear) Overtemp condition, deg F.

- CTBYS = ECT to set overtemp condition, deg F.

- CTBYS\_CL = ECT to reset (clear) Overtemp condition, deg F.

- EAM\_ANTP\_DLY = Time delay to allow idle speed load compensation before

activating the air pump.

- EAM\_LAM\_DEL = Delta LAMAVE to allow air pump hot retest.

- EAMM\_TST\_TM = Minimum amount of time EAMM must have no errors to pass,

sec.

- ER\_DELTA\_RPM = DELTA RPM TO RAMP SAIR\_ER\_RPM DURING SECOND AIR KOER TEST.

- ER\_LAM\_BAS = Base value for LAMBSE requested during engine running

on-demand test.

- FN606(TCSTRT) = Time to delay upstream air after startup, sec.

- FN607(TCSTRT) = Time to provide upstream air after start, sec.

- LEQV = Lean limit for LAMBDA units.

- NUMEGO = Number of HEGOs in the system.

- REQV = Rich limit for LAMBDA units are LAMBDAS.

| - SAIR\_AMB\_MIN = Minimum ambient temperature to disable setting SAIR fault

| codes because of component freezing.

- SAIR\_DLAM = Delta LAMBSE value used to ramp fuel rich in continuous

second air test.

- SAIR\_EGO\_LVL = Voltage on EGO sensor indicating lean/rich boundry.

- SAIR\_ER\_DONE = Value for state of ER\_STATUS to indicate that the engine

running secondary air test is complete.

- SAIR\_ER\_INIT = Value for state of ER\_STATUS to request the engine running

secondary air test.

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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- SAIR\_ER\_RPM = Engine RPM to be used during secondary air KOER test.

- SAIR\_HOLD\_TM = Maximum amount of time to hold LAMBSE at SAIR\_REQV before

exiting continuous second air test.

- SAIR\_LAM\_DEL = Delta LAMBSE for secondary air pump test.

- SAIR\_LEQV = Leanest allowable LAMBSE value to start continuous flow test.

- SAIR\_LN\_TM = Total amount of time that both egos must be lean to pass

thermactor flow test.

- SAIR\_PG\_MIN = Minimum purge duty cycle to start continuous flow test.

- SAIR\_PRM\_TM = Minimum amount of time primary circuit must have no errors

to pass.

- SAIR\_RAMP\_TM = Time for hegos to detect switch in fuel initialization.

- SAIR\_RCH\_TM = Minimum amount of time EGOs must be rich to start

continuous flow test.

- SAIR\_REQV = Richest allowable LAMBSE value to conduct continuous flow

test.

- SAIR\_STB\_TM = Minimum time to wait to run secondary air monitor.

- SAIR\_VIPLR1 = Ramp rate for fuel lean.

- SAIR\_VIPRR1 = Ramp rate for fuel rich.

- TCVEGO\_SAIR = Filter constant for upstream hego voltages.

- TEMPFB = ECT at which closed loop fuel is allowed.

- THRMHP = Thermactor hardware present switch; 0 -> no thermactor.

- V\_AP\_TST\_TM = Time duration to allow hot retest of EAM system.

- V\_EAMM\_ENA = Switch to enable EAMM (Electric Air Management Monitor)

tests (KOEO, KOER and continuous).

- V\_EAMM\_TM = Minimum time with EAM monitor (EAMM secs).

- VIPLR1 = Rate of ramp lean units are LAMBDAS/sec.

- VIPRR1 = Ramp rate for fuel rich.

- V\_THERM\_TM = Time required to set code for EAM circuit failure.

OTHER

- malfunction(sair,Pxxx) = A public procedure for updating the MIL control

process provided by the MIL control module.

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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- sair\_codes = set of {P0412,P0411,P1413,P1414}

- P0411 = Secondary air not detected.

- P0412 = EAM primary circuit malfunction

- P1413 = EAM Monitor (EAMM) low with pump commanded on.

- P1414 = EAM Monitor (EAMM) high with pump commanded off.

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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PROCESS

STRATEGY MODULE: THERM\_EAM\_OBDII\_COM4

BEGIN: therm\_main

Execute the following process once per background pass.

Set up some parameter definitions to allow use of symbolic names.

unconditionally -------------------| sair\_koer\_primary\_test := 1

| sair\_koer\_fuel\_init := 2

| sair\_koer\_fuel\_done := 3

ECT, ACT overtemp flag to force open loop and bypass air.

ECT > CTBYS -----------|

|AND -|S Q -| OVERTEMP\_FLG

ACT > ATBYS -----------| |

|

ECT < CTBYS\_CL --------| |

|OR --|C

ACT < ATBYS\_CL --------|

Calculate second ordered filtered value of ego voltage for use in the flow

test.

SAIR\_TST\_RDY = 1 -|

|OR --|

ER\_STATUS = | |AND -| VEGO11\_FIL1 := rolav(VEGO11,TCVEGO\_SAIR)

SAIR\_ER\_INIT --| | | VEGO11\_FIL2 := rolav(VEGO11\_FIL1,TCVEGO\_SAIR)

| |

NUMEGO = 1 -------------| | VEGO21\_FIL2 := FFFFh

| VEGO12\_FIL2 := FFFFh

| ;fill to max value for mode 06 reporting

|

| --- ELSE ---

SAIR\_TST\_RDY = 1 -------| |

|OR --| VEGO11\_FIL1 := rolav(VEGO11,TCVEGO\_SAIR)

ER\_STATUS = | | VEGO11\_FIL2 := rolav(VEGO11\_FIL1,TCVEGO\_SAIR)

SAIR\_ER\_INIT --------| | VEGO21\_FIL1 := rolav(VEGO21,TCVEGO\_SAIR)

| VEGO21\_FIL2 := rolav(VEGO21\_FIL1,TCVEGO\_SAIR)

|

| VEGO12\_FIL2 := FFFFh

| ;fill to max value for mode 06 reporting

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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When an OBDII parameter reset is requested, clear all necessary parameters.

OBD\_PARM\_RST = 1 ------------| SAIR\_ON\_MON := 0

| SAIR\_OFF\_MON := 0

| PSPN\_FLWTST := 0

| SAIR\_ER\_NOW := 0

| V\_THERM\_TMR := 0

| V\_EAMM\_TMR := 0

| SAIR\_HLD\_TMR := 0

| SAIR\_FLWTST := 0

| LN\_CTL\_FLG := 0

| SAIR\_TST\_RDY := 0

| V\_AP\_TSTTMR := 0

| VEGO11\_FIL2 := 0

| VEGO21\_FIL2 := 0

| VEGO12\_FIL2 := FFFFh

| SAIR\_TMRK1 := 0

| SAIR\_TMRK2 := FFh

PSPN\_FLWTST = 1 -------------|

|AND -| PSPN\_FLWTST := 0

ISCFLG = 0 ------------------|

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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THRMHP = 0 ------------------------| Do: therm\_no\_hardware

| Exit therm\_main

|

| --- ELSE ---

|

ER\_STATUS = SAIR\_ER\_INIT ----------| Do: therm\_koer

|

| --- ELSE ---

|

EO\_STATUS = ECU\_EO\_DONE -----------| V\_EAMM\_TMR := 0

;on demand about to be requested | V\_THERM\_TMR := 0

| ;Clear EAM fault timers before KOEO

|

| --- ELSE ---

|

OSM\_EO\_ON = 1 ---------------------| eam := 1

;on demand on state requested | ;EAM engine off test

|

| --- ELSE ---

|

OSM\_EO\_OFF = 1 --------------------| eam := 0

;on demand off test requested | ;EAM KOEO test

|

| --- ELSE ---

|

| Do: therm\_normal

Perform Output State Control logic:

unconditionally -------------------| Do: substitute(1,eam)

| ;output state control override

| EAM := eam

If EAM state changes occurs, zero the fault timers.

EAM <> EAM\_OLD --------------------| V\_EAMM\_TMR := 0

| V\_THERM\_TMR := 0

| ;Clear fault timers

unconditionally -------------------| EAM\_OLD := EAM

| ;Save last pass value of EAM

ER\_STATUS = SAIR\_ER\_INIT ----|

|AND -| Do: therm\_koer\_circuit\_test

DEMAND\_STATE = | |

sair\_koer\_primary\_test ----| |

| --- ELSE ---

|

EAM = 1 ---------------------------| Do: therm\_primary\_test

| Do: therm\_commanded\_on\_test

|

| --- ELSE ---

|

| Do: therm\_primary\_test

| Do: therm\_commanded\_off\_test

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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The flags SAIR\_ON\_MON, and SAIR\_OFF\_MON are set when the pump on and off

tests have been completed (pass or fail). When they are all set the flag

SAIR\_MON is set to indicate that Thermactor monitoring has been completed for

this trip.

SAIR\_ON\_MON = 1 --------------|

;on test complete |

|

SAIR\_END\_TMR > SAIR\_END\_TM ---|AND -|

;delay ending of SAIR test | |

| |

SAIR\_OFF\_MON = 1 -------------| |

|OR --| SAIR\_MON := 1

P0412MALF = 1 ----------------| | | ;secondary air monitoring

| | | ; complete for this trip

P1413MALF = 1 ----------------|OR --|

|

P1414MALF = 1 ----------------|

;off test complete

BEGIN: therm\_pid\_definitions

EAM = 0 ---------------------------| pid\_def( j1979\_01\_12, 4)

| ;air off

|

| --- ELSE ---

|

| pid\_def( j1979\_01\_12, 1)

| ;air on

END: therm\_pid\_definitions

END: therm\_main

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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BEGIN: therm\_no\_hardware

Execute the following process only when called.

SUBST\_REQ1 = 1 --------------------| Do: OSC\_RESPONSE(1,10h)

| ;OSC requested but hardware not present

| ; send general reject.

ER\_STATUS = SAIR\_ER\_INIT ----------| ER\_STATUS := SAIR\_ER\_DONE

;engine running test in | Exit therm\_no\_hardware

; progress |

| --- ELSE ---

|

OVERTEMP\_FLG = 0 ------------------| CHKAIR := 1

;not overtemp allow closed loop | Exit therm\_no\_hardware

|

| --- ELSE ---

|

| CHKAIR := 0

| ;Overtemp, force open loop

| Exit therm\_no\_hardware

END: therm\_no\_hardware

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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BEGIN: therm\_koer

Execute the following process only when called.

SAIR\_ER\_NOW = 0 -------------------| DEMAND\_STATE := sair\_koer\_primary\_test

;test not started yet | ;clear all counters needed in KOER

|

| DEMAND\_TIMER := 0

| ;restart test timer

|

| LN\_CTL\_FLG := 0

| SAIR\_ON\_MON := 0

| SAIR\_OFF\_MON := 0

| ;Reset flags used to determine when

| ; test complete.

| SAIR\_EGO\_LN := 0

| SAIR\_EGO\_RC := 0

| SAIR\_LN\_TMR := 0

| ;flags used to set up fuel during on

| ; demand test fuel ramp

| SAIR\_PRM\_FLG := 0

| SAIR\_PRM\_TMR := 0

| EAMM\_TST\_TMR := 0

| V\_THERM\_TMR := 0

| V\_EAMM\_TMR := 0

|

| SAIR\_ER\_NOW := 1

| ;test in progress

|

| eam := 0

DEMAND\_ABORT = 1 ------------------| eam := 0

| ER\_STATUS := SAIR\_ER\_DONE

| ;signal executive that abort is

| ; complete

|

| --- ELSE ---

DEMAND\_STATE = |

sair\_koer\_primary\_test ----| |

|AND -|

DEMAND\_TIMER <= SAIR\_PRM\_TM -| | SAIR\_LN\_TMR := 0

| ER\_RPM := max(ER\_RPM - ER\_DELTA\_RPM,

| SAIR\_ER\_RPM)

|

| --- ELSE ---

DEMAND\_STATE = |

sair\_koer\_primary\_test ----| |

| |

SAIR\_PRM\_FLG = 0 ------------|AND -| malfunction(sair,P0412)

| | ER\_STATUS := SAIR\_ER\_DONE

EAMM = 1 --------------------| |

;Monitor indicates pump on | FFG\_SAIR := 1

|

| --- ELSE ---

(continued on next page)

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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(continued from previous page)

DEMAND\_STATE = |

sair\_koer\_primary\_test ----| |

|AND -| malfunction(sair,P0412)

SAIR\_PRM\_FLG = 0 ------------| | ER\_STATUS := SAIR\_ER\_DONE

|

|

| --- ELSE ---

DEMAND\_STATE = |

sair\_koer\_primary\_test ----------| malfunction(sair,P1414)

| ER\_STATUS := SAIR\_ER\_DONE

|

| --- ELSE ---

DEMAND\_STATE = |

sair\_koer\_fuel\_init -------------| Do: therm\_fuel\_init

| ;ramp each side lean until the HEGO

| ; switches, then ramp fuel until

| ; slightly rich.

| ;DEMAND\_STATE will then be

| ; incremented to sair\_koer\_fuel\_done

|

| --- ELSE ---

DEMAND\_STATE = |

sair\_koer\_fuel\_done -------| |

|AND -| EAM\_ANTICIP := 1

EAM\_ANTICIP = 0 -------------| | EAM\_ANTP\_TMR := 0

|

| --- ELSE ---

DEMAND\_STATE = |

sair\_koer\_fuel\_done -------| |

|AND -| ;wait for idle speed compensation

EAM\_ANTP\_TMR < EAM\_ANTP\_DLY -| |

| --- ELSE ---

DEMAND\_STATE = |

sair\_koer\_fuel\_done -------| |

| |

SAIR\_ON\_MON = 0 -------------|AND -| ;EAM Engine Running test

| | eam := 1

EAM := 0 --------------------| | SAIR\_PRM\_TMR := 0

| V\_THERM\_TMR := 0

| SAIR\_PRM\_FLG := 0

| V\_EAMM\_TMR := 0

| EAMM\_TST\_TMR := 0

| V\_AP\_TSTTMR := 0

| Do: therm\_flow\_test

| ;Test EAMM and check for flow

|

| --- ELSE ---

DEMAND\_STATE = |

sair\_koer\_fuel\_done -------| |

|AND -| ;EAM Engine Running test

SAIR\_ON\_MON = 0 -------------| | Do: therm\_flow\_test

;monitor not complete |

| --- ELSE ---

(continued on next page)

17-16

THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

DEMAND\_STATE = |

sair\_koer\_fuel\_done -------| |

| |

SAIR\_ON\_MON = 1 -------------|AND -| ER\_STATUS := SAIR\_ER\_DONE

| | ;signal executive that

SAIR\_OFF\_MON = 1 ------------| | ; koer thermactor test is complete

ER\_STATUS = SAIR\_ER\_DONE ----------| SAIR\_ER\_NOW := 0

| ER\_LAM\_DSD1 := ER\_LAM\_BAS

| ER\_LAM\_DSD2 := ER\_LAM\_DSD1

END: therm\_koer

17-17

THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: therm\_normal

Execute the following process only when called.

OVERTEMP\_FLG = 1 -----------------|

|

EAM = 0 --------------------| | | ; START FAILURE MODE

;Pump commanmed off | |OR --| eam := 0

| | | CHKAIR := 0

EAMM = 1 -------------------| | | ;over temperature or EAMM failure

;EAMM indicates pump | | | ; force Open Loop and turn off air

; on when it is | | |

; commanded off |AND -| | SAIR\_TST\_RDY := 0

| | EAM\_ANTICIP := 0

SAIR\_END\_TMR > | |

SAIR\_END\_TM ------------| |

;Pump should have stopped | |

| |

V\_EAMM\_ENA = 1 -------------| |

;EAMM Test enabled |

| --- ELSE ---

|

ER\_ACTIVE = 1 --------------------------| eam := 0

| EAM\_ANTICIP := 0

| SAIR\_TST\_RDY : 0

| ; test unable to execute the idle

| ; period wait until next idle

|

| --- ELSE ---

ATMR1 >= FN606(TCSTRT) - |

EAM\_ANTP\_DLY ---| |

;pump will turn on in | |

;EAM\_ANTP\_DLY seconds. |AND -| |

| | |

ATMR1 <= FN606(TCSTRT) -----| | |

|OR --| eam := 0

ATMR1 > FN606(TCSTRT) ------| | | EAM\_ANTICIP := 1

| | | CHKAIR = 1

ATMR1 < FN607(TCSTRT) ------| | | ;allow closed loop

|AND -| | SAIR\_TST\_RDY = 0

EAM = 0 -------------------| |

| |

EAM\_FAULT <> 0 -------------| |

| --- ELSE ---

ATMR1 > FN606(TCSTRT) ------------| |

|AND -| eam := 1

ATMR1 < FN607(TCSTRT) ------------| | CHKAIR := 0

| SAIR\_TST\_RDY = 0

| EAM\_ANTICIP := 1

| ;maintain EAM load correction

| ;in ISC

|

| --- ELSE ---

(continued on next page)

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

PSPN\_FLWTST = 1 ------------------------| eam := 0

| EAM\_ANTICIP := 0

| SAIR\_TST\_RDY = 0

| ; test unable to execute the idle

| ; period wait until next idle

|

| --- ELSE ---

SAIR\_ON\_MON = 0 ------------------| |

;Test not yet complete | |

| |

ISCFLG = 1 -----------------------| |

;at idle | |

| |

SAIR\_TST\_ENA = 0 -----------------| |

;monitor not yet enabled | |

| | ; entry conditions to enable

abs(1. + BIAS\_G1 - LAMAVE1) | | ; continuous flow test

< EAM\_LAM\_DEL ---------| |

;adaptive learned |AND -| SAIR\_FLWTST := 0

; enough to let lambse | |

; be close to 1 | | SAIR\_TST\_RDY := 1

| | ;signal OBD-II executive that test

NUMEGO = 1 -----------------| | | ; is ready to run

| | |

NUMEGO = 2 -----------| |OR --| | CHKAIR := 1

| | | | ;allow closed loop

abs(1. + BIAS\_G2 - |AND -| | |

LAMAVE2) < | | | eam := 0

EAM\_LAM\_DEL ------| | |

| | EAM\_ANTICIP := 0

ECT > TEMPFB ---------------------| | EAM\_ANTP\_TMR := 0

;Warm engine | |

| | SAIR\_LAM\_DSD :=

USPD\_RUN\_TMR > SAIR\_STB\_TM -------| | min(LAMBSE1,LAMBSE2)

;delay SAIR OBD-II test | SAIR\_LAM\_DSD :=

| max(SAIR\_REQV,SAIR\_LAM\_DSD)

|

| --- ELSE ---

|

SAIR\_TST\_RDY = 1 -----------------| | ;no longer at idle, start delay

| |

ISCFLG = 0 -----------------------|AND -| CHKAIR = 1

;not at idle | | ;allow closed loop

| |

SAIR\_END\_FLG = 0 -----------------| | EAM\_ANTICIP := 0

| eam := 0

| SAIR\_END\_TMR := 0

| SAIR\_END\_FLG := 1

|

| --- ELSE ---

(continued on next page)

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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SAIR\_END\_FLG = 1 -----------------|

|AND -| NO ACTION

SAIR\_END\_TMR <= SAIR\_END\_TM ------| | ;Wait until timer expires

|

| --- ELSE ---

|

SAIR\_END\_FLG = 1 -----------------------| SAIR\_TST\_RDY := 0

| SAIR\_END\_FLG := 0

| CHKAIR := 1

| EAM\_ANTICIP := 0

| eam := 0

|

| --- ELSE ---

SAIR\_TST\_RDY = 1 -----------------| |

| |

SAIR\_ON\_MON = 1 ------------------|AND -| eam := 0

| | ;Test complete, turn off pump

SAIR\_END\_TMR > SAIR\_END\_TM -------| | CHKAIR = 1

| ;allow closed loop

| SAIR\_TST\_RDY := 0

| EAM\_ANTICIP := 0

|

| --- ELSE ---

SAIR\_TST\_RDY = 1 -----------------| |

|AND -| eam := 0

SAIR\_ON\_MON = 1 ------------------| | ;Test complete, turn off pump

| CHKAIR = 1

| ;allow closed loop

|

| --- ELSE ---

|

SAIR\_TST\_ENA = 1 -----------------| | ;delay until idle speed

;test enabled by exec | | ; can compensate air pump

| | ; and purge is off

EAM\_ANTICIP = 0 ------------| |AND -| eam := 0

| | | CHKAIR := 1

EAM\_ANTP\_TMR < | | | ;allow closed loop

EAM\_ANTP\_DLY -----|OR --| | SAIR\_HLD\_TMR := 0

;not enough time | | SAIR\_RCH\_TMR := 0

; for ISC to react | | EAM\_ANTICIP := 1

| | SAIR\_LAM\_DSD :=

PG\_DC > SAIR\_PG\_MIN --------| | min(LAMBSE1,LAMBSE2)

| SAIR\_LAM\_DSD :=

| max(SAIR\_REQV,SAIR\_LAM\_DSD)

|

| --- ELSE ---

(continued on next page)

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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SAIR\_TST\_ENA = 1 -----------------| |

|AND -| Do: therm\_fuel\_init

SAIR\_FLWTST = 0 ------------------| |

| --- ELSE ---

|

SAIR\_TST\_ENA = 1 -----------------------| ;conduct flow test

;test enabled by exec | eam := 1

| CHKAIR := 0

| ;force open loop

| Do: therm\_flow\_test

|

| --- ELSE ---

|

| ;\*\*\*\*\* DEFAULT - PUMP OFF \*\*\*\*\*

|

| eam := 0

| CHKAIR := 1

| SAIR\_TST\_RDY := 0

| ;signal OBD-II executive that test

| ; is off

| EAM\_ANTICIP := 0

END: therm\_normal

17-21

THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: therm\_primary\_test

Execute the following process only when called.

The Output State Monitor is tested to insure that it is indicating the

correct state. If it is incorrect for V\_THERM\_TM seconds, code P0412 is set.

EAM\_FAULT = 0 ---------------------| V\_THERM\_TMR = 0

;primary monitor indicates | ;No error, hold timer at zero

; correct state |

| --- ELSE ---

|

V\_THERM\_TMR > V\_THERM\_TM ----| |

;a fault has been present | |

; long enough | |

| |

EAMM = 1 --------------------|AND -| malfunction(sair,P0412)

;Monitor indicates pump on | | ;ECA failure or short across relay,

| | ; set code P0412

OSM\_EO\_ON = 1 ---------| | |

;KOEO test enabled | | | SAIR\_ON\_MON := 1

| | | ;monitor complete, failure detected

OSM\_EO\_OFF = 1 --------| | |

;KOEO off test ena. | | | FFG\_SAIR := 1

| | | ;Signal OBD-II exectutive that

CCM\_ER\_ENA = 1 --------|OR --| | ; thermactor air is flowing

;KOER test enabled | |

| |

CCM\_TST\_ENA = 1 -------| |

;Continuous test ena. |

| --- ELSE ---

|

V\_THERM\_TMR > V\_THERM\_TM ----| |

;a fault has been present | |

; long enough | |

|AND -| malfunction(sair,P0412)

OSM\_EO\_ON = 1 ---------| | | ;ECA failure or short across relay,

;KOEO on test enabled | | | ; set code P0412

| | |

OSM\_EO\_OFF = 1 --------| | | SAIR\_ON\_MON := 1

;KOEO off test ena. | | | ;monitor complete, failure detected

| | |

CCM\_ER\_ENA = 1 --------|OR --| |

;KOER test enabled | |

| |

CCM\_TST\_ENA = 1 -------| |

;Continuous test ena. |

| --- ELSE ---

|

| No Action.

END: therm\_primary\_test

17-22

THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: therm\_koer\_circuit\_test

Execute the following process only when called.

The Output State Monitor is tested to insure that it is indicating the

correct state. If it is incorrect for V\_THERM\_TM seconds, code P0412 is set.

EAM\_FAULT = 0 ---------------|

;primary monitor indicates |

; correct state |AND -| V\_THERM\_TMR := 0

| | ;no error, hold timer at zero

SAIR\_PRM\_TMR < SAIR\_PRM\_TM --| |

| --- ELSE ---

|

EAM\_FAULT = 0 ---------------------| V\_THERM\_TMR := 0

| clear\_malf(P0412)

| SAIR\_PRM\_FLG := 1

|

| --- ELSE ---

|

V\_THERM\_TMR > V\_THERM\_TM ----| |

;a fault has been present | |

; long enough |AND -| malfunction(sair,P0412)

| | ;ECA failure or short across relay,

EAMM = 0 --------------------| | ; set code P0412

;Monitor indicates pump off |

| SAIR\_ON\_MON := 1

| ;monitor complete, failure detected

|

| ER\_STATUS := SAIR\_ER\_DONE

|

| --- ELSE ---

V\_THERM\_TMR > V\_THERM\_TM ----| |

;a fault has been present | |

; long enough |AND -| malfunction(sair,P0412)

| | FFG\_SAIR := 1

EAMM = 1 --------------------| | ;Signal OBD-II exectutive that

;Monitor indicates pump on | ; thermactor air is flowing

|

| SAIR\_ON\_MON := 1

| ;monitor complete, failure detected

|

| ER\_STATUS := SAIR\_ER\_DONE

|

| --- ELSE ---

|

| SAIR\_PRM\_TMR := 0

17-23

THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EAMM = EAM ------------------|

;secondary monitor shows |

; correct state |

|AND -| V\_EAMM\_TMR := 0

EAMM\_TST\_TMR < EAMM\_TST\_TM --| | ;no error, hold timer at zero

| |

EAM = 0 ---------------------| | FFG\_SAIR := 0

|

| --- ELSE ---

EAMM = EAM ------------------| |

;secondary monitor shows | |

; correct state |AND -| V\_EAMM\_TMR := 0

| | ;no error, hold timer at zero

EAMM\_TST\_TMR < EAMM\_TST\_TM --| |

| --- ELSE ---

EAMM = 0 --------------------| |

|AND -| V\_EAMM\_TMR := 0

EAM = 0 ---------------------| | clear\_malf(P1414)

| SAIR\_OFF\_MON := 1

| FFG\_SAIR := 0

|

| --- ELSE ---

EAMM = 1 --------------------| |

|AND -| V\_EAMM\_TMR := 0

EAM = 1 ---------------------| | clear\_malf(P1413)

|

| --- ELSE ---

EAMM <> EAM -----------------| |

;primary monitor indicates | |

; wrong state | |

| |

V\_EAMM\_TMR > V\_EAMM\_TM ------|AND -| malfunction(sair,P1414)

;a fault has been present | | ;EAMM failure commanded off

; long enough | | ; set code P1414

| |

EAM = 0 ---------------------| | SAIR\_OFF\_MON := 1

| ;monitor complete, failure detected

|

| ER\_STATUS := SAIR\_ER\_DONE

| FFG\_SAIR := 1

|

| --- ELSE ---

(continued on next page)

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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EAMM <> EAM -----------------| |

;primary monitor indicates | |

; wrong state |AND -| malfunction(sair,P1413)

| | ;EAMM failure commanded off

V\_EAMM\_TMR > V\_EAMM\_TM ------| | ; set code P1413

;a fault has been present |

; long enough | SAIR\_ON\_MON := 1

| ;monitor complete, failure detected

|

| ER\_STATUS := SAIR\_ER\_DONE

|

| --- ELSE ---

EAMM <> EAM -----------------| |

|AND -| EAMM\_TST\_TMR := 0

EAM = 0 ---------------------| |

| --- ELSE ---

|

EAMM <> EAM -----------------------| EAMM\_TST\_TMR := 0

DEMAND\_STATE =

sair\_koer\_primary\_test ----|

|

SAIR\_PRM\_FLG = 1 ------------|AND -| DEMAND\_STATE :=

| | sair\_koer\_fuel\_init

SAIR\_OFF\_MON = 1 ------------| | DEMAND\_TIMER := 0

END: therm\_koer\_circuit\_test

17-25

THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: therm\_commanded\_on\_test

Execute the following process only when called.

The EAM Monitor (EAMM) is tested to insure that it is indicating the correct

state. If it is incorrect for V\_EAMM\_TM seconds, code P1413 is set.

EAMM = 1 --------------------|

;Secondary monitor |

; indicates correct state |

|OR --| V\_EAMM\_TMR = 0

V\_EAMM\_ENA = 0 --------------| | ;No error, hold timer at zero

;Test not enabled | | clear\_malf(P1413)

| |

P0412MALF = 1 ---------------| |

;Primary circuit failure |

| --- ELSE ---

|

V\_EAMM\_TMR > V\_EAMM\_TM ------| |

;a fault has been present | |

; long enough | |

|AND -| malfunction(sair,P1413)

OSM\_EO\_ON = 1 ---------| | | ;Circuit open from battery or relay

;KOEO test enabled | | | ; not closed, set code P1413

| | |

CCM\_ER\_ENA = 1 --------|OR --| | SAIR\_ON\_MON = 1

;KOER test enabled | | ;monitor complete, failure detected

| |

CCM\_TST\_ENA = 1 -------| |

;Continuous test ena. |

| --- ELSE ---

|

| No Action.

END: therm\_commanded\_on\_test

17-26

THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: therm\_flow\_test

Execute the following process only when called.

Test for flow (Checks for not stuck rich HEGO with upstream air):

In order to test the pump, it must be capable of driving the HEGO lean while

the A/F ratio is rich in Open loop. If the A/F ratio is too rich for the air

pump to drive the HEGO lean at the current Thermactor flow rate (proportional

to exhaust back pressure - which is inferred from AM) then the test cannot be

performed.

P0412MALF = 1 ---------------|

|OR --| exit flow test

P1413MALF = 1 ---------------| | ; errors detected

| ; do not need to test for flow

|

| --- ELSE ---

VEGO11\_FIL2 < |

SAIR\_EGO\_LVL ---------| |

|AND -| |

NUMEGO = 1 ------------| | |

| |

VEGO11\_FIL2 < |OR --| LN\_CTL\_FLG := 1

SAIR\_EGO\_LVL --------| | | ;no error detected

| | | ; allow V\_AP\_TSTTMR and

VEGO21\_FIL2 < | | | ; SAIR\_LN\_TMR to run

SAIR\_EGO\_LVL --------|AND -| | ; HEGOs are lean, but are warmed

| | ; up - indicates air pump is

NUMEGO = 2 ------------| | ; functional

|

| --- ELSE ---

|

| LN\_CTL\_FLG := 0

| ;freeze SAIR\_LN\_TMR

| ;allow V\_AP\_TSTTMR to run

| ;HEGOs are rich and system is testable,

| ; possible error condition

| ;A rich indication from HEGOs indicate

| ; that they have warmed up

17-27

THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

If rich error exists for a calibratable time, the pump is considered failed.

(CODE P0411). If sufficient test time passes without a failure detected, the

test is passed.

V\_AP\_TSTTMR > V\_AP\_TST\_TM ---|

;test timed out |AND -| SAIR\_ON\_MON = 1

| | ;done testing

SAIR\_LN\_TMR >= SAIR\_LN\_TM ---| | ; "pass"

;no failure |

| SAIR\_END\_TMR := 0

| ;Begin delay to allow pump to spin down

|

| SAIR\_TMRK1 := SAIR\_LN\_TMR

| ;update for mode 06 reporting

| SAIR\_TMRK2 := FFh

| ;fill to max value for mode 06

| ; reporting

|

| --- ELSE ---

V\_AP\_TSTTMR > V\_AP\_TST\_TM ---| |

| ;test timed out | |

| | |

| SAIR\_LN\_TMR < SAIR\_LN\_TM ----|AND -| SAIR\_ON\_MON = 1

| ;Error persists under test | | ;a failure was detected, but do not set

| ; enabled conditions | | ; code because valve could be frozen

| | |

| INFAMB\_KAM < SAIR\_AMB\_MIN ---| | SAIR\_TMRK1 := SAIR\_LN\_TMR

| ;Ambient temp too low | ;update for mode 06 reporting

| | SAIR\_TMRK2 := FFh

| | ;fill to max value for mode 06

| | ; reporting

| |

| | --- ELSE ---

| V\_AP\_TSTTMR > V\_AP\_TST\_TM ---| |

;test timed out |AND -| malfunction(sair,P0411)

| | ;set failure code

SAIR\_LN\_TMR < SAIR\_LN\_TM ----| | SAIR\_ON\_MON = 1

;Error persists under test | ;a failure was detected while

; enabled conditions | ; the test was enabled

|

| SAIR\_TMRK1 := SAIR\_LN\_TMR

| ;update for mode 06 reporting

| SAIR\_TMRK2 := FFh

| ;fill to max value for mode 06

| ; reporting

|

| --- ELSE ---

|

| No action

| ;haven't passed or failed yet

END: therm\_flow\_test

17-28

THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: therm\_commanded\_off\_test

Execute the following process only when called.

If an EAMM failure exists that indicates that there may be secondary air

present when the pump is commanded off, set the flag FFG\_SAIR so the OBD-II

executive will disable tests that would be adversly affected by secondary

air.

unconditionally -------------------| V\_AP\_TSTTMR = 0

| ;hold timers used in thermactor on

| ; test to zero

P0412MALF = 1 ---------------| |

|AND -| V\_EAMM\_TMR = 0

EAMM = 1 --------------------| | ;No error, hold timer at zero

;Monitor indicates pump on | clear\_malf(P1414)

| SAIR\_OFF\_MON = 1

|

| --- ELSE ---

|

EAMM = 0 --------------------| |

;Secondary monitor indicates| |

; correct state | |

|OR --| V\_EAMM\_TMR = 0

V\_EAMM\_ENA = 0 --------------| | ;No error, hold timer at zero

;Test not enabled | | clear\_malf(P1414)

| | SAIR\_OFF\_MON = 1

P0412MALF = 1 ---------------| | FFG\_SAIR = 0

;Primary circuit failure | ;no eamm failure

|

| --- ELSE ---

|

V\_EAMM\_TMR > V\_EAMM\_TM ------| |

;a fault has been present | |

; long enough | | malfunction(sair,P1414)

|AND -| ;ECU failure or primary circuit

CCM\_TST\_ENA = 1 -------| | | ; failure (open or ground)

;Continuous test ena. | | | ; set code P1414

| | |

OSM\_EO\_OFF = 1 --------|OR --| | SAIR\_OFF\_MON = 1

;KOEO test enabled | | FFG\_SAIR = 1

| | ;eamm failure

CCM\_ER\_ENA = 1 --------| |

;KOER test enabled |

| --- ELSE ---

|

| NO ACTION

| ;allow V\_EAMM\_TMR to run

END: therm\_commanded\_off\_test

17-29

THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: therm\_fuel\_init

Execute the following process only when called.

SAIR\_TST\_ENA = 1 -----------------| Do: therm\_rich\_continuous

|

| --- ELSE ---

|

SAIR\_EGO\_LN = 0 ------------------| Do: therm\_lean\_check

|

| --- ELSE ---

|

| Do: therm\_rich\_check

END: therm\_fuel\_init

BEGIN: therm\_rich\_continuous

Execute the following process only when called.

VEGO11\_FIL2 < SAIR\_EGO\_LVL -|

|AND -|

NUMEGO = 1 -----------------| |

|

VEGO11\_FIL2 < |OR --| SAIR\_EGO\_LN := 1

SAIR\_EGO\_LVL -----| | |

|OR --| | |

VEGO21\_FIL2 < | | | |

SAIR\_EGO\_LVL -----| |AND -| |

| |

NUMEGO = 2 -----------------| |

| --- ELSE ---

|

| SAIR\_EGO\_LN := 0

| ; ramp LAMBSE until rich is seen

SAIR\_LAM\_DSD > SAIR\_REQV ---------| | ; on both hegos

|AND -| SAIR\_LAM\_DSD := max(SAIR\_LAM\_DSD -

SAIR\_LAM\_DSD > | | SAIR\_DLAM,SAIR\_REQV)

SAIR\_LEQV -------------| | | SAIR\_HLD\_TMR := 0

|OR --| | SAIR\_RCH\_TMR := 0

SAIR\_EGO\_LN = 1 ------------| | eam := 0

| CHKAIR := 0

| ;force open loop

|

| --- ELSE ---

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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SAIR\_LAM\_DSD <= SAIR\_REQV --------| |

| |

SAIR\_HLD\_TMR > |AND -| EAM\_ANTICIP := 0

SAIR\_HOLD\_TM --------------| | PSPN\_FLWTST := 1

| | ; we're at clip for SAIR\_HOLD\_TM

SAIR\_EGO\_LN = 1 ------------------| | ; seconds and both hegos have not

| ; seen rich

| ; abort test, inform exec

|

| SAIR\_TST\_RDY := 0

| eam := 0

| CHKAIR := 1

| ; allow closed loop

|

| --- ELSE ---

|

SAIR\_EGO\_LN = 1 ------------------------| ; we're at clip

| ; allow time for hego

| ; to see rich state

|

| eam := 0

| CHKAIR = 0

| ;force open loop)

| SAIR\_RCH\_TMR := 0

|

| --- ELSE ---

|

SAIR\_RCH\_TMR < SAIR\_RCH\_TM -------------| CHKAIR := 0

| ; hegos have not been rich for

| ; SAIR\_RCH\_TM seconds

| ; just wait

|

| eam := 0

| SAIR\_HLD\_TMR := 0

|

| --- ELSE ---

|

| ; hegos have been rich for

| ; SAIR\_RCH\_TM seconds start

| ; flow test

|

| eam : 0

| CHKAIR : 0

| (force open loop)

|

| SAIR\_FLWTST := 1

| SAIR\_LN\_TMR := 0

| V\_AP\_TSTTMR := 0

END: therm\_rich\_continuous

17-31

THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: therm\_lean\_check

Execute the following process only when called.

NUMEGO = 1 -----------------|

|AND -|

VEGO11\_FIL2 < SAIR\_EGO\_LVL -| |

|OR --| SAIR\_EGO\_LN = 1

NUMEGO = 2 -----------------| | | DEMAND\_TIMER := 0

| | | ;completed lean ramp

VEGO11\_FIL2 < SAIR\_EGO\_LVL -|AND -| | ; restart timer for rich ramp

| |

VEGO21\_FIL2 < SAIR\_EGO\_LVL -| | ER\_EAM\_LEAN = ER\_LAM\_DSD1

| ;save lambse value to use as base

| ; during ramp in rich direction

|

| --- ELSE ---

|

ER\_LAM\_DSD1 < LEQV ---------------------| ER\_LAM\_DSD1 := min(ER\_LAM\_BAS +

;haven't reached clip yet | (DEMAND\_TIMER \*

| SAIR\_VIPLR1),LEQV)

| ER\_LAM\_DSD2 := ER\_LAM\_DSD1

| ;ramp fuel lean until lean state

| ;seen on both HEGOs.

|

| --- ELSE ---

ER\_LAM\_DSD1 = LEQV ---------------| |

|AND -| do nothing

DEMAND\_TIMER < SAIR\_RAMP\_TM ------| | ; allow HEGO time to detect switch

|

| --- ELSE ---

|

ER\_LAM\_DSD1 >= LEQV --------------------| ER\_LAM\_DSD1 := ER\_LAM\_BAS

;at lambda clip | ER\_LAM\_DSD2 := ER\_LAM\_DSD1

| (reset fuel)

| ER\_STATUS := SAIR\_ER\_DONE

| (give up, can't do test.)

|

| --- ELSE ---

|

| (no action)

END: therm\_lean\_check

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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BEGIN: therm\_rich\_check

Execute the following process only when called.

NUMEGO = 1 -----------------|

|AND \_|

VEGO11\_FIL2 > SAIR\_EGO\_LVL -| |

|OR --| SAIR\_EGO\_RC = 1

NUMEGO = 2 -----------------| | | ; fuel initialization complete

| | | ER\_LAM\_DSD1 := ER\_LAM\_DSD1 -

VEGO11\_FIL2 > SAIR\_EGO\_LVL -|AND -| | SAIR\_LAM\_DEL

| | ER\_LAM\_DSD2 := ER\_LAM\_DSD1

VEGO21\_FIL2 > SAIR\_EGO\_LVL -| | ;step fuel a little more rich

| V\_THERM\_TMR := 0

| DEMAND\_STATE := sair\_koer\_fuel\_done

|

| --- ELSE ---

|

ER\_LAM\_DSD1 > REQV ---------------------| ER\_LAM\_DSD1 := max(ER\_EAM\_LEAN -

;havn't reached clip yet | (DEMAND\_TIMER \*

| SAIR\_VIPRR1),REQV)

| ER\_LAM\_DSD2 := ER\_LAM\_DSD1

| ;ramp fuel rich untill rich state

| ; seen on both HEGOs.

|

| --- ELSE ---

ER\_LAM\_DSD1 = REQV ---------------| |

|AND -| do nothing

DEMAND\_TIMER < SAIR\_RAMP\_TM ------| | ; allow HEGO time to detect switch

|

| --- ELSE ---

|

ER\_LAM\_DSD1 = REQV ---------------------| ER\_LAM\_DSD1 := ER\_LAM\_BAS

(at lambda clip) | ER\_LAM\_DSD2 := ER\_LAM\_DSD1

| (reset fuel)

| ER\_STATUS := SAIR\_ER\_DONE

| (give up, can't do test.)

END: therm\_rich\_check

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THERMACTOR AIR STRATEGY, ELECTRIC AIR MANAGEMENT - CDAN2

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CHAPTER 18

INTAKE MANIFOLD RUNNER CONTROL STRATEGY

18-1

INTAKE MANIFOLD RUNNER CONTROL STRATEGY

18.1 FEATURE: INTAKE MANIFOLD RUNNER CONTROL - V1.3A\_IMRC\_ONOFF (CDAN2)

18.1.1 IMRC COMMAND LOGIC (CDAN0)

OVERVIEW

This Intake Manifold Runner Control (IMRC) module determines the desired

position of the IMRC valve. The strategy is enabled by the IMRC H/W present

switch, (IMRCHP = 1). The IMRC valve is used to increase airflow to the

engine and improve top-end performance. The desired valve position is based

on the current engine speed, N, and the throttle position, TP\_REL, as defined

in FN503. Independent hysterisis values for both engine speed and throttle

position are used to prevent overuse of the valve due to jittering at the

on/off boundary.

The IMRC strategy supports the following:

1) Normally open and normally closed valves. The calibrations should be as

follows:

Normally Closed: IMRC\_OFF\_POS = 0, IMRC\_ON\_POS = 1

Normally Open: IMRC\_OFF\_POS = 1, IMRC\_ON\_POS = 0

2) OBDII diagnostics, which are enabled by the sensor H/W present switch,

(IMRCSENSHP = 1), and the driver diagnostics. KOEO OBDII diagnostics are not

valid for vacuum systems and should be disabled by setting IMRC\_TYPE = 0.

3) Disabling IMRC state changes when the transmission strategy requests it

via FLG\_IMRC\_HLD.

DEFINITIONS

Registers:

- APT(Input) = Throttle mode flag (UNITLESS).

- ECT(Input) = Engine Coolant Temperature (DEG F).

- IMRCSPK\_W(Output) = Weighting factor for IMRC spark modifiers. Unitless

multiplier from 0 (IMRC valve fully closed) to 1.99 (IMRC valve fully

open).

- IMRC\_N\_REL = Engine speed hysteresis to hold the IMRC valve open (RPM).

- IMRC\_RSP\_TMR(Input/Output) = Time since last IMRC state change request

(SEC).

- IMRC\_STATUS(Input) = IMRC status; 0 -> OK, 1 -> stuck closed, 2 -> stuck

open.

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY - CDAN2

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- IMRC\_TP\_REL = Throttle position to enable the IMRC to open (COUNTS).

- N(Input) = Engine speed (RPM).

- TP\_REL(Input) = Throttle Position (COUNTS).

- VBAT(Input) = Battery voltage.

- VS(Input) = Vehicle speed (MPH).

Bit Flags:

- CCM\_EO\_ENA(Input) = Continuous monitor, engine off, enable flag.

- CCM\_ER\_ENA(Input) = Continuous monitor, engine running, enable flag.

- CCM\_TST\_ENA(Input) = Continuous monitor test enabled flag.

- CRKFLG(Input) = Crank flag; 1 -> cranking.

- FLG\_IMRC\_HLD(Input) = Indicates that IMRC should not change state during

a shift event.

- IMRC\_AS\_ENA = IMRC anti-sludging enable flag; 1 -> enable IMRC to open.

- IMRC\_CMND = Commanded state of IMRC; 1 -> port throttle open.

- IMRC\_CMNDOLD = Last commanded state of IMRC; 1 -> port throttle open.

- IMRC\_EN\_KOEO = Enable switch for IMRC plate diagnostics on KOEO. Used

for vacuum systems. 1 -> enable KOEO plate diagnostics. 0 -> Disable.

- IMRCKAM\_SWAP = IMRC last-trip cycling information has been uploaded into

RAM; 1 -> yes.

- IMRCLAST\_KAM = Was IMRC cycled on previous trip? 1 -> yes.

- IMRCLASTTRIP = Did IMRC cycle on the previous trip? 1 -> yes.

- IMRCTHISTRIP = Was IMRC cycled yet this trip? 1 -> yes.

- IMRC\_POSN(Input/Output) = Measured valve position;1 -> open.

- IMRC\_POSNOLD = Previous value of IMRC\_POSN

- IMRC\_TP\_ENA = IMRC throttle position enable; 1 -> IMRC open is desirable

for engine performance.

- OSM\_EO\_ON(Input) = Output state monitor, engine off, on demand test.

- OSM\_EO\_OFF(Input) = Output state monitor, engine off, off demand test.

- P1516MALF(Input) = IMRC bank 1 input error.

- P1517MALF(Input) = IMRC bank 2 input error.

- SUBST\_REQ21 = Substitution Requested flag for channel 21.

Calibration Constants:

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY - CDAN2

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- FN185 = Function to ramp-out spark as valve closes.

- FN186 = Function to add spark as valve opens.

- FN503 = IMRC enable for turning on IMRC as a function of desired TP\_REL

states and engine speeds.

- IMRC\_CRK\_POS = Desired IMRC position during cranking; 0 -> closed, 1 ->

open.

- IMRC\_CYC\_ECT = ECT that enables forced IMRC cycling (DEG F).

- IMRC\_CYC\_VS = VS that enables forced IMRC cycling (MPH).

- IMRCHP = IMRC hardware present; 0 -> No IMRC hardware, 1 -> IMRC hardware

present.

- IMRC\_N\_HYS = Engine speed hystersis value to avoid valve jitter (RPM).

- IMRC\_OFF\_POS = De-energized position; 1 -> open, 0 -> closed.

- IMRC\_ON\_POS = Energized position; 1 -> open, 0 -> closed.

- IMRCSENSHP = Position sensor hardware present switch; 0 -> no IMRC

position sensor, 1 -> IMRC position sensor hardware present.

- IMRC\_SFT = Prevents IMRC from changing states during a shift. 1 ->

prevents state changes; 0 -> allows changes during a shift.

- IMRC\_TP\_HYS = Throttle position hystersis value to avoid valve jitter

(COUNTS).

- IMRC\_TYPE = Electric/Vacuum switch; 1 -> Electric, 0 -> Vacuum

- VBAT\_CCM\_MIN = Minimum battery voltage necessary to run OBDII

diagnostics.

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY - CDAN2

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PROCESS

STRATEGY MODULE: IMRC\_COMMAND\_COM1

BEGIN: imrc\_command\_main

;This process is executed once per background loop.

If IMRC hardware is not present, disable spark modification and exit

IMRC logic completely.

OSC response logic: If Output State Control has been requested for IMRC\_CMND

but IMRC hardware is not present, a sequence error message will be sent.

SUBST\_REQ21 = 1 ------------------|

|AND -| Do: OSC\_RESPONSE(21,22h)

IMRCHP = 0 -----------------------| | ;OSC substitute requested but local

| ; conditions will not allow

| ; substitution

|

| IMRCSPK\_W := 0

| ;no spark modification

|

| EXIT imrc\_command\_main

| ;do not execute the logic

| ;below

|

| --- ELSE ---

|

IMRCHP = 0 -----------------------------| IMRCSPK\_W := 0

;no IMRC hardware | ;no spark modification

|

| EXIT imrc\_command\_main

| ;do not execute the logic

| ;below

There are two modes of IMRC operation, on-demand and normal

OSM\_EO\_ON = 1 --------------------|

;Engine-off On-demand test |OR --| Do: imrc\_demand\_state

| |

OSM\_EO\_OFF = 1 -------------------| |

;Engine-off Off-demand test |

| --- ELSE ---

|

| Do: imrc\_normal\_operation

| ;set command based on normal

| ;operating conditions

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY - CDAN2

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If the command has changed, then reset the diagnostics timer.

IMRC\_CMND = IMRC\_CMNDOLD ---------------| NO ACTION

;command has not changed | ;let timer run freely

|

| --- ELSE ---

|

| IMRC\_RSP\_TMR := 0

| ;command has changed,

| ;reset response timer

Store the previous commanded and measured positions.

unconditionally ------------------------| IMRC\_CMNDOLD := IMRC\_CMND

| ;store old commanded value

|

| IMRC\_POSNOLD := IMRC\_POSN

| ;store old position value

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY - CDAN2

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Spark timing is advanced as the plates move from their closed to open

position. The spark modification is done in a purely open-loop fashion based

on the time since the command position has changed. If IMRC fails open, then

fully open spark is given. If IMRC fails closed then spark is not advanced.

IMRC\_STATUS = 1 ------------------|

;IMRC is stuck closed. |

|OR --| IMRCSPK\_W := 0

P1516MALF = 1 --------------------| | ;Use closed plate spark

;IMRC1 input error | |

| |

P1517MALF = 1 --------------------| |

;IMRC2 input error |

| --- ELSE ---

|

IMRC\_STATUS = 2 ------------------------| IMRCSPK\_W := FN186( FFh )

;IMRC is stuck open | ;Use max open plate spark

| ; (Maximum value for IMRC\_RSP\_TMR)

|

| --- ELSE ---

|

IMRC\_CMND = 0 --------------------------| IMRCSPK\_W := FN185(IMRC\_RSP\_TMR)

;commanding plates closed | ;OK to adjust spark smoothly to

| ;fully closed value

|

| --- ELSE ---

|

IMRC\_CMND = 1 --------------------------| IMRCSPK\_W := FN186(IMRC\_RSP\_TMR)

;commanding plates open | ;OK to adjust spark smoothly to

;IMRC is stuck open | ;fully open value

unconditionally ------------------------| Do: imrc\_output\_main

| ;generate output signal

If sensor hardware is present then read the position sensor. If the sensor

is not present, then assume that the actual position is the desired position.

IMRCSENSHP = 1 -------------------------| Do: imrc\_input\_main

| ;read position sensor

|

| --- ELSE ---

|

| IMRC\_POSN := IMRC\_CMND

Record if the measured plate position has changed. If so set appropriate

flags which will disable anti-sludging routine.

IMRC\_POSN <> IMRC\_POSNOLD --------|

;measured plate position |

;has changed |AND -| IMRCLAST\_KAM := 1

| | IMRCTHISTRIP := 1

IMRCTHISTRIP = 0 -----------------| | ;store KAM info for next trip

;IMRC has not cycled this trip

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY - CDAN2

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Output driver diagnostics

VBAT >= VBAT\_CCM\_MIN -------------|

;battery voltage stable |

|

CCM\_TST\_ENA = 1 ------------| |AND -| Do: imrc\_diagnostics\_osm\_main

;continuous CCM test | | | ;check for driver faults

;enabled | | |

| | |

CCM\_ER\_ENA = 1 -------------|OR --| |

;Engine-Running On-Demand | |

;test enabled | |

| |

CCM\_EO\_ENA = 1 -------------| |

;Engine-Off On-Demand |

;test enabled |

| --- ELSE ---

|

| NO ACTION

KOEO system diagnostics are not valid for vacuum systems, due to lack of

vacuum to actuate valves.

IMRC\_TYPE = 1 --------------------|

;Electric IMRC |AND -| IMRC\_EN\_KOEO = 1

| | ;Enable KOEO system

CCM\_EO\_ENA = 1 -------------------| | ;diagnostics

;Engine-off On-demand |

;test enabled |

| --- ELSE ---

|

| IMRC\_EN\_KOEO = 0

| ;Disable KOEO system

| ;diagnostics

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY - CDAN2

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Systems diagnostics

VBAT >= VBAT\_CCM\_MIN -------------|

;battery voltage stable |

|

IMRCSENSHP = 1 -------------------|

;sensor HW present |

|

CCM\_TST\_ENA = 1 ------------| |AND -| Do: imrc\_diagnostics\_main

;continuous CCM test | | | ;check for system faults

;enabled | | |

| | |

CCM\_ER\_ENA = 1 -------------|OR --| |

;Engine-Running On-Demand | |

;test enabled | |

| |

IMRC\_EN\_KOEO = 1 -----------| |

;Enable KOEO test |

| --- ELSE ---

|

| NO ACTION

END: imrc\_command\_main

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY - CDAN2

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BEGIN: imrc\_demand\_state

;This routine is executed only when explicitly called to the the IMRC command

;during engine-off on-demand test.

OSM\_EO\_ON = 1 --------------------------| IMRC\_CMND := IMRC\_ON\_POS

;on-demand OSM test | ;command actuator to energize

;requesting "on" state |

| --- ELSE ---

|

| IMRC\_CMND := IMRC\_OFF\_POS

| ;command actuator to de-energize

END: imrc\_demand\_state

BEGIN: imrc\_normal\_operation

;This routine is executed only when explicitly called and is the core

;logic to command the IMRC plates during all engine-running conditions.

After the engine has started, move last trip's cycling info in from KAM, then

clear the KAM ONCE per trip.

N > 600 --------------------------|

|AND -| IMRCLASTTRIP := IMRCLAST\_KAM

IMRCKAM\_SWAP = 0 -----------------| | ;move last trip's cycling

;info from last trip | ;record into RAM

;not yet uploaded |

| IMRCLAST\_KAM := 0

| IMRCKAM\_SWAP := 1

| ;reset trip record ONCE, at

| ;beginning of current trip

Determine if open plates are needed for engine performance. Hysteresis is

used to prevent jitter caused by small changes or noise in throttle position.

unconditionally ------------------------| IMRC\_TP\_REL := FN503(N)

| ;set TP limit

unconditionally ------------------------| IMRC\_N\_REL := FN503(N + IMRC\_N\_HYS)

| ;set N limit

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY - CDAN2

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TP\_REL > IMRC\_TP\_REL -------------------| IMRC\_TP\_ENA := 1

| ;open plates desired

| ;for engine performance

|

| --- ELSE ---

TP\_REL < IMRC\_TP\_REL - |

IMRC\_TP\_HYS ------| |

|AND -| IMRC\_TP\_ENA := 0

TP\_REL < IMRC\_N\_REL --------------| | ;open plates not desired

| ;for engine performance

;Determine if open plates are needed for anti-sludging. The

;anti-sludging cycling will only be forced if it was not cycled on the

;last trip, and will be done at most once every other trip.

ECT > IMRC\_CYC\_ECT ---------------|

;ECT high enough |

|

APT = -1 -------------------------|

;closed throttle |

|

VS > IMRC\_CYC\_VS -----------------|AND -| IMRC\_AS\_ENA := 1

;vehicle speed high enough | | ;open plates desired

| | ;for anti-sludging

IMRCLASTTRIP = 0 -----------------| |

;did not cycle | |

;previous trip | |

| |

IMRCTHISTRIP = 0 -----------------| |

;has not cycled this trip |

| --- ELSE ---

|

| IMRC\_AS\_ENA := 0

| ;anti-sludging action

| ;not needed

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY - CDAN2

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;Determine the desired position of the IMRC plates.

CRKFLG = 1 -----------------------------| imrc\_cmnd := IMRC\_CRK\_POS

;cranking | ;keep IMRC de-energized

| ;during cranking

|

| --- ELSE ---

IMRC\_SFT = 1 ---------------------| |

;calibration to hold IMRC | |

;during shifts |AND -| imrc\_cmnd := IMRC\_CMNDOLD

| | ;do not command IMRC change during

FLG\_IMRC\_HLD = 1 -----------------| | ; transmission events

;Hold IMRC, shift event |

| --- ELSE ---

P1516MALF = 0 --------------------| |

;IMRC1 input OK | |

|AND -|

P1517MALF = 0 --------------------| | imrc\_cmnd := 1

;IMRC2 input OK | | ;command plates to open

| |

IMRC\_TP\_ENA = 1 ------------| | |

;open plates desired | | |

;for performance |OR --| |

| |

IMRC\_AS\_ENA = 1 ------------| |

;open plates desired |

;for anti-sludging |

| --- ELSE ---

|

| imrc\_cmnd := 0

| ;command plates to close

Output State Control

unconditionally ------------------------| DO: substitute(21,imrc\_cmnd)

| IMRC\_CMND := imrc\_cmnd

| ; output state control override

END: imrc\_normal\_operation

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

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18.1.2 IMRC DIAGNOSTICS (CDAM0)

OVERVIEW

This IMRC module determines the status of the IMRC valves for OBDII

diagnostics and for adding spark. When plates are commanded open or closed,

the IMRC response timer, IMRC\_RSP\_TMR, is reset and compared to the

calibrations, IMRC\_OPN\_TIM or IMRC\_CLS\_TIM. If the plate sensors do not

measure that the valves have reached the commanded position within the

cailbration, the corresponding stuck open or stuck closed fault filter are

incremented. The fault filters are incremented until a calibratabled stuck

closed or stuck open counter threshold is reached. This triggers the

malfunction counters to increment and the fault filters to zero. Stuck

closed counters are allowed to only increment once per open command event.

Once the malfucntion counter has reached the counter threshold, a code is

set. The diagnostics are as follows:

DEFINITIONS

Registers:

- IMRC\_LOD\_TMR = Free running timer that is used to disable stuck open

diagnosticss (SEC).

- IMRC\_RSP\_TMR(Input) = Free running timer to delay checking if a valve has

moved (SEC).

- IMRC\_SC1\_CNT = Stuck closed fault counter for bank 1.

- IMRC\_SC1\_FIL = Stuck closed fault filter for bank 1.

- IMRC\_SC2\_CNT = Stuck closed fault counter for bank 2

- IMRC\_SC2\_FIL = Stuck closed fault filter for bank 2.

- IMRC\_SO1\_CNT = Stuck open fault counter for bank 1.

- IMRC\_SO1\_FIL = Stuck open fault filter for bank 1.

- IMRC\_SO2\_CNT = Stuck open fault counter for bank 2.

- IMRC\_SO2\_FIL = Stuck open fault filter for bank 2.

- IMRC\_STATE1 = Instantaneous bank 1 failure indicator; 2 -> stuck open, 1

-> stuck closed, 0 -> OK.

- IMRC\_STATE2 = Instantaneous bank 2 failure indicator; 2 -> stuck open, 1

-> stuck closed, 0 -> OK.

- IMRC\_STAOLD1 = Previous event bank 1 failure indicator; 2 -> stuck open,

1 -> stuck closed, 0 -> OK.

- IMRC\_STAOLD2 = Previous event bank 2 failure indicator; 2 -> stuck open,

1 -> stuck closed, 0 -> OK.

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

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- IMRC\_STATUS(Output) = Logical function of IMRC\_STATE1 and IMRC\_STATE2

used in the IMRC command spark adder logic.

- PCT\_LOAD = Percent Load, unitless.

Bit Flags:

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled.

- IMRC\_BK1\_SCL = Bank 1 valve stuck closed; 1 -> stuck.

- IMRC\_BK1\_SOP = Bank 1 valve stuck open; 1 -> stuck.

- IMRC\_BK2\_SCL = Bank 2 valve stuck closed; 1 -> stuck.

- IMRC\_BK2\_SOP = Bank2 valve stuck open; 1 -> stuck.

- IMRC\_CMND(Input) = Commanded position of valves; 1 -> open, 0 -> closed.

- IMRC\_POSN\_1(Input) = Position of Bank 1 valves. 1 -> open, 0 -> closed.

- IMRC\_POSN\_2(Input) = Position of Bank 2 valves. 1 -> open, 0 -> closed.

- KAM\_ERROR = INDICATES KEEP ALIVE RAM INVALID.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II scan tool

reset message.

- P1516MALF = Bank 1 input error currently exists.

- P1517MALF = Bank 2 input error currently exists.

Calibration Constants:

- IMRC\_CLS\_TIM = Time to close valves before fault filtering begins (SEC).

- IMRC\_FALT\_TC = Fault filter time constant.

- IMRC\_OPN\_TIM = Time to open valves before fault filtering begins (SEC).

- IMRC\_TWOPOSN = IMRC hardware present switch for 2 position inputs; 0 ->

read 1 input, 1 -> read 2 inputs.

- IMRC\_VAC\_LOD = PCT\_LOAD at which "lack of vacuum" could cause stuck open

failures (UNITLESS).

- IMRC\_VAC\_TIM = Time that "lack of vacuum" must be present to disable

failure diagnostics (SEC).

- IMSO\_CNT\_LVL = Counter level at which to set stuck open code.

- IMSO\_ERRLVL = Error level threshold to increment stuck open counter.

- IMSC\_CNT\_LVL = Counter level at which to set stuck closed IMRC fault.

- IMSC\_ERRLVL = Error level threshold to increment stuck closed counter.

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

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OTHER

- P1512 = Non-MIL fault code for bank one stuck closed.

- P1513 = Non-MIL fault code for bank two stuck closed.

- P1518 = MIL fault code for both banks stuck open.

- P1519 = Non-MIL fault code for both banks stuck closed.

- P1537 = MIL fault code for bank one stuck open.

- P1538 = MIL fault code for bank two stuck open.

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

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PROCESS

STRATEGY MODULE: IMRC\_DIAG\_OBDII\_COM1

BEGIN: imrc\_diagnostics\_main

;This process is executed only when explicity called.

P1516MALF = 0 --------------------------| Do: imrc\_diagnostics\_bank1

;The bank 1 pos'n sensor is OK |

IMRC\_TWOPOSN = 1 -----------------|

;Two IMRC position sensors |

;present |AND -| Do: imrc\_diagnostics\_bank2

| |

P1517MALF = 0 --------------------| |

;The bank 2 pos'n sensor is OK |

| --- ELSE ---

|

| IMRC\_SC2\_FIL := 0

| IMRC\_SC2\_CNT := 0

| IMRC\_SO2\_FIL := 0

| IMRC\_SO2\_CNT := 0

In the event of an OBDII reset or a KAM error, clear all codes, and reset

all counters.

OBDII\_RESET = 1 ------------------------|

|OR --| IMRC\_SC1\_FIL := 0

KAM\_ERROR = 1 --------------------------| | IMRC\_SC1\_CNT := 0

| IMRC\_SO1\_FIL := 0

| IMRC\_SO1\_CNT := 0

| IMRC\_SC2\_FIL := 0

| IMRC\_SC2\_CNT := 0

| IMRC\_SO2\_FIL := 0

| IMRC\_SO2\_CNT := 0

| clear\_malf(P1512)

| clear\_malf(P1513)

| clear\_malf(P1518)

| clear\_malf(P1519)

| clear\_malf(P1537)

| clear\_malf(P1538)

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

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The IMRC\_STATUS variable is used as the input to the spark calculation. If a

bank fails closed, no spark should be added until that bank has opened

correctly at least once. If both banks fail open, then the status should be

set such that full open-plate spark is added, to protect the catalyst.

Otherwise, the status flag is cleared, for normal ramp in and ramp out spark

operation.

IMRC\_SC1\_FIL > 0 -----------------|

|

IMRC\_SC1\_CNT > 0 -----------------|

|OR --| IMRC\_STATUS := 1

IMRC\_SC2\_FIL > 0 -----------------| | ;At least one bank has failed

| | ;closed. Do not allow spark

IMRC\_SC2\_CNT > 0 -----------------| | ;addition

|

| --- ELSE ----

IMRC\_SO1\_FIL > 0 -----------| |

|OR --| |

IMRC\_SO1\_CNT > 0 -----------| | |

|AND -| IMRC\_STATUS := 2

IMRC\_SO2\_FIL > 0 -----------| | | ;Both banks have failed open.

|OR --| | ;Allow only full-open spark.

IMRC\_SO2\_CNT > 0 -----------| |

| --- ELSE ---

|

| IMRC\_STATUS := 0

| ;IMRC is working properly

| ;Allow normal spark addition

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INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Vacuum actuated valves can fail due to "lack of vacuum environments". If the

percent load exceeds a calibrated low vacuum load, IMRC\_VAC\_LOD, then a timer

is activated. If the environment exists for more than a calibratable time,

IMRC\_VAC\_TIM, then the malfunction codes are disabled.

IMRC\_TYPE = 0 --------------------|

;vaccum actuation |AND -| Let IMRC\_LOD\_TMR run freely

| |

PCT\_LOAD > IMRC\_VAC\_LOD ----------| |

;Vacuum too low to close valve |

| --- ELSE ---

|

| IMRC\_LOD\_TMR := 0

| ;reset the low vacuum timer

IMRC\_TYPE = 0 --------------------|

;vacuum actuation |AND--| IMRC\_RSP\_TMR := 0

| | ;Do not allow the fault

IMRC\_LOD\_TMR >= IMRC\_VAC\_TIM -----| | ;filters or counters to

;Lack of vacuum of sufficient | ;increment

;duration |

| --- ELSE ---

|

| NO ACTION

Perform the appropriate diagnostics.

IMRC\_TYPE = 1 --------------------------| Do: imrc\_obdii\_code\_elect

;electric actuation | ;set or clear appropriate

| ;malfunction codes

|

| --- ELSE ---

|

| Do: imrc\_obdii\_code\_vac

| ;set or clear appropriate

| ;malfunction codes

|

END: imrc\_diagnostics\_main

18-18

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: imrc\_diagnostics\_bank1

When the IMRC valves are commanded to a position, they have a calibratable

opening time and closing time before the corresponding fault filter are

incremented. These filter are used as inputs to malfunction counters. The

stuck closed counter should be incremented only once per event.

IMRC\_RSP\_TMR >= IMRC\_CLS\_TIM -----|

;valves should have closed |

|

IMRC\_POSN\_1 = 1 ------------------|AND -| IMRC\_SO1\_FIL := ROLAV(1,

;bank 1 measuring open | | IMRC\_FALT\_TC)

| | ;increment the bank 1 stuck open

IMRC\_CMND = 0 --------------------| | ;fault filter

;commanding closed |

| IMRC\_STATE1 := 2

| ;indicate instantaneous failure

|

| --- ELSE ---

IMRC\_RSP\_TMR >= IMRC\_OPN\_TIM -----| |

;valves should have opened | |

| |

IMRC\_POSN\_1 = 0 ------------------| |

;bank 1 measuring closed |AND -| IMRC\_SC1\_FIL := ROLAV(1,

| | IMRC\_FALT\_TC

IMRC\_CMND = 1 --------------------| | ;increment the bank 1 stuck closed

;commanding open | | ;fault filter

| |

IMRC\_STAOLD1 <> 1 ----------| | | IMRC\_STATE1 := 1

;Stuck closed counter has | | | ;indicate instantaneous failure

;not incremnted this event |OR --| |

| |

CCM\_EO\_ENA = 1 -------------| |

;KOEO test in progress |

| --- ELSE ---

|

| IMRC\_STATE1 := 0

| ;clear failure indicator

18-19

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

If the valves are commanded to close, and the measured position indicates

they have closed, then the valves are not stuck open. Reset the stuck-open

filters and counters to zero. Likewise, if the valves are commanded open and

the measured position indicates they have opened, then reset both the stuck

closed filters and stuck closed counters. If the valves reach the commanded

position, reset the old status function, IMRC\_STAOLD(bank) to indicate that

the valves worked correctly on the last event.

IMRC\_CMND = 0 --------------------|

;commanding closed plates |AND -| IMRC\_SO1\_FIL := 0

| | ;plates closed properly

IMRC\_POSN\_1 = 0 ------------------| | ;at least once, reset

;measuring bank 1 plates | ;the bank 1 stuck open

;closed | ;filter

|

| IMRC\_SO1\_CNT := 0

| ;plates closed properly

| ;at least once, reset

| ;reset the bank 1 stuck

| ;open counter

|

| IMRC\_STAOLD1 = 0

| ;bank 1 functioned properly

|

| --- ELSE ---

IMRC\_CMND = 1 --------------------| |

;commanding open plates |AND -| IMRC\_SC1\_FIL := 0

| | ;plates opened properly

IMRC\_POSN\_1 = 1 ------------------| | ;at least once, reset

;measuring bank 1 plates | ;the bank 1 stuck closed

;open | ;filter

|

| IMRC\_SC1\_CNT := 0

| ;plates opened properly

| ;at least once, reset

| ;reset the bank 1 stuck

| ;closed counter

|

| IMRC\_STAOLD1 = 0

| ;bank 1 functioned properly

18-20

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

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If a fault filter exceeds the corresponding fault filter threshold, then the

fault counter is incremented. When the counter is incremented, the old

status flag is set to indicate that at least one failure increment occured.

IMRC\_SO1\_FIL > IMSO\_ERRLVL -------------| IMRC\_SO1\_CNT := IMRC\_SO1\_CNT + 1

| CLIP(IMRC\_SO1\_CNT,0,255)

| ;increment stuck open counter

|

| IMRC\_SO1\_FIL := 0

| ;clear filter so another

| ;error count can occur

|

| IMRC\_STAOLD1 := 2

| ;bank 1 is stuck open

IMRC\_SC1\_FIL > IMSC\_ERRLVL -------------| IMRC\_SC1\_CNT := IMRC\_SC1\_CNT + 1

| CLIP(IMRC\_SC1\_CNT,0,255)

| ;increment stuck closed counter

|

| IMRC\_SC1\_FIL := 0

| ;clear filter so another

| ;error count can occur

|

| IMRC\_STAOLD1 := 1

| ;bank 1 is stuck closed

Compare each banks stuck open fault counters to the stuck open fault count

threshold. If the levels are exceeded, then set the bank stuck open flag.

IMRC\_SO1\_CNT > IMSO\_CNT\_LVL ------------| IMRC\_BK1\_SOP := 1

| ;bank 1 is stuck open

|

| --- ELSE ---

|

| IMRC\_BK1\_SOP := 0

| ;Bank 1 is not stuck open

Compare each banks stuck closed fault counters to the stuck closed fault

count threshold. If the levels are exceeded, then set the bank stuck closed

flag.

IMRC\_SC1\_CNT > IMSC\_CNT\_LVL ------------| IMRC\_BK1\_SCL := 1

| ;bank 1 is stuck closed

|

| --- ELSE ---

|

| IMRC\_BK1\_SCL := 0

| ;bank 1 is not stuck closed

END: imrc\_diagnostics\_bank1

18-21

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: imrc\_diagnostics\_bank2

Determine the state and fault filter value for bank 2.

When the IMRC valves are commanded to a position, they have a calibratable

opening time and closing time before the corresponding fault filter are

incremented. These filter are used as inputs to malfunction counters. The

stuck closed counter should be incremented only once per event.

IMRC\_RSP\_TMR >= IMRC\_CLS\_TIM -----|

;valves should have closed |

|

IMRC\_POSN\_2 = 1 ------------------|AND -| IMRC\_SO2\_FIL := ROLAV(1,

;bank 2 measuring open | | IMRC\_FALT\_TC)

| | ;increment the bank 2 stuck open

IMRC\_CMND = 0 --------------------| | ;fault filter

;commanding closed |

| IMRC\_STATE2 := 2

| ;indicate instantaneous failure

|

| --- ELSE ---

IMRC\_RSP\_TMR >= IMRC\_OPN\_TIM -----| |

;valves should have opened | |

| |

IMRC\_POSN\_2 = 0 ------------------| |

;bank 2 measuring closed |AND -| IMRC\_SC2\_FIL := ROLAV(1,

| | IMRC\_FALT\_TC)

IMRC\_CMND = 1 --------------------| | ;increment the bank 2 stuck closed

;commanding open | | ;fault filter

| |

IMRC\_STAOLD2 <> 1 ----------| | | IMRC\_STATE2 := 1

;Stuck closed counter has | | | ;indicate instantaneous failure

;not incremnted this event |OR --| |

| |

CCM\_EO\_ENA = 1 -------------| |

;KOEO test in progress |

| --- ELSE ---

|

| IMRC\_STATE2 := 0

| ;clear instantaneous failure

18-22

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

If the valves are commanded to close, and the measured position indicates

they have closed, then the valves are not stuck open. Reset the stuck-open

filters and counters to zero. Likewise, if the valves are commanded open and

the measured position indicates they have opened, then reset both the stuck

closed filters and stuck closed counters. If the valves reach the commanded

position, reset the old status function, IMRC\_STAOLD(bank) to indicate that

the valves worked correctly on the last event.

IMRC\_CMND = 0 --------------------|

;commanding closed plates |AND -| IMRC\_SO2\_FIL := 0

| | ;plates closed properly

IMRC\_POSN\_2 = 0 ------------------| | ;at least once, reset

;measuring bank 2 plates | ;the bank 2 stuck open

;closed | ;filter

|

| IMRC\_SO2\_CNT := 0

| ;plates closed properly

| ;at least once, reset

| ;reset the bank 2 stuck

| ;open counter

|

| IMRC\_STAOLD2 := 0

| ;bank 2 functioned properly

|

| --- ELSE ---

IMRC\_CMND = 1 --------------------| |

;commanding open plates |AND -| IMRC\_SC2\_FIL := 0

| | ;plates opened properly

IMRC\_POSN\_2 = 1 ------------------| | ;at least once, reset

;measuring bank 2 plates | ;the bank 2 stuck closed

;open | ;filter

|

| IMRC\_SC2\_CNT := 0

| ;plates opened properly

| ;at least once, reset

| ;reset the bank 2 stuck

| ;closed counter

|

| IMRC\_STAOLD2 := 0

;bank 2 functioned properly

18-23

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

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If a fault filter exceeds the corresponding fault filter threshold, then the

fault counter is incremented. When the counter is incremented, the old

status flag is set to indicate that at least on failure increment occured.

IMRC\_SO2\_FIL > IMSO\_ERRLVL -------------| IMRC\_SO2\_CNT := IMRC\_SO2\_CNT + 1

| CLIP(IMRC\_SO2\_CNT,0,255)

| ;incrementstuck open

|

| IMRC\_SO2\_FIL := 0

| ;clear filter so another

| ;error count can occur

|

| IMRC\_STAOLD2 := 2

| ;bank 2 is stuck open

IMRC\_SC2\_FIL > IMSC\_ERRLVL -------------| IMRC\_SC2\_CNT := IMRC\_SC2\_CNT + 1

| CLIP(IMRC\_SC2\_CNT,0,255)

| ;increment stuck closed counter

|

| IMRC\_SC2\_FIL := 0

| ;clear filter so another

| ;error count can occur

|

| IMRC\_STAOLD2 := 1

| ;bank 2 is stuck closed

Compare each banks stuck open fault counters to the stuck open fault count

threshold. If the levels are exceeded, then set the bank stuck open flag.

IMRC\_SO2\_CNT > IMSO\_CNT\_LVL ------------| IMRC\_BK2\_SOP := 1

| ;bank 2 is stuck open

|

| --- ELSE ---

|

| IMRC\_BK2\_SOP := 0

| ;Bank 2 is not stuck open

Compare each banks stuck closed fault counters to the stuck closed fault

count threshold. If the levels are exceeded, then set the bank stuck closed

flag.

IMRC\_SC2\_CNT > IMSC\_CNT\_LVL ------------| IMRC\_BK2\_SCL := 1

| ;bank 2 is stuck closed

|

| --- ELSE ---

|

| IMRC\_BK2\_SCL := 0

| ;Bank 2 is not stuck closed

END: imrc\_diagnostics\_bank2

18-24

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: imrc\_obdii\_code\_elect

If the bank stuck open flags are set, then set the appropriate MIL function

codes. If the bank stuck closed flags are set, then set the appropriate

Non-MIL function codes. Currently, all electric IMRC applications have

position sensors on only one bank.

IMRC\_BK1\_SOP = 1 -----------------------| Do: malfunction(CCM,P1518)

;Bank 1 stuck open | ;plates stuck open

| ;set MIL malfunction flag

|

| --- ELSE ---

|

| clear\_malf(P1518)

| ;clear malfunction flag

IMRC\_BK1\_SCL = 1 -----------------------| store\_code(P1519)

;Bank 1 stuck closed | ;plates stuck closed

| ;set Non-MIL malfunction flag

|

| --- ELSE ---

|

| clear\_malf(P1519)

| ;clear malfunction flag

END: imrc\_obdii\_code\_elect

18-25

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DIAGNOSTICS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: imrc\_obdii\_code\_vac

If the bank stuck/open stuck closed flags are set, then set the appropriate

MIL function codes and Non-MIL function codes. For both banks stuck open

failure and one bank stuck open failure, calibratable switches are provided

to choose between MIL and Non-MIL codes. Stuck closed failures are Non-MIL

codes.

IMRC\_BK1\_SCL = 1 -----------------------| store\_code(P1512)

;Bank 1 stuck closed | ;set Non-MIL malfunction flag

|

| --- ELSE ---

|

| clear\_malf(P1512)

| ;clear malfunction flag

IMRC\_BK2\_SCL = 1 -----------------------| store\_code(P1513)

;Bank 2 stuck closed | ;set Non-MIL malfunction flag

|

| --- ELSE ---

|

| clear\_malf(P1513)

| ;clear malfunction flag

IMRC\_BK1\_SOP = 1 -----------------------| Do: malfunction(CCM,P1537)

;Bank 1 stuck open | ;set MIL malfunction flag

|

| --- ELSE ---

|

| clear\_malf(P1537)

| ;clear malfunction flag

IMRC\_BK2\_SOP = 1 -----------------------| Do: malfunction(CCM,P1538)

;Bank 2 stuck open | ;set MIL malfunction flag

|

| --- ELSE ---

|

| clear\_malf(P1538)

| ;clear malfunction flag

END: imrc\_obdii\_code\_vac

18-26

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, INPUT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

18.1.3 IMRC INPUT LOGIC (CDAM0)

OVERVIEW

This IMRC module determines the measured position of the IMRC valves and is

called from the IMRC command module if the sensor H/W present switch is

enabled (IMRCSENSHP = 1). It is configured for IMRC systems with either one

or two sensors. This configuration is detemined by the calibration switch,

IMRC\_TWOPOSN, such that,

IMRC\_TWOPOSN = 1 -> Two position sensors

IMRC\_TWOPOSN = 0 -> One position sensor. (Default)

In either case, the HWINT module passes two 10-bit (0 -> 1023 counts) A/D

values from ACH-13 and ACH-14. These count values, IMRCP1\_CNTS (ACH-13) and

IMRCP2\_CNTS (ACH-14), represent the voltage signals from the sensors on bank

1 and 2 respectively. If the system is configured for one sensor, then the

actual sensor is read from ACH-13.

Regardless of the sensor number, this module generates three measured

position outputs of the following form:

1 -> IMRC valve measured open.

0 -> IMRC valve measured closed.

There are two measured bank positions, IMRC\_POSN\_1 and IMRC\_POSN\_2, which are

used for OBDII diagnostics. If only one sensor is being used (IMRC\_TWOPOSN =

0), then the bit flag, IMRC\_POSN\_1 is copied to IMRC\_POSN\_2. The third

measured position output of this module, IMRC\_POSN, is used by the variable

cam timing strategy and the IMRC anti-sludging logic. The IMRC anti-sludging

logic is found in the the IMRC command module.

The measured position is determined by comparing the A/D counts to an "closed

counts window" and an "open counts window". For bank 1,

IMRC\_CNT1 <= IMRCP1\_CNTS <= IMRC\_CNT2 -> IMRC\_POSN\_1 = 0

IMRC\_CNT3 <= IMRCP2\_CNTS <= IMRC\_CNT4 -> IMRC\_POSN\_1 = 1

There is no diagnostic support for partially open/closed valves.

18-27

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, INPUT LOGIC - CDAN2

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DEFINITIONS

Registers:

- IMRC1\_FL\_TMR = IMRC1 sensor counts out-of-range timer.

- IMRC2\_FL\_TMR = IMRC2 sensor counts out-of-range timer.

- IMRCP1\_CNTS(Input) = A/D counts of bank 1 position sensor.

- IMRCP2\_CNTS(Input) = A/D counts of bank 2 position sensor.

Bit Flags:

- IMRC\_POSN(Output) = 1 -> All banks measured open, 0 -> Not all banks

are measured open.

- IMRC\_POSN\_1(Output) = Measured bank 1 valve position; 1 -> open.

- IMRC\_POSN\_2(Output) = Measured bank 2 valve position; 1 -> open.

- KAM\_ERROR = INDICATES KEEP ALIVE RAM INVALID.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II

scan tool reset message.

Calibrations Constants:

- IMRC\_CNT1 = Low count value of measured closed window.

- IMRC\_CNT2 = High count value of measured closed window.

- IMRC\_CNT3 = Low count value of measured open window.

- IMRC\_CNT4 = High count value of measured open window.

- IMRC\_FL\_TM = IMRC input out of range error time.

- IMRC\_TWOPOSN = Two IMRC position sensors present switch;

1 -> two sensors are being used. 0 -> 1 sensor being used.

OTHER

- P1516 = Bank 1 input error.

- P1517 = Bank 2 input error.

18-28

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, INPUT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: IMRC\_INPUT\_COM2

BEGIN: imrc\_input\_main

;This process is executed only when explicitly called.

In the event of an OBDII\_RESET or a KAM\_ERROR, reset all fault timers and

clear the malfuntion bits.

OBDII\_RESET = 1 ------------|

|OR --| IMRC1\_FL\_TMR := 0

KAM\_ERROR = 1 --------------| | IMRC2\_FL\_TMR := 0

| Do: clear\_malf(P1516)

| Do: clear\_malf(P1517)

Determine the measured valve position of bank 1, IMRC\_POSN\_1, by comparing

the sensor counts, IMRCP1\_CNTS, to the "closed window counts" and the "open

window counts".

IMRCP1\_CNTS >= IMRC\_CNT1 ---|

|AND -| IMRC\_POSN\_1 := 0

IMRCP1\_CNTS <= IMRC\_CNT2 ---| | ;IMRC bank 1 position is

| ;measured closed

| IMRC1\_FL\_TMR := 0

|

| --- ELSE ---

IMRCP1\_CNTS >= IMRC\_CNT3 ---| |

|AND -| IMRC\_POSN\_1 := 1

IMRCP1\_CNTS <= IMRC\_CNT4 ---| | ;IMRC bank 1 position is

| ;measured open

| IMRC1\_FL\_TMR := 0

|

| --- ELSE ---

|

| Allow IMRC1\_FL\_TMR to increment

| as a free-running timer.

| ;Bank 1 input error detected.

18-29

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, INPUT LOGIC - CDAN2

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If only one sensor is being used, then copy the bank 1 measured position,

IMRC\_POSN\_1, to the bank 2 measured position, IMRC\_POSN\_2. If two position

sensors are being used, then use the same algorithm as bank 1 for determining

the measured position.

IMRC\_TWOPOSN = 0 -----------------| IMRC\_POSN\_2 := IMRC\_POSN\_1

;There is only one sensor | ;Set IMRC bank 2 valave position

| ;equal to bank 1 valve position

| IMRC2\_FL\_TMR := 0

|

| --- ELSE ---

IMRCP2\_CNTS >= IMRC\_CNT1 ---| |

|AND -| IMRC\_POSN\_2 := 0

IMRCP2\_CNTS <= IMRC\_CNT2 ---| | ;IMRC Bank 2 position is

| ;measured closed

| IMRC2\_FL\_TMR := 0

|

| --- ELSE ---

IMRCP2\_CNTS >= IMRC\_CNT3 ---| |

|AND -| IMRC\_POSN\_2 := 1

IMRCP2\_CNTS <= IMRC\_CNT4 ---| | ;IMRC Bank 2 position is

| ;measured open

| IMRC2\_FL\_TMR := 0

|

| --- ELSE ---

|

| Allow IMRC2\_FL\_TMR to increment

| as a free-running timer.

| ;Bank 2 input error detected.

Determine the value of IMRC\_POSN for variable cam timing and anti-sludging

routine. If both valves are measured open, then the IMRC\_POSN is "open".

IMRC\_POSN\_1 = 1 ------------|

;IMRC bank 1 measured open |AND -| IMRC\_POSN := 1

| | ;IMRC valve is open

IMRC\_POSN\_2 = 1 ------------| |

;IMRC bank 2 measured open |

| --- ELSE ---

|

| IMRC\_POSN := 0

| ;IMRC valve is closed

18-30

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, INPUT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

IMRC1\_FL\_TMR >= IMRC\_FL\_TM -------| Do: malfunction(CCM,P1516)

;IMRC1 input out of range |

;too long |

| --- ELSE ---

|

| Do: clear\_malf(P1516)

IMRC2\_FL\_TMR >= IMRC\_FL\_TM -------| Do: malfunction(CCM,P1517)

;IMRC2 input out of range |

;too long |

| --- ELSE ---

|

| Do: clear\_malf(P1517)

END: imrc\_input\_main

18-31

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DRIVER DIAGNOSTICS - CDAN2

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18.1.4 IMRC DRIVER DIAGNOSTICS (CDAM0)

OVERVIEW

This IMRC module provides diagnostics for the IMRC output driver. The HWINT

module passes this module the IMRC driver fault bit flag, IMRC\_FAULT, which

is defined as follows:

A fault is present -> IMRC\_FAULT = 1

No fault is present -> IMRC\_FAULT = 0

The IMRC driver fault filter, P1520FIL, is the output of a first order low

pass filter routine, ROLAV, which is filtererd towards 1 if, IMRC\_FAULT = 1,

or towards 0 if, IMRC\_FAULT = 0. When the IMRC driver fault filter passes

the calibrated threshold, P1520\_ERRLVL, the malfunction code, P1520, is set.

An IMRC driver fault hysterisis calibration, P1520HYS, is provided to

prevent jittering of the malfunction flag (P1520MALF).

DEFINITIONS

Registers:

- P1520FIL = Value of driver fault error filter.

Bit Flags:

- IMRC\_FAULT(Input) = Driver fault status.

- KAM\_ERROR = INDICATES KEEP ALIVE RAM INVALID.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II

scan tool reset message.

Calibration Constants:

- IMRC\_FALT\_TC = Fault filter time constant.

- P1520\_ERRLVL = Threshold level to store code for output driver fault.

- P1520HYS = Filter hysterisis for driver fault filter.

OTHER

- P1520 = IMRC driver fault malfunction code.

18-32

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, DRIVER DIAGNOSTICS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: IMRC\_DIAG\_OSM\_COM1

BEGIN: imrc\_diagnostics\_osm\_main

;This process is executed only when explicity called.

In the event of an OBDII\_RESET or KAM\_ERROR, reset the fault filter and clear

the IRMC driver fault flag.

OBDII\_RESET = 1 ------------------|

|OR --| Do: clear\_malf(P1520)

KAM\_ERROR = 1 --------------------| | P1520FIL := 0

Determine the operational status of the IMRC output driver.

IMRC\_FAULT = 0 -------------------------| P1520FIL := ROLAV(0,IMRC\_FALT\_TC)

;no IMRC driver fault present | ;filter toward zero

|

|

| --- ELSE ---

|

|

IMRC\_FAULT = 1 -------------------------| P1520FIL := ROLAV(1,IMRC\_FALT\_TC)

;an IMRC driver fault is present | ;filter toward one

If the fault is present long enough to cause the fault filter to exceed a

threshold value, set the malfunction flag.

P1520FIL > P1520\_ERRLVL ----------------| Do: malfunction(CCM,P1520)

| ;set IMRC driver fault flag

|

|

| --- ELSE ---

|

|

P1520FIL < P1520\_ERRLVL - P1520HYS -----| Do: clear\_malf(P1520)

| ;clear IMRC driver fault flag

END: imrc\_diagnostics\_osm\_main

18-33

INTAKE MANIFOLD RUNNER CONTROL STRATEGY, OUTPUT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

18.1.5 IMRC OUTPUT CONTROL LOGIC (CDAL0)

OVERVIEW

This IMRC module deteremines if the IMRC solenoid should be energized by

comparing the commanded IMRC plate position, IMRC\_CMND, to the de-energized

IMRC position, IMRC\_OFF\_POS. If the commanded position is the same as the

de-energized position, then the solendoid input, IMRC\_OUT, is cleared to the

de-energized state, IMRC\_OUT = 0. If the commanded position is not the same

as the de-energized position, then the solenoid input is set to the energized

state, IMRC\_OUT = 1.

DEFINITIONS

Bit Flags:

- IMRC\_CMND(Input) = Commanded IMRC valve postion; 1 -> open, 0 -> closed.

- IMRC\_OUT(Output) = Commanded solenoid state; 1 -> energize 0 ->

de-energize.

Calibration Constants:

- IMRC\_OFF\_POS = De-energized position; 1 -> open, 0 -> closed.

PROCESS

STRATEGY MODULE: IMRC\_OUTPUT\_COM1

BEGIN: imrc\_output\_main

;This process is executed only when explicitly called.

IMRC\_CMND = IMRC\_OFF\_POS ---------------| IMRC\_OUT := 0

;IMRC command is the de-energized | ;De-energize IMRC

;position |

| --- ELSE ---

|

| IMRC\_OUT := 1

| ;Energize IMRC

END: imrc\_output\_main

18-34

CHAPTER 19

DATA OUTPUT LINK

19-1

DATA OUTPUT LINK, PULSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

19.1 PULSE CALCULATION (CDAI1)

OVERVIEW

The Data Output Link (DOL) provides fuel consumption information to the

vehicle dashboard fuel economy display products (Tripminder or Message

Center). The output, in the form of pulses, represents the amount of fuel

used since the last update. This information is used in calculating fuel

economy and distance-to-empty for display to the driver.

The injector fuel flow (in lbmf/(injector/port)) is accumulated in the

register FUEL\_SUM every time an injector port is energized. Once a

background loop, FUEL\_SUM is converted to the appropriate integer number of

DOL pulses, and DOL\_COUNT is updated according to the equation shown below.

The amount of FUEL\_SUM which cannot be converted to an integer count remains

in FUEL\_SUM for the next conversion.

Approximately every two milliseconds, the value of DOL\_COUNT is checked. If

DOL\_COUNT is greater than 1.0, the DOL output is energized for about one

msec, and DOL\_COUNT is reduced by 1.0.

DEFINITIONS

INPUTS

Registers:

- DOL\_COUNT = Number of pulses to be output to the Fuel Economy display

device.

- FUEL\_SUM = Accumulated fuel mass for one injector per output port since

the last DOL\_COUNT update, including the remainder from the previous

conversion, units in lbmf/(injector/port).

Calibration Constants:

- DOLHP = Data Output Link "hardware present" indicator. (0 = NO, 1 = YES)

- PUL\_PER\_GAL = Number of DOL pulses to be issued for each gallon of fuel

used, pulse per gal.

NOTE: THE VALUE FOR PUL\_PER\_GAL MUST BE OBTAINED FROM EED/INSTRUMENT

SYSTEMS FOR EACH APPLICATION.

OUTPUTS

Registers:

- DOL\_COUNT = See above.

- FUEL\_SUM = See above.

19-2

DATA OUTPUT LINK, PULSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: DOL\_PULSE\_CALC\_COM4

Once per background loop execute the following:

DOLHP = 1 ----------------| [pulses] :=

| FUEL\_SUM

| --------------------------------

| (6.15 lbmf/gallon) / PUL\_PER\_GAL

|

| DOL\_COUNT := DOL\_COUNT + integer([pulses])

|

| FUEL\_SUM := FUEL\_SUM -

| (integer([pulses]) \* 6.15 / PUL\_PER\_GAL)

19-3

DATA OUTPUT LINK, PULSE CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

19-4

CHAPTER 20

RIDE CONTROL

20-1

RIDE CONTROL STRATEGY - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

20.1 ADJUSTABLE SHOCK ABSORBER OUTPUT (CDAB0)

OVERVIEW

The adjustable shock absorber module is a stand alone module, separate from

the EEC IV, which controls shock absorber firmness. The EEC-IV ACL output

provides an indication of vehicle acceleration to the shock control module.

In some vehicles, the state of this output is sent to the adjustable shock

absorber module via the Standard Corporate Protocol (SCP) network. In

others, the ACL state is sent via a hardwired output from the EEC-IV to the

ride control module.

Other inputs to the shock module come directly from the appropriate sensor

(VSS, brake input, etc.). The ACL output will be set under engine running

conditions by the logic shown below to indicate hard acceleration. The ACL

output may also be set during key on, engine off conditions by a high TP

value in order to verify wiring harness (or SCP link) integrity during VIP.

DEFINITIONS

INPUTS

Registers:

- CYLARC\_BG = Air Charge Mass inducted per Intake Stroke, lbm/Intake.

- TP\_REL = Relative Throttle Position, counts.

Bit Flags:

- CRKFLG = Indicates status of engine; 1 -> engine is in CRANK mode.

Calibration Constants:

- HPACL = Hardware present switch to indicate if module includes output for

adjustable shock absorber; 1 -> Hardware present.

- SHK\_CHG = Minimum CYLARC\_BG value to indicate if hard acceleration.

Typical value: .00015 lbm/pip.

- SHKTP = Minimum number of throttle counts above the closed throttle

position (RATCH) to indicate hard acceleration. Typical value: 650

counts.

OUTPUTS

Bit Flags:

- ACL = Flag indicating vehicle acceleration to the shock control module.

20-2

RIDE CONTROL STRATEGY - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: RIDE\_CONTROL\_COM4

Determine the state of ride control output (Hardwire or SCP).

HPACL = 0 ------------------------------| EXIT

| (no change)

|

| --- ELSE ---

CRKFLG = 0 -----------------| |

(Underspeed/Run Modes) |AND -| |

| | |

CYLARC\_BG >= SHK\_CHG -------| |OR --| ACL = 1

(high engine load) | |

| |

| | --- ELSE ---

| |

TP\_REL >= SHKTP ------------------| |

(Large throttle opening) | ACL = 0

20-3

RIDE CONTROL STRATEGY - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

20-4

CHAPTER 21

EXPORT FEATURES

21-1

EXPORT FEATURES, SPEED WARNING CHIME - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

21.1 SPEED WARNING CHIME (CDAJ0)

OVERVIEW

Saudi Arabia has a legal requirement for a warning chime to sound when the

vehicle speed exceeds 75 mph. This strategy operates a chime when a

calibrateable vehicle speed has been exceeded.

In the event of a vehicle speed sensor fault, there will be no speed warning

chime.

There is no selftest output circuit check on SWC, however for test purposes

the chime can be switched on through the throttle operated Output Test Mode.

DEFINITIONS

INPUTS

Registers:

- VSBAR = Filtered Vehicle Speed.

- VSFMFLG = Vehicle speed sensor failure mode flag.

Calibration Constants:

- SWC\_HP = Speed Warning Chime hardware present switch; 1 -> Speed warning

chime hardware present, 0 -> No speed warning chime hardware present.

- SWCVS\_SH = Minimum vehicle speed to turn on Speed Warning Chime, mph.

- SWCVS\_CL = Maximum vehicle speed to turn off Speed Warning Chime, mph.

OUTPUTS

Bit Flags:

- SWC = Flag which determines the state of the speed warning chime; 1 ->

Chime is on, 0 -> Chime is off.

- SWCVS\_FLG = Flag indicating warning chime vehicle speed has been

exceeded; 1 -> vehicle speed exceeded, 0 -> vehicle speed not exceeded.

21-2

EXPORT FEATURES, SPEED WARNING CHIME - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EXP\_VS\_CHIME\_COM2

SWC\_HP = 0 ----------------------| Exit module

;no chime hardware present

VSBAR > SWCVS\_SH ----------------|S Q -| SWCVS\_FLG

|

VSBAR < SWCVS\_CL ----------------|C

VSFMFLG = 0 ---------------------| SWC := SWCVS\_FLG

;no VSS fault present |

| --- ELSE ---

|

| No operation on SWC

21-3

EXPORT FEATURES, SPEED WARNING CHIME - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

21-4

CHAPTER 22

ALTERNATIVE CALIBRATION

22-1

ALTERNATIVE CALIBRATION, CALIBRATION INITIALIZE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

22.1 CALIBRATION INITIALIZE LOGIC (CDAI0)

OVERVIEW

The purpose of the alternate calibration strategy is to run the vehicle in a

pre-delivery condition in order to protect against spark plug fouling.

This module sets the flag which will invoke the alternate calibration. To do

this, it looks at the value of the parameter NO\_OF\_STARTS which may have been

downloaded at end of line via SCP, and it also checks the check byte which is

the one's complement of NO\_OF\_STARTS. The value of NO\_OF\_STARTS is

subsequently decremented. These checks are performed during the RAM

initialization process only.

DEFINITIONS

INPUTS

Registers:

- NO\_OF\_STARTS = Number of starts using alternative calibration.

- NO\_START\_CHK = Number of starts, check byte.

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

OUTPUTS

Registers:

- NO\_OF\_STARTS = See above.

- NO\_START\_CHK = See above.

Bit Flags:

- ALT\_CAL\_FLG = See above.

22-2

ALTERNATIVE CALIBRATION, CALIBRATION INITIALIZE LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ALTR\_CAL\_INIT\_COM1

Performed during RAM Initialization only.

NO\_OF\_STARTS > 0 ------------------|

|AND -| ALT\_CAL\_FLG = 1

NO\_START\_CHK = 255 - NO\_OF\_STARTS -| |

| --- ELSE ---

|

| ALT\_CAL\_FLG = 0

ALT\_CAL\_FLG = 1 -------------------------| Decrement NO\_OF\_STARTS

| Increment NO\_START\_CHK

|

| --- ELSE ---

|

| Do nothing

22-3

ALTERNATIVE CALIBRATION, CALIBRATION CLEAR LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

22.2 CALIBRATION CLEAR LOGIC (CDAI0)

OVERVIEW

This module erases any remaining alternate calibration starts should the

vehicle travel further than ALT\_CAL\_DIST in any one journey. The value of

ALT\_CAL\_FLG is also set each background loop to reduce the effect of any

possible corruption of the register that may occur.

Should the VSS fail while using the alternate calibration, the distance will

be ignored and the alternate calibration will be exited immediately. This

will prevent this calibration from being in the customers hands and prevent

the calibration from being active during an EOL emissions test if the VSS had

failed.

DEFINITIONS

INPUTS

Registers:

- BG\_TMR = Background loop timer.

- DISTANCE = Distance traveled since start, miles.

- NO\_OF\_STARTS = Number of starts using alternative calibration.

- NO\_START\_CHK = Number of starts, check byte.

- VSBAR = Filtered vehicle speed.

Calibration Constants:

- ALT\_CAL\_DIST = Distance traveled before alternate calibration is revoked,

miles.

OUTPUTS

Registers:

- DISTANCE = See above.

- NO\_OF\_STARTS = See above.

- NO\_START\_CHK = See above.

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

22-4

ALTERNATIVE CALIBRATION, CALIBRATION CLEAR LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: ALTR\_CAL\_CLR\_COM1

DISTANCE = DISTANCE + (VSBAR \* BG\_TMR) / 3600

VSFMFLG = 1 -----------------------|

|OR --| NO\_OF\_STARTS = 0

DISTANCE > ALT\_CAL\_DIST -----------| | NO\_START\_CHK = 0

| ALT\_CAL\_FLG = 0

|

| --- ELSE ---

NO\_OF\_STARTS > 0 ------------------| |

|AND -| ALT\_CAL\_FLG = 1

NO\_START\_CHK = 255 - NO\_OF\_STARTS -| |

| --- ELSE ---

|

| ALT\_CAL\_FLG = 0

22-5

ALTERNATIVE CALIBRATION, CALIBRATION CLEAR LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

22-6

CHAPTER 23

OBDII STRATEGY

23-1

OBDII STRATEGY

23.1 FEATURE: OBDII EXECUTIVE - V1.4B\_OBDII\_EXEC (CDAN0)

23.1.1 DIAGNOSTIC SCHEDULER (CDAN0)

OVERVIEW

+---------------------------------+

| OBDII\_SCHEDULER\_COM1 |

+---------------------------------+

| PUBLIC PROCESSES: |

| . definitions |

| . scan\_tool\_interface |

| . diagnostic\_scheduler\_control |

| . determine\_demand\_mode |

| . parameter\_reset\_signal\_control|

+---------------------------------+

| PRIVATE PROCESSES: |

| . diagnostic\_scheduler |

| . disable\_all\_monitors |

| . enable\_cont\_monitors |

| . scheduler\_delay |

+---------------------------------+

The OBD-II Executive Diagnostic Scheduler is the software module that

controls and coordinates the execution of the individual OBD-II system

monitors (EGO, CAT, PURG, SAIR, FUEL, MIS, EGR, CCM) and the On-Demand self

test procedures (ER, EO, OTM). The diagnostic scheduler enables/disables

diagnostic tests in order to effect the following requirements:

- Provide mutual exclusion between tests that are intrusive, or would

otherwise interfere with one another.

- Ensure that all OBD-II required tests have an opportunity to run during

the first two bags of a CVS-75 test.

- Sequence OBD-II tests such that when a test runs, each input that it

relies upon has already been tested.

- Interface with the scan tool to coordinate the performance of special

requests or tests.

- Perform elegant transitions between the various states of the diagnostic

system, so as not to adversely affect the operation of the vehicle.

- Allow the engine-off, engine-running, and output test mode self test

routine to execute. All control of other monitors is turned over to the

individual sequence controller for the diagnostic procedure.

The diagnostic executive is the realization of a finite state machine

controlling the sequencing and mutual exclusion needed for the intrusive

tests. See the finite state machine diagrams on the following pages for more

detail on how the system functions.

23-2

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The diagnostic scheduler also monitors the scan tool interface in

anticipation of an OBD-II reset command from the scan tool. When an OBD-II

reset message is received from the scan tool, the strategy takes several

actions in order to place the OBD-II system in a state of reset. This

includes resetting both the trip monitoring system, and the MIL controllers.

The SCP communications interface sets the OBDII\_RESET flag when a reset

message is received. The logic below clears the flag, and effects the

required reset actions.

There is a manual mode of operation available to the developer. This can be

invoked in one way: through the calibration of the sys\_TST\_SW bits. When

the corresponding bit of a system monitor is set, the monitor is enabled and

the test will be executed. By clearing all but one of the sys\_TST\_SW bits,

only one test will ever be executed. The automatic scheduling of tests

continues in this mode, only scheduling those which have been selected.

The enable flags are mapped into the byte called OBDII\_TST\_SW as follows:

bit 0 = CAT\_TST\_SW

bit 1 = CCM\_TST\_SW

bit 2 = PURG\_TST\_SW

bit 3 = SAIR\_TST\_SW

bit 4 = FUEL\_TST\_SW

bit 5 = EGO\_TST\_SW

bit 6 = EGR\_TST\_SW

bit 7 = MIS\_TST\_SW

For development purposes, the OBD-II system may be placed in a state of reset

by writing a 1 to the OBDII\_RESET flag with an RCON. This will have the same

affect as receipt of the reset message from the scan tool.

23-3

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Below is a description of how a finite state machine functions.

A finite state machine is a way to graphically illustrate the functioning of

a system or process that can be in a set of DISCRETE states. The diagram

shows how and when transitions can occur between the states.

+----------------------+

| |

| STATE X |<-------------------

| | condition

+-----+----------A-----+ ---------

| | action

| |

condition | | condition

--------- | | ---------

action | | action

| |

| |

+-----V----------+-----+

| |

| STATE Y |

| |

+----------------------+

CONVENTIONS:

· BOXES represent STATES of the system.

· ARROWS represent TRANSITIONS between states.

· CONDITIONS will CAUSE a transition to be taken.

· ACTIONS are done WHEN a transition is taken.

RULES:

· The system can be in only one state at a time.

· The system remains in a given state until an event

occurs to cause a transition.

· No other transitions than those shown can be taken.

23-4

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Finite State Machine Diagram

ENGINE OFF On-Demand Test Control

EO\_TST\_RDY=0 &

SCPEO\_START=1

-------------

send(GENERAL\_RESPONSE:

7Fh,31h,81h,00h,00h,22h)

SCPEO\_START=0

+------+

| |

| +--V--------+

+---| any state |

| except |

| eo\_running|

+-----+-----n

|

| EO\_TST\_RDY=1 &

| SCPEO\_START=1

| -------------

| send(GENERAL\_RESPONSE:

| 7Fh,31h,81h,00h,00h,00h)

| disable\_all\_monitors

| EO\_TST\_ENA=1

| SCPEO\_START=0

| inc\_warmup\_counters

| RESULTS=0

|

+-----V-----+

| eo\_running|

+------------------------| state |----------------+

| +-----+---- 8 |

| | |

| SCPEO\_EXIT=1 |EO\_MON=1 | EO\_TST\_RDY=0

| ------------ |------------ | ------------

| EO\_TST\_ENA=0 |EO\_TST\_ENA=0 | EO\_TST\_ENA=0

| send(GENERAL\_RESPONSE: |EO\_MON=0 |

| 7Fh,32h,81h,00h,00h,64h) |RESULTS=1 |

| SCPEO\_EXIT=0 | |

| | |

+--------------------------+ | +------------------+

| | |

+-V---V---V-+

| initial |

| state |

+-----------0

23-5

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Finite State Machine Diagram

ENGINE ON On-Demand Test Control

ER\_TST\_RDY=0 &

SCPER\_START=1

-------------

send(GENERAL\_RESPONSE:

7Fh,31h,82h,00h,00h,22h)

SCPER\_START=0

+------+

| |

| +--V--------+

+---| any state |

| except |

| er\_running|

+-----+-----n

|

|

| ER\_TST\_RDY=1 &

| SCPER\_START=1

| -------------

| send(GENERAL\_RESPONSE:

| 7Fh,31h,82h,00h,00h,00h)

| disable\_all\_monitors

| ER\_TST\_ENA=1

| SCPER\_START=0

| inc\_warmup\_counters

| RESULTS=0

|

+-----V-----+

| er\_running|

+------------------------| state |----------------+

| +-----+---- 7 |

| | |

| SCPER\_EXIT=1 |ER\_MON=1 | ER\_TST\_RDY=0

| ------------ |------------ | ------------

| ER\_TST\_ENA=0 |ER\_TST\_ENA=0 | ER\_TST\_ENA=0

| send(GENERAL\_RESPONSE: |ER\_MON=0 |

| 7Fh,32h,82h,00h,00h,64h) |RESULTS=1 |

| SCPER\_EXIT=0 | |

| | |

+--------------------------+ | +------------------+

| | |

+-V---V---V-+

| initial |

| state |

+-----------0

23-6

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Finite State Machine Diagram

OUTPUT TEST MODE On-Demand Test Control

OTM\_TST\_RDY=0 &

SCPOTM\_START=1

-------------

send(GENERAL\_RESPONSE:

7Fh,31h,84h,00h,00h,22h)

SCPOTM\_START=0

+------+

| |

| +--V--------+

+---| any state |

| except |

|otm\_running|

+-----+-----n

|

| OTM\_TST\_RDY=1 &

| SCPOTM\_START=1

| -------------

| send(GENERAL\_RESPONSE:

| 7Fh,31h,84h,00h,00h,00h)

| disable\_all\_monitors

| OTM\_TST\_ENA=1

| SCPOTM\_START=0

| inc\_warmup\_counters

| RESULTS=0

|

+-----V-----+

|otm\_running|

+------------------------| state |

| +-----+---- 9

| |

| SCPOTM\_EXIT=1 | OTM\_TST\_RDY=0

| ------------ | ------------

| OTM\_TST\_ENA=0 | OTM\_TST\_ENA=0

| send(GENERAL\_RESPONSE: |

| 7Fh,32h,84h,00h,00h,61h) |

| SCPOTM\_EXIT=0 |

| RESULTS=1 |

+--------------------------+ |

| |

+-V---V-----+

| initial |

| state |

+-----------0

23-7

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Finite State Machine Diagram

EGO Monitor Control

+-----------+

| |<--- .PUTMR<4 seconds OR

| initial | .On-Demand Exit OR

| state | .OBDII\_RESET=true OR

+----------------| | .KAM\_ERROR=true OR

| +--+--------0 --------------------

| | .disable\_all\_monitors

·UNDSP=0 & | ·UNDSP=0 & |

·PUTMR>=4 & | ·PUTMR>=4 & |

·EGO\_TST\_SW=0 | ·EGO\_FMEM=0 & |

OR EGO\_MON=1 | ·EGO\_TST\_SW=1 & |

----------------- | ·EGO\_MON=0 & |

·EGO\_TST\_ENA=0 | --------------- | ·EGO\_DEL\_TMR=0 &

| ·EGO\_TST\_ENA=1 | ·EGO\_FMEM=0

| +--v--------+ ------------------

| |EGO monitor| ·EGO\_TST\_ENA=1

| | enabled |<--------------------+

| +----+----- 1 |

| | +-----------+ |

| ·EGO\_TST\_RDY=1 | |EGO monitor|------+

| -------------- | | aborted |<-----+

| ·change state | +---------- 3 |

| +----v------+ |

| |EGO monitor| |

| | running |---------------------+

| +----+----- 2 ·EGO\_FMEM=1 OR

| ·EGO\_MON=1 | ·EGO\_MON=0 &

| -------------- | EGO\_TST\_RDY=0

| ·EGO\_TST\_ENA=0 | ----------------

| | ·EGO\_TST\_ENA=0

+-------------------+ | ·EGO\_DEL\_TMR=EGO\_DEL\_TM

| |

A B

(continued on next page)

23-8

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Finite State Machine Diagram

SAIR/PURG Monitor Control

and Mutual Exclusion

(continued from previous page)

A B

| |

| |

·SAIR\_TST\_RDY=0 OR | | ·PURG\_TST\_RDY=0 OR

·SAIR\_FMEM=1 OR | | ·PURG\_FMEM=1 OR

·SAIR\_MON=1 | | ·PURG\_MON=1

------------------------- | | ------------------------

·SAIR\_DEL\_TMR=SAIR\_DEL\_TM | | ·PURG\_DEL\_TM=PURG\_DEL\_TM

·SAIR\_TST\_ENA=0 | | ·PURG\_TST\_ENA=0

+------------------+ | | +-----------------------+

| | | | | |

| +-----------+ | | | | +-----------+ |

+--|SAIRmonitor| | | | | |PURGmonitor|----+

+->| running | | | | | | running |<---+

| +---------- 6 | | | | +---------- 5 |

| +v--v-v--v--+ |

| | SAIR/PURG | |

+-----------------|ARBITRRATOR|--------------------+

+---------- 4

|

·SAIR\_TST\_SW=1 & | ·PURG\_TST\_SW=1 &

·SAIR\_TST\_RDY=1 & | ·PURG\_TST\_RDY=1 &

·SAIR\_FMEM=0 & | ·PURG\_FMEM=0 &

·SAIR\_DEL\_TMR=0 & | ·PURG\_DEL\_TMR=0 &

·SAIR\_MON=0 | ·PURG\_MON=0

----------------- | ------------------

·SAIR\_TST\_ENA=1 | ·PURG\_TST\_ENA=1

|

|

·PURG\_MON=1 OR |

PURG\_TST\_SW=0 & |

·SAIR\_MON=1 OR |

SAIR\_TST\_SW=0 & |

|

+-----v-----+

| Final |

| state |

+---------- 10

23-9

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- ATMR3 = Time in run mode.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag; 1 -> test

enabled.

- CCM\_TST\_RDY = CCM test ready flag; 1 -> all local conditions have be en

met; rea dy to run CCN test.

- EGO\_DEL\_TMR = Time remaining before re-attempting EGO Monitor enablement.

- EGO\_TST\_RDY = EGO test ready flag; 1 -> all local conditions have been

met; ready to run EGO test.

- EGR\_TST\_ENA = OBD-II EGR Test enable flag; 1 -> test enabled.

- EGR\_TST\_RDY = EGR test ready flag; 1 -> all local conditions have been

met; ready to run EGR test.

- EO\_STATUS = State pointer that indicates current state of engine off on

demand test sequence.

- ER\_STATUS = State pointer that indicated current state of engine running

on demand test.

- FUEL\_TST\_ENA = OBD-II Fuel Test enable flag; 1 -> test enabled.

- FUEL\_TST\_RDY = Fuel system test ready flag; 1 -> all local conditions

have been met; ready to run fuel test.

- KAM\_ERROR = Indicates keep alive RAM invalid.

- MIS\_TST\_ENA = OBD-II Misfire Test enable flag; 1 -> test enabled.

- OTM\_TST\_ENA = Flag to activate the output test mode on demand test.

- OTM\_TST\_RDY = Flag to signal the OBD-II executive that the output test

mode is ready.

- PURG\_DEL\_TMR = Minimum possible time remaining before re-attempting PURG

Monitor enablement.

- PURG\_TST\_RDY = PURG test ready flag; 1 -> all local conditions have been

met; ready to run PURG test.

- PUTMR = Time after CPU power up.

- SAIR\_DEL\_TMR = Minimum possible time remaining before re-attempting SAIR

Monitor enablement.

- SAIR\_TST\_RDY = SAIR test ready flag; 1 -> all local conditoins have been

met; ready to run test.

23-10

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- CAT\_FMEM = CAT system FMEM flag; 1 -> don't run CAT system due to FMEM.

- CAT\_TST\_ENA = OBDII catalyst test enable flag; 1 -> test enabled.

- CCM\_FMEM = CCM system FMEM flag; 1 -> don't run CCM due to FMEM.

- DEMAND\_MODE = Flag set when an On-Demand self test mode is active.

- EGO\_FMEM = EGO system FMEM flag; 1 -> don't run EGO monitor due to FMEM.

- EGO\_MON = OBDII monitor flag for EGO system; 1 -> all fuel faults been

monitored since power-up.

- EGO\_TST\_ENA = OBDII EGO test enable flag; 1 -> test enabled.

- EGR\_FMEM = EGR system FMEM flag; 1 -> don't run EGR monitor due to FMEM

- EO\_MON = Flag indicating the engine off on-demand test is complete.

- EO\_TST\_ENA = Flag to activate engine off on demand test.

- EO\_TST\_RDY = Flag that signals OBD-II executive that the engine off test

is able to run.

- ER\_MON = Flag indicating the engine running on demand test is complete.

- ER\_TST\_ENA = Flag to signal engine running on demand test to run.

- ER\_TST\_RDY = Flag to signal OBD-II executive that the engine running on

demand test is able to run.

- FLG\_CONT\_MON = Flag set when continuous monitors are enabled in the OBDII

system.

- FUEL\_FMEM = FUEL system FMEM flag; 1 -> don't run FUEL monitor due to

system FMEM.

- MIS\_FMEM = MIS system FMEM flag; 1 -> don't run MIS monitor due to FMEM.

- OBDII\_RESET = Flag used to simulate the erceipt of an OBD-II scan tool

reset message.

- OBDII\_STATE = Current state of the OBDII scheduler.

- OBD\_PARM\_RST = OBDII parameter reset signal; 1-> reset parameters.

- PURG\_FMEM = PURG system FMEM flag; 1 -> don't run PURG monitor due to

FMEM.

- PURG\_MON = OBDII monitor flag for evaporative purge; 1 -> all purge

faults been monitored since power-up.

- PURG\_TST\_ENA = OBDII purg test enable flag. (1 -> test enabled)

- RESET\_DONE = Flag used to notify that an OBD-II scan tool reset occurred

the previous background loop.

23-11

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- RESULTS = Flag indicating self test results are available, 1 -> results

available.

- SAIR\_FMEM = SAIR system FMEM flag; 1 -> don't run SAIR monitor due to

FMEM.

- SAIR\_MON = Secomdary air has been monitored for OBD-II trip.

- SAIR\_TST\_ENA = OBDII secondary air test enable flag. (1 -> test enabled)

- SCPEO\_EXIT = Siganl to abort the engine off self test.

- SCPEO\_START = Siganl to start the engine off self test.

- SCPER\_EXIT = Signal to abort the engine running self test.

- SCPER\_START = Signal to start the engine running self test.

- SCPOTM\_EXIT = Signal to abort the output test mode diagnostic procedure.

- SCPOTM\_START = Siganl to start output test mode diagnostic procedure.

- UNDSP = Underspeed flag.

Calibration Constants:

- CAT\_TST\_SW = CAT test present calibration switch; 1 -> CAT test present.

- CCM\_TST\_SW = CCM test present calibration switch; 1 -> CCM test present.

- ECU\_EO\_INIT = Value of EO\_STATUS to signal for ECU test (Instruction,

KAM, RAM, ROM), pointer.

- EGO\_DEL\_TM = Time delay between succesive runs of the EGO monitor.

- EGO\_TST\_SW = EGO test present calibration switch; 1 -> EGO test present.

- EGR\_TST\_SW = EGR test present calibration switch; 1 -> EGR test present.

- EO\_DONE = Value of EO\_STATUS when engine off on demand t est is complete.

- ER\_DONE = Value of ER\_STATUS when engine running test is complete.

- ER\_INIT = Value for state of ER\_STATUS when engine running test first

inits.

- FUEL\_TST\_SW = FUEL test present calibration switch; 1 -> FUEL test

present.

- MIS\_TST\_SW = MIS test present calibration switch; 1 -> MIS test present.

- OBDII\_DELAY = Time into run mode before enabling any continuous OBD-II

monitor.

- PURG\_DEL\_TM = Time delay between succesive runs of the PURG monitor.

- PURG\_TST\_SW = PURG test present calibration switch; 1 -> PURG test

present.

23-12

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SAIR\_DEL\_TM = Time delay between succesive runs of the SAIR monitor.

- SAIR\_TST\_SW = SAIR test present calibration switch; 1 -> SAIR test

present.

OTHER

- clear\_ff = Logic process imported form the Freeze Frame module.

- reset\_codes = Logic process imported form the CODES module.

- reset\_mil = Logic process imported fromt the MIL module.

- reset\_trips = Logic process imported from the TRIPS module.

23-13

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: OBDII\_SCHEDULER\_COM1

BEGIN: definitions

;This process is not to be specifically executed. It exists only to make

;the documentation more readable.

unconditionally -----------------------------| initial\_state = 0

;set local symbols to improve | ego\_mon\_enabled = 1

;readability of documentation | ego\_mon\_running = 2

| ego\_mon\_aborted = 3

| sair\_purg\_arb = 4

| sair\_mon\_running = 5

| purg\_mon\_running = 6

| er\_running = 7

| eo\_running = 8

| otm\_running = 9

| final\_state = 10

| true = 1

| false = 0

END: definitions

23-14

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: parameter\_reset\_signal\_control

(executed each background loop)

OBDII\_RESET = true --------------------|

|

KAM\_ERROR = true ----------------------|

| |

ER\_STATUS = ER\_INIT -------------------| |

|OR --| OBD\_PARM\_RST := true

ER\_STATUS = ER\_DONE--------------------| |

| |

EO\_STATUS = ECU\_EO\_INIT----------------| |

| |

EO\_STATUS = EO\_DONE--------------------| |

| --- ELSE ---

|

| OBD\_PARM\_RST := false

END: parameter\_reset\_signal\_control

BEGIN: scan\_tool\_interface

(executed each background loop)

OBDII\_RESET = true --------------------|

|AND -| OBDII\_RESET = false

RESET\_DONE = true ---------------------| | RESET\_DONE = false

| ;wait 1 background loop

| ; to clear OBDII\_RESET

KAM\_ERROR = true ----------------------|

|OR --| OBDII\_STATE = initial\_state

OBDII\_RESET = true --------------------| | Do: disable\_all\_monitors

(obdII reset requested) | (reset sequence controller)

| Do: reset\_mil

| (notify mil control module)

| Do: clear\_ff

| (notify freeze frame control

| module)

| Do: reset\_trips

| (notify trips module)

| Do: reset\_codes

| (notify fault code module)

| Do: reset\_drive\_cycle

| (notify drive cycle module)

| Do: reset\_fmem

| (notify system FMEM module)

| RESULTS = false

OBDII\_RESET = true --------------------------| RESET\_DONE = true

END: scan\_tool\_interface

23-15

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: diagnostic\_scheduler\_control

(executed ONCE per background loop)

PUTMR >= 4 ----------------------------------| Do: check\_sys\_mon\_complete

| Do: system\_fmem

| Do: diagnostic\_scheduler

|

| --- ELSE ---

|

| Do: disable\_all\_monitors

| OBDII\_STATE = initial\_state

END: diagnostic\_scheduler\_control

BEGIN: disable\_all\_monitors

(called from other processes)

unconditionally -----------------------------| CCM\_TST\_ENA = false

| EGR\_TST\_ENA = false

| FUEL\_TST\_ENA = false

| MIS\_TST\_ENA = false

| EGO\_TST\_ENA = false

| SAIR\_TST\_ENA = false

| PURG\_TST\_ENA = false

| CAT\_TST\_ENA = false

| ER\_TST\_ENA = false

| EO\_TST\_ENA = false

| OTM\_TST\_ENA = false

| FLG\_CONT\_MON = false

END: disable\_all\_monitors

23-16

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: enable\_cont\_monitors

(called from diagnostic\_scheduler process)

CAT\_TST\_SW = true ---------------------|

|AND -| CAT\_TST\_ENA = true

CAT\_FMEM = false ----------------------| |

| --- ELSE ---

|

| CAT\_TST\_ENA = false

CCM\_TST\_SW = true ---------------------|

|

CCM\_TST\_RDY = true --------------------|AND -| CCM\_TST\_ENA = true

| |

CCM\_FMEM = false ----------------------| |

| --- ELSE ---

|

| CCM\_TST\_ENA = false

EGR\_TST\_SW = true ---------------------|

|

EGR\_TST\_RDY = true --------------------|AND -| EGR\_TST\_ENA = true

| |

EGR\_FMEM = false ----------------------| |

| --- ELSE ---

|

| EGR\_TST\_ENA = false

FUEL\_TST\_SW = true --------------------|

|AND -| FUEL\_TST\_ENA = true

FUEL\_FMEM = false ---------------------| |

| --- ELSE ---

|

| FUEL\_TST\_ENA = false

MIS\_TST\_SW = true ---------------------|

|AND -| MIS\_TST\_ENA = true

MIS\_FMEM = false ----------------------| |

| --- ELSE ---

|

| MIS\_TST\_ENA = false

unconditionally -----------------------------| FLG\_CONT\_MON = true

END: enable\_cont\_monitors

23-17

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: diagnostic\_scheduler

;called from diagnostic\_scheduler\_control process.

EO\_TST\_RDY = true ---------------------|

|

SCPEO\_START = true --------------------|AND -| OBDII\_STATE = eo\_running

| | Do: disable\_all\_monitors

OBDII\_STATE <> eo\_running -------------| | EO\_TST\_ENA = true

| SCPEO\_START = false

| Do: inc\_warmup\_counters

| send(GENERAL\_RESPONSE:

| 7Fh,31h,81h,00h,00h,00h)

| RESULTS = false

|

| --- ELSE ---

OBDII\_STATE <> eo\_running -------------| |

|AND -| send(GENERAL\_RESPONSE:

SCPEO\_START = true --------------------| | 7Fh,31h,81h,00h,00h,22h)

| ;unable to enter self-test

| SCPEO\_START = false

ER\_TST\_RDY = true ---------------------|

|

SCPER\_START = true --------------------|AND -|

| | OBDII\_STATE = er\_running

OBDII\_STATE <> er\_running -------------| | Do: disable\_all\_monitors

| ER\_TST\_ENA = true

| SCPER\_START = false

| Do: inc\_warmup\_counters

| send(GENERAL\_RESPONSE:

| 7Fh,31h,82h,00h,00h,00h)

| RESULTS = false

|

| --- ELSE ---

OBDII\_STATE <> er\_running -------------| |

|AND -| send(GENERAL\_RESPONSE:

SCPER\_START = true --------------------| | 7Fh,31h,82h,00h,00h,22h)

| ;unable to enter self-test

| SCPER\_START = false

23-18

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OTM\_TST\_RDY = true --------------------|

|

SCPOTM\_START = true -------------------|AND -| OBDII\_STATE = otm\_running

| | Do: disable\_all\_monitors

OBDII\_STATE <> otm\_running ------------| | OTM\_TST\_ENA = true

| SCPOTM\_START = false

| Do: inc\_warmup\_counters

| send(GENERAL\_RESPONSE:

| 7Fh,31h,84h,00h,00h,00h)

| RESULTS = false

|

| --- ELSE ---

OBDII\_STATE <> otm\_running ------------| |

|AND -| send(GENERAL\_RESPONSE:

SCPOTM\_START = true -------------------| | 7Fh,31h,84h,00h,00h,22h)

| ;unable to enter output

| ;test mode

| SCPOTM\_START = false

23-19

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OBDII\_STATE = er\_running --------------|

|AND -| OBDII\_STATE = initial\_state

ER\_MON = true -------------------------| | ER\_TST\_ENA = false

;engine running self-test complete. | ER\_MON = false

| RESULTS = true

|

| --- ELSE ---

OBDII\_STATE = er\_running --------------| |

|AND -| OBDII\_STATE = initial\_state

SCPER\_EXIT = true ---------------------| | ER\_TST\_ENA = false

| SCPER\_EXIT = false

| send(GENERAL\_RESPONSE:

| 7Fh,32h,82h,00h,00h,64h)

| ;test aborted, no results.

|

| --- ELSE ---

OBDII\_STATE = er\_running --------------| |

|AND -| ER\_TST\_ENA = false

ER\_TST\_RDY = false --------------------| | OBDII\_STATE = initial\_state

OBDII\_STATE = eo\_running --------------|

|AND -| OBDII\_STATE = initial\_state

EO\_MON = true -------------------------| | EO\_TST\_ENA = false

;engine off self-test complete. | EO\_MON = false

| RESULTS = true

|

| --- ELSE ---

OBDII\_STATE = eo\_running --------------| |

|AND -| OBDII\_STATE = initial\_state

SCPEO\_EXIT = true ---------------------| | EO\_TST\_ENA = false

| SCPEO\_EXIT = false

| send(GENERAL\_RESPONSE:

| 7Fh,32h,81h,00h,00h,64h)

| ;test aborted, no results.

|

| --- ELSE ---

OBDII\_STATE = eo\_running --------------| |

|AND -| EO\_TST\_ENA = false

EO\_TST\_RDY = false --------------------| | OBDII\_STATE = initial\_state

OBDII\_STATE = otm\_running -------------|

|AND -| OBDII\_STATE = initial\_state

SCPOTM\_EXIT = true --------------------| | OTM\_TST\_ENA = false

| SCPOTM\_EXIT = false

| send(GENERAL\_RESPONSE:

| 7Fh,32h,84h,00h,00h,61h)

| RESULTS = true

|

| --- ELSE ---

OBDII\_STATE = otm\_running -------------| |

|AND -| OTM\_TST\_ENA = false

OTM\_TST\_RDY = false -------------------| | OBDII\_STATE = initial\_state

23-20

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ATMR3 >= OBDII\_DELAY ------------------|

|

UNDSP = false -------------------------|

|

OBDII\_STATE <> eo\_running -------------|AND -| Do: enable\_cont\_monitors

| | (RUN mode, not in self-test)

OBDII\_STATE <> er\_running -------------| | EO\_TST\_ENA := false

| | ER\_TST\_ENA := false

OBDII\_STATE <> otm\_running ------------| | OTM\_TST\_ENA := false

|

| --- ELSE ---

OBDII\_STATE <> eo\_running -------------| |

| |

OBDII\_STATE <> er\_running -------------|AND -| Do: disable\_all\_monitors

| | OBDII\_STATE = initial\_state

OBDII\_STATE <> otm\_running ------------| | Exit this process.

| (not RUN mode, not

| self-test)

|

| --- ELSE ---

|

| Exit this process.

| (in self-test)

OBDII\_STATE = ego\_mon\_aborted ---|

|

EGO\_DEL\_TMR = 0 -----------------|AND -|

| |

EGO\_FMEM = false ----------------| |

|

OBDII\_STATE = initial\_state -----| |OR --| OBDII\_STATE = ego\_mon\_enabled

| | | EGO\_TST\_ENA = true

EGO\_MON = false -----------------| |

| |

EGO\_TST\_SW = true ---------------|AND -|

|

EGO\_FMEM = false ----------------|

|

ATMR3 >= OBDII\_DELAY ------------|

OBDII\_STATE = ego\_mon\_enabled ---------|

|AND -| OBDII\_STATE = ego\_mon\_running

EGO\_TST\_RDY = true --------------------|

OBDII\_STATE = ego\_mon\_running ---|

|

EGO\_MON = false -----------------|AND -|

| |

EGO\_TST\_RDY = false -------------| |OR --| OBDII\_STATE = ego\_mon\_aborted

| | EGO\_TST\_ENA = false

OBDII\_STATE = ego\_mon\_running ---| | | Do: scheduler\_delay(ego)

|AND -|

EGO\_FMEM = true -----------------|

23-21

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OBDII\_STATE = ego\_mon\_running ---|

|AND -|

EGO\_MON = true ------------------| |

|

OBDII\_STATE = initial\_state -----| |OR --| OBDII\_STATE = sair\_purg\_arb

| | | EGO\_TST\_ENA = false

ATMR3 >= OBDII\_DELAY ------------| |

| |

EGO\_MON = true ------------| |AND -|

|OR --|

EGO\_TST\_SW = false --------|

OBDII\_STATE = sair\_purg\_arb -----------|

|

SAIR\_TST\_SW = true --------------------|

|

SAIR\_TST\_RDY = true -------------------|

|AND -| OBDII\_STATE = sair\_mon\_running

SAIR\_DEL\_TMR = 0 ----------------------| | SAIR\_TST\_ENA = true

|

SAIR\_MON = false ----------------------|

|

SAIR\_FMEM = false ---------------------|

OBDII\_STATE = sair\_mon\_running --------|

|

SAIR\_TST\_RDY = false ------------| |AND -| OBDII\_STATE = sair\_purg\_arb

| | | SAIR\_TST\_ENA = false

SAIR\_MON = true -----------------|OR --| | Do: scheduler\_delay(sair)

|

SAIR\_FMEM = true ----------------|

OBDII\_STATE = sair\_purg\_arb -----------|

|

PURG\_TST\_SW = true --------------------|

|

PURG\_TST\_RDY = true -------------------|

|AND -| OBDII\_STATE = purg\_mon\_running

PURG\_DEL\_TMR = 0 ----------------------| | PURG\_TST\_ENA = true

|

PURG\_MON = false ----------------------|

|

PURG\_FMEM = false ---------------------|

OBDII\_STATE = purg\_mon\_running --------|

|

PURG\_TST\_RDY = false ------------| |AND -| OBDII\_STATE = sair\_purg\_arb

| | | PURG\_TST\_ENA = false

PURG\_MON = true -----------------|OR --| | Do: scheduler\_delay(purg)

|

PURG\_FMEM = true ----------------|

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OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OBDII\_STATE = sair\_purg\_arb ------|

|

SAIR\_MON = true ------------| |

|OR --|

SAIR\_TST\_SW = false --------| |AND -| OBDII\_STATE = final\_state

|

PURG\_MON = true ------------| |

|OR --|

PURG\_TST\_SW = false --------|

END: diagnostic\_scheduler

23-23

OBDII STRATEGY, DIAGNOSTIC SCHEDULER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: determine\_demand\_mode

(public process executed once per background loop to determine the

state of the DEMAND\_MODE flag)

OBDII\_STATE = er\_running --------------|

|

OBDII\_STATE = eo\_running --------------|OR --| DEMAND\_MODE = true

| |

OBDII\_STATE = otm\_running -------------| |

| --- ELSE ---

|

| DEMAND\_MODE = false

END: determine\_demand\_mode

BEGIN: scheduler\_delay(sys\_monitor)

(executed on demand from within the disagnostic\_scheduler process, where

sys\_monitor is one of {ego, sair, purg, cat})

sys\_monitor = ego ---------------------------| EGO\_DEL\_TMR = EGO\_DEL\_TM

|

| --- ELSE ---

|

sys\_monitor = sair --------------------------| SAIR\_DEL\_TMR = SAIR\_DEL\_TM

|

| --- ELSE ---

|

sys\_monitor = purg --------------------------| PURG\_DEL\_TMR = PURG\_DEL\_TM

END: scheduler\_delay(sys\_monitor)

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.1.2 SYSTEM FMEM (CDAN0)

OVERVIEW

+--------------------------------+

| OBDII\_SYSTEM\_FMEM\_COM1 |

+--------------------------------+

| PUBLIC PROCESSES: |

| . definitions |

| . reset\_fmem |

| . intermittent\_initialization |

| . system\_fmem |

| PRIVATE PROCESSES: |

| . fmem\_system\_configuration |

| . determine\_sys\_fmem\_flags |

| . intermittent\_check |

| . clear\_intermittent([sensor]) |

| . set\_intermittent([sensor]) |

| . update\_mon\_lst\_flags |

+--------------------------------+

This module is used to define the eight OBD-II System Monitor FMEM flags:

CAT\_FMEM

CCM\_FMEM

PURG\_FMEM

SAIR\_FMEM

FUEL\_FMEM

EGO\_FMEM

EGR\_FMEM

MIS\_FMEM

The states of these flags are used by the OBD-II Diagnostic Scheduler to

determine if an OBD-II System Monitor can be allowed to execute. If an

individual System Monitor's corresponding sys\_FMEM flag is set (=1), then

something upon which the Monitor depends for its proper functioning is

faulted, and the Monitor may give false results if it's executed. If the

corresponding sys\_FMEM flag is cleared (=0), then all information upon which

the System Monitor depends for its proper functioning is assumed by the

OBD-II Diagnostic Scheduler to be valid (or not yet monitored).

The structure of the Diagnostic Scheduler is designed so that all of the

information upon which a System Monitor depends will have had a chance to be

monitored prior to enablement of the Monitor. This may not be entirely true

for those System Monitors that run continuously. In those cases, the Monitor

could be disabled during its execution if an input is found to be invalid.

The following table, sorted by System Monitor, shows the inputs upon which

each Monitor depends and the sensors which are used to determine these

inputs.

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MONITOR INPUT PARAMETER SENSORS FFG's USED

------- --------------- ------- ----------

CATALYST ECT ECT FFG\_ECT

CATALYST AM MAF,ACT,ECT, FFG\_MAF,FFG\_ACT,

PIP,TP FFG\_ECT,FFG\_PIP,

FFG\_TP

CATALYST active EGOs EGOnm FFG\_EGOnm

CATALYST APT TP FFG\_TP

CATALYST sair system EAM FFG\_SAIR

CATALYST egr system EGV,DEPT FFG\_EGR

CATALYST purg system TPR FFG\_PURG

(CVS, VMV)

MONITOR INPUT PARAMETER SENSORS FFG's USED

------- --------------- ------- ----------

CCM NONE N/A NONE

MONITOR INPUT PARAMETER SENSORS FFG's USED

------- --------------- ------- ----------

PURGE ECT ECT FFG\_ECT

PURGE ACT ACT FFG\_ACT

PURGE VSBAR VSS FFG\_VS

PURGE LOAD MAF,ACT,ECT, FFG\_MAF,FFG\_ACT,

PIP,TP FFG\_ECT,FFG\_PIP,

FFG\_TP

PURGE FLG\_STALL PIP,ECT FFG\_PIP,FFG\_ECT

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MONITOR INPUT PARAMETER SENSORS FFG's USED

------- --------------- ------- ----------

SAIR ECT ECT FFG\_ECT

SAIR ACT ACT FFG\_ACT

SAIR LAMBSE1 N/A FFG\_LAMBSE1

SAIR LAMBSE2 N/A FFG\_LAMBSE2

SAIR active EGOs EGOnm FFG\_EGOnm

MONITOR INPUT PARAMETER SENSORS FFG's USED

------- --------------- ------- ----------

FUEL NONE N/A NONE

MONITOR INPUT PARAMETER SENSORS FFG's USED

------- --------------- ------- ----------

EGO ECT ECT FFG\_ECT

EGO VSBAR VSS FFG\_VS

EGO LOAD MAF,ACT,ECT, FFG\_MAF,FFG\_ACT,

PIP,TP FFG\_ECT,FFG\_PIP,

FFG\_TP

EGO N PIP FFG\_PIP

EGO AM MAF,ACT,ECT, FFG\_MAF,FFG\_ACT,

PIP,TP FFG\_ECT,FFG\_PIP,

FFG\_TP

EGO LAMBSE1 N/A FFG\_LAMBSE1

EGO LAMBSE2 N/A FFG\_LAMBSE2

EGO misfiring engine PIP,CID FFG\_MISFIRE

EGO SYNC\_CTR CID FFG\_CID

23-27

OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MONITOR INPUT PARAMETER SENSORS FFG's USED

------- --------------- ------- ----------

EGR ECT ECT FFG\_ECT

EGR N PIP FFG\_PIP

EGR APT TP FFG\_TP

EGR AIR\_CHG MAF,ACT,ECT, FFG\_MAF,FFG\_ACT,

PIP,TP FFG\_ECT,FFG\_PIP,

FFG\_TP

EGR INF\_MVAC MAF,ACT,ECT, FFG\_MAF,FFG\_ACT,

PIP,TP FFG\_ECT,FFG\_PIP,

FFG\_TP

EGR PEXHAUST MAF,ACT,ECT, FFG\_MAF,FFG\_ACT,

PIP,TP FFG\_ECT,FFG\_PIP,

FFG\_TP

EGR WRM\_IDL\_FLG ECT,PIP,TP FFG\_ECT,FFG\_PIP,

FFG\_TP

MONITOR INPUT PARAMETER SENSORS FFG's USED

------- --------------- ------- ----------

MISFIRE NONE N/A NONE

NOTE: The Misfire Monitor checks the PIP validity and the CID

validity in the foreground; therefore the OBD-II FMEM-related

background processes will not attempt to control the enabling

and the disabling of the Misfire Monitor based on bad PIP or

bad CID; these are handled internally in the Misfire Monitor.

23-28

OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

If the preceding tables are condensed into only the base set of systems or

sensors required to be functional to enable a given OBD-II system monitor,

then the following matrix is obtained. This matrix is implemented in this

module.

CAT CCM PURG SAIR FUEL EGO EGR MIS RESP. MON

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_ECT | X | | X | X | | X | X | | CCM |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_ACT | X | | X | X | | X | X | | CCM |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_MAF | X | | X | | | X | X | | CCM |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_PIP | X | | X | | | X | X | | CCM |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_TP | X | | X | | | X | X | | CCM |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_CID | | | | | | X | | | CCM |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_VS | | | X | | | X | | | CCM |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_EGOnm | X | | | X | | | | | EGO |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_LAMBSEn| | | | X | | X | | | FUEL |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_PURG | X | | | | | | | | PURGE |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_SAIR | X | | | | | | | | SAIR |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_EGR | X | | | | | | | | EGR |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

|FFG\_MISFIRE| | | | | | X | | | MISFIRE |

+-----------+----+-----+------+------+------+-----+-----+----+-----------+

PLEASE NOTE: If a particular OBD-II System Monitor is not present, it is the

responsibility of the OBD-II Diagnostic Executive to ensure that all related

FFGs are continuously cleared. The fmem\_system\_configuration process will

take these actions.

This module will also control a set of non-MIL fault codes. These fault

codes are used to identify intermittent faults on a set of sensors.

The related strategy identifies when an obdii monitor is aborted because an

intermittent fault of the sensor is detected. After the obdii monitor has

been aborted a calibratable number of times and the monitor has not yet been

completed and the IM readiness code is stored, an additional fault code will

be stored identifying the intermittent sensor signal.

There are five such codes, one each for ect,act, tps, vss, and mafs. The

calibratable number of times the monitor is aborted prior to storing the code

is selected so that the code can be stored after driving for some reasonable

amount of time at the required steady state conditions. The diagnostic

procedure will be written to incorporate this time for verification of the

intermittent fault condition as well as the repair effectiveness.

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- ACT = Air charge temperature, deg F.

- ACT\_FIL\_MAX = Highest value the fault filter ACT\_FIL sees.

- AIR\_CHG = Air charge value after the filling model.

- AM = Air mass flow, lb/min.

- APT = At Part Throttle; -1 -> Closed throttle, 0 -> Part throttle,

1 -> Wide Open throttle.

- ECT = Engine coolant temperature, deg F.

- ECT\_FIL\_MAX = Highest value the fault filter ECT\_FIL achieves.

- INF\_MVAC = Inferred Manifold Vacuum.

- LAMBSE1 = Desired equivalence ratio for Bank1 injectors.

- LAMBSE2 = Desired equivalence ratio for Bank2 injectors.

- LOAD = Universal normalized load parameter.

- MAF = The air flow that is computed at each PIP edge, lbm/tick.

- MAF\_FIL\_MAX = Highest value the fault filter MAF\_FIL sees.

- N = Engine RPM.

- PEXHAUST = Exhaust Back Pressure, inches H2O.

- SYNC\_CTR = Counter which counts cylinders from the PIP signal and resets

when equal to the number of cylinders in the engine.

- TP = Instantaneous throttle position, counts.

- TP\_FIL\_MAX = Highest value the fault filter TP\_FIL sees.

- VS = Instantaneous vehicle speed (unverified).

- VSBAR = Filtered vehicle speed for transmission.

- VS\_FIL\_MAX = Highest value the fault filter VS\_FIL sees.

Bit Flags:

- ACT\_INT = Flag set when intermittent is detected on the CAT sensor.

- CAT\_FMEM = CAT system FMEM flag; 1 -> don't run CAT system due to FMEM.

- CAT\_MON = OBDII monitor flag for catalyst; 1 -> all catalyst faults have

been monitored since power-up.

23-30

OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- CAT\_MON\_LST = Last background pass value of CAT\_MON.

- CAT\_TST\_RDY = CAT test ready flag; 1 -> all local conditions have been

met; ready to run CAT test.

- CCM\_FMEM = CCM system FMEM flag; 1 -> don't run CCM due to FMEM.

- CCM\_MON = Obdii monitor flag for comp components. 1=>all CCM faults have

been monitored since power-up.

- CCM\_MON\_LST = Last background pass value of CCM\_MON.

- ECT\_INT = Flag set when intermittent is detected on ECT sensor.

- EGO\_FMEM = EGO system FMEM flag; 1 -> don't run EGO monitor due to FMEM.

- EGO\_MON = OBDII monitor flag for EGO system; 1=> all fuel faults been

monitored since power-up.

- EGO\_MON\_LST = Last background pass value of EGO\_MON.

- EGO\_TST\_RDY = EGO test ready flag; 1 -> all local conditions have been

met; ready to run EGO test.

- EGR\_FMEM = EGR system FMEM flag; 1 -> don't run EGR monitor due to FMEM

- EGR\_MON = OBDII monitor flag for EGR system; 1=> all EGR faults been

monitored since power-up.

- EGR\_MON\_LST = Last pass value of EGR\_MON.

- EGR\_TST\_RDY = EGR test ready flag; 1 -> all local conditions have been

met; ready to run EGR test.

- FFG\_ACT = OBDII system FMEM flag for ACT; 1 -> ACT is currently

unreliable.

- FFG\_CID = OBDII system FMEM flag for CID; 1 -> CID is not currently

reliable.

- FFG\_ECT = OBDII system FMEM flag for ECT; 1 -> ECT is currently

unreliable.

- FFG\_EGO11 = OBDII system FMEM flag for EGO11; 1 -> EGO11 is not currently

switching reliably.

- FFG\_EGO12 = OBDII system FMEM flag for EGO12; 1 -> EGO12 is not currently

switching reliably.

- FFG\_EGO21 = OBDII system FMEM flag for EGO21; 1 -> EGO21 is not currently

switching reliably.

- FFG\_EGO22 = OBDII system FMEM flag for EGO22; 1 -> EGO22 is not currently

switching reliably.

- FFG\_EGR = OBDII system FMEM flag for the EGR system; 1 -> EGR system not

currently operating reliably.

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FFG\_LAMBSE1 = OBDII system FMEM flag for LAMBSE1; 1 -> LAMBSE1 is not

currently reliable.

- FFG\_LAMBSE2 = OBDII system FMEM flag for LAMBSE2; 1 -> LAMBSE2 is not

currently reliable.

- FFG\_MAF = OBDII system FMEM flag for MAF; 1 -> MAF not currently

reliable.

- FFG\_MISFIRE = OBDII system FMEM flag for engine misfire; 1 -> currently

misfiring.

- FFG\_PIP = OBDII system FMEM flag for PIP; 1 -> PIP not currently

reliable.

- FFG\_PURG = OBDII system FMEM flag for the purge system; 1 -> purge system

is not under control reliably.

- FFG\_SAIR = OBDII system FMEM flag for the sair system; 1 -> sair sytem is

not currently under control reliably.

- FFG\_TP = OBDII system FMEM flag for TP; 1 -> TP is not currently

reliable.

- FFG\_VS = OBDII system FMEM flag for VS; 1 -> VS is currently unreliable.

- FLG\_CONT\_MON = Flag set when continuous monitors are enabled in the

OBD-II system.

- FUEL\_FMEM = FUEL system FMEM flag; 1 -> don't run FUEL monitor due to

system FMEM.

- FUEL\_MON = OBDII monitor flag for fuel system; 1 -> all fuel faults been

monitored since power-up.

- FUEL\_MON\_LST = Last background pass value of FUEL\_MON.

- KAM\_ERROR = Indicates keep alive RAM invalid.

- MAF\_INT = Flag set when intermittent is detected on the MAF sensor.

- MIS\_FMEM = MIS system FMEM flag; 1 -> don't run MIS monitor due to FMEM.

- MIS\_MON = OBDII misfire test monior complete for trip indication.

- MIS\_MON\_LST = Last background pass value of MIS\_MON.

- PURG\_FMEM = PURG system FMEM flag; 1 -> don't run PURG monitor due to

FMEM.

- OBDII\_STATE = Current state of the obdii sequence controller.

- PURG\_MON = OBDII monitor flag for evaporative purge; 1=> all purge faults

been monitored since power-up.

- PURG\_MON\_LST = Last background pass value of PURGE\_MON.

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PURG\_TST\_RDY = Purge test ready flag; 1 -> all local conditions have been

met ;ready to run purge test.

- PxxxFAULT = Fault flag for code Pxxx; 1 -> a fault has been stored for

code Pxxx.

- SAIR\_FMEM = SAIR system FMEM flag; 1 -> don't run SAIR monitor due to

FMEM.

- SAIR\_MON = OBDII monitor flag for SAIR system; 1=> all SAIR faults been

monitored since power-up.

- SAIR\_MON\_LST = Last background pass value of SAIR\_MON.

- TP\_INT = Fag set when intermittent is detected on the TP sensor.

- VS\_INT = Flag set when intermittent is detected on the VS sensor.

- WRM\_IDL\_FLG = Warm Idle Flag. Used for EGR.

Calibration Constants:

- ACT\_FIL = Intermittent fault filter for the ACT sensor.

- ACT\_LVL = Fault level for intermittent ACT sensor.

- ECT\_FIL = Intermittent fault filter for the ECT sensor.

- ECT\_LVL = Fault level for intermittent ECT sensor.

- EGR\_TST\_SW = EGR test present calibration switch; 1 -> EGR test present.

- MAF\_FIL = Intermittent fault filter for the MAF sensor.

- MAF\_LVL = Fault level for intermittent MAF sensor.

- MIS\_TST\_SW = MIS test present calibration switch; 1 -> MIS test present.

- PURG\_TST\_SW = PURG test present calibration switch; 1 -> PURG test

present.

- SAIR\_TST\_SW = SAIR test present calibration switch; 1 -> SAIR test

present.

- TP\_FIL = Intermittent fault filter for the TP sensor.

- TP\_LVL = Fault level for intermittent TP sensor.

- VS\_FIL = Intermittent fault filter for the VS sensor.

- VS\_LVL = Fault level for intermittent VS sensor.

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OTHER

- P1000 = Additional mixed city and highway driving required to complete

OBD-II system check-out.

- P1100 = Fault code for intermittent MAF sensor.

- P1112 = Fault code for intermittent ACT sensor.

- P1117 = Fault code for intermittent ECT sensor.

- P1125 = Fault code for intermittent TP sensor.

- P1500 = Fault code for intermittent VS sensor.

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: OBDII\_SYSTEM\_FMEM\_COM1

BEGIN: definitions

;process not to be explicitly executed, but to define locally

;used symbols.

unconditionally ------------------------| true := 1

| false := 0

| ego\_mon\_running := 2

| sair\_mon\_running := 5

| purg\_mon\_running := 6

END: definitions

BEGIN: system\_fmem

;This process is used as the controlling process for the system fmem

strategy

;contained in this module. It is called from within the diagnostic

;scheduler.

unconditionally ------------------------| Do: intermittent\_check

| Do: update\_mon\_lst\_flags

| Do: fmem\_system\_configuration

| Do: determine\_sys\_fmem\_flags

END: system\_fmem

BEGIN: reset\_fmem

;PUBLIC process used to reset the FMEM flags upon OBD-II RESET. This

;process is called from the scan\_tool\_interface.

unconditionally ------------------------| CAT\_FMEM := false

| CCM\_FMEM := false

| PURG\_FMEM := false

| SAIR\_FMEM := false

| FUEL\_FMEM := false

| EGO\_FMEM := false

| EGR\_FMEM := false

| MIS\_FMEM := false

| Do: intermittent\_initialization

KAM\_ERROR = true -----------------------| MAF\_FIL\_MAX := 0

| ACT\_FIL\_MAX := 0

| ECT\_FIL\_MAX := 0

| TP\_FIL\_MAX := 0

| VS\_FIL\_MAX := 0

END: reset\_fmem

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: fmem\_system\_configuration

;PRIVATE process executed on demand from system\_fmem. This process will

;ensure that those FFGs related to an OBD-II system monitor that is not

;present are always false. This is a bullet-proofing action. An

;assumption is being made that all packages will have component monitoring

;to some degree on ECT, ACT, MAF, PIP, TP, CID, VSS, EGOs, AND the adaptive

;fuel system. Therefore, those FFGs will always be under control in the

;external strategy features and are not need in this process.

MIS\_TST\_SW = false ---------------------| FFG\_MISFIRE := false

SAIR\_TST\_SW = false --------------------| FFG\_SAIR := false

PURG\_TST\_SW = false --------------------| FFG\_PURG := false

EGR\_TST\_SW = false ---------------------| FFG\_EGR := false

END: fmem\_system\_configuration

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: determine\_sys\_fmem\_flags

;PRIVATE process used to calculate the flag sys\_FMEM flags for use

;in the diagnostic scheduler.

FFG\_ECT = true -------------------|

|

FFG\_ACT = true -------------------|

|

FFG\_MAF = true -------------------|

|

FFG\_PIP = true -------------------|

|

FFG\_PURG = true ------------------|

|

FFG\_TP = true --------------------|

|OR --| CAT\_FMEM := true

FFG\_EGO11 = true -----------------| |

| |

FFG\_EGO21 = true -----------------| |

| |

FFG\_EGO12 = true -----------------| |

| |

FFG\_EGO22 = true -----------------| |

| |

FFG\_SAIR = true ------------------| |

| --- ELSE ---

|

| CAT\_FMEM := false

23-37

OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FFG\_ECT = true -------------------|

|

FFG\_ACT = true -------------------|

|

FFG\_MAF = true -------------------|

|OR --| PURG\_FMEM := true

FFG\_PIP = true -------------------| |

| |

FFG\_TP = true --------------------| |

| |

FFG\_VS = true --------------------| |

| --- ELSE ---

|

| PURG\_FMEM := false

FFG\_ECT = true -------------------|

|

FFG\_ACT = true -------------------|

|

FFG\_EGO11 = true -----------------|

|

FFG\_EGO21 = true -----------------|

|OR --| SAIR\_FMEM := true

FFG\_EGO12 = true -----------------| |

| |

FFG\_EGO22 = true -----------------| |

| |

FFG\_LAMBSE1 = true ---------------| |

| |

FFG\_LAMBSE2 = true ---------------| |

| --- ELSE ---

|

| SAIR\_FMEM := false

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FFG\_ECT = true -------------------|

|

FFG\_ACT = true -------------------|

|

FFG\_MAF = true -------------------|

|

FFG\_PIP = true -------------------|

|

FFG\_TP = true --------------------|

|OR --| EGO\_FMEM := true

FFG\_CID = true -------------------| |

| |

FFG\_VS = true --------------------| |

| |

FFG\_LAMBSE1 = true ---------------| |

| |

FFG\_LAMBSE2 = true ---------------| |

| |

FFG\_MISFIRE = true ---------------| |

| --- ELSE ---

|

| EGO\_FMEM := false

FFG\_ECT = true -------------------|

|

FFG\_ACT = true -------------------|

|

FFG\_MAF = true -------------------|OR --| EGR\_FMEM := true

| |

FFG\_PIP = true -------------------| |

| |

FFG\_TP = true --------------------| |

| --- ELSE ---

|

| EGR\_FMEM := false

unconditionally ------------------------| CCM\_FMEM := false

unconditionally ------------------------| FUEL\_FMEM := false

unconditionally ------------------------| MIS\_FMEM := false

END: determine\_sys\_fmem\_flags

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: intermittent\_initialization

;execute during RAM init or OBDII reset conditions.

For [sensor] := {ECT, ACT, TP, MAF, VS} perform the following:

unconditionally -------------------------| [sensor]\_FIL := 0

| [sensor]\_INT := 0

END: intermittent\_initialization

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: intermittent\_check

;PRIVATE process called from the system\_fmem process to determine if

;intermittent faults are preventing execution of an OBD-II monitor.

For [sensor] := {ECT, ACT, TP, MAF, VS} perform the following:

[sensor]\_INT = 0 --------------------------|

;this FFG\_ event has not been |

;counted yet. |

|

P1000FAULT = 1 ----------------------------|

;the IM readiness code is stored, i.e., |

;this vehicle cannot get plates. |

|

FFG\_[sensor] = 1 --------------------------|

;the fault is detected the b.g. pass. |

|

EGR\_TST\_RDY = 1 ---| |AND -| [sensor]\_INT := 1

|AND -| | | [sensor]\_FIL :=

EGR\_MON = 0 -------| | | | [sensor]\_FIL + 1

|OR --| | |

CAT\_TST\_RDY = 1 ---| | | | |

|AND -| | | |

CAT\_MON = 0 -------| |AND -| | |

| | | |

FLG\_CONT\_MON = 1 --------------| | | |

| | | |

[sensor] <> VS ----------------| | | |

| | |

EGO\_TST\_RDY = 1 ---------------| | | |

|AND -| | |

OBDII\_STATE = ego\_mon\_running -| | | |

;the scheduled EGO monitor | | |

;should be running, but the |OR --| |

;sensor fault is preventing it | |

| |

PURG\_TST\_RDY = 1 --------------| | |

|AND -| |

OBDII\_STATE = | | |

purg\_mon\_running -----| | |

| |

SAIR\_TST\_RDY = 1 --------------| | |

| | |

OBDII\_STATE = | | |

sair\_mon\_running ------| | |

| | |

[sensor] <> TP ----------------|AND -| |

| |

[sensor] <> MAF ---------------| |

| |

[sensor] <> VS ----------------| |

| --- ELSE ---

|

FFG\_[sensor] = 0 --------------------------------| [sensor]\_INT := 0

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P1000FAULT = 0 --------------------------|

;the IM readiness code is no longer |

;stored, this vehicle can get plates. |

|

SAIR\_MON\_LST = 0 ------------------| |

|AND -|

SAIR\_MON = 1 ----------------------| |

|

PURG\_MON\_LST = 0 ------------------| |

|AND -|

PURG\_MON = 1 ----------------------| |

|

EGO\_MON\_LST = 0 -------------------| |

|AND -|

EGO\_MON = 1 -----------------------| |

;after each monitor in the schedule |OR --| clear\_intermittent([sensor])

;completes, reset the fault filter | |

;to prevent storing the code when | |

;no real problems exist. | |

| |

SAIR\_MON = 1 ----------------| | |

| | |

[sensor] = VS ---------------| | |

|OR --| | |

[sensor] = MAF --------------| | | |

| | | |

[sensor] = TP ---------------| | | |

| | |

CAT\_MON = 1 -----------------| | | |

|OR --|AND -| |

[sensor] = VS ---------------| | |

| |

EGR\_MON = 1 -----------------| | |

|OR --| |

[sensor] = VS ---------------| | |

| |

EGO\_MON = 1 -----------------------| |

| |

PURG\_MON = 1 ----------------------| |

;all systems that depend on this |

;sensor input have run to completion. | --- ELSE ---

|

[sensor]\_FIL > [sensor]\_LVL -------------------| set\_intermittent([sensor])

;enough fault events which stop a monitor

;from running have been encountered, store

;a fault code indicating this.

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

[sensor]\_FIL > [sensor]\_FIL\_MAX ----------| [sensor]\_FIL\_MAX := [sensor]\_FIL

| ;ratchet up to the highest value

| ;encountered. Used by diag.

END: intermittent\_check

BEGIN: clear\_intermittent([sensor])

;PRIVATE process called from intermittent\_check to erase the fault code.

unconditionally ---------------------------------| [sensor]\_FIL := 0

| [sensor]\_INT := 0

[sensor] = ECT ----------------------------------| clear\_malf(P1117)

|

| --- ELSE ---

|

[sensor] = ACT ----------------------------------| clear\_malf(P1112)

|

| --- ELSE ---

|

[sensor] = TP -----------------------------------| clear\_malf(P1125)

|

| --- ELSE ---

|

[sensor] = MAF ----------------------------------| clear\_malf(P1100)

|

| --- ELSE ---

|

[sensor] = VS -----------------------------------| clear\_malf(P1500)

END: clear\_intermittent([sensor])

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OBDII STRATEGY, SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: set\_intermittent([sensor])

;PRIVATE process called from intermittent\_check() to store the fault code.

[sensor] = ECT ----------------------------------| store\_code(P1117)

|

| --- ELSE ---

|

[sensor] = ACT ----------------------------------| store\_code(P1112)

|

| --- ELSE ---

|

[sensor] = TP -----------------------------------| store\_code(P1125)

|

| --- ELSE ---

|

[sensor] = MAF ----------------------------------| store\_code(P1100)

|

| --- ELSE ---

|

[sensor] = VS -----------------------------------| store\_code(P1500)

END: set\_intermittent([sensor])

BEGIN: update\_mon\_lst\_flags

;PRIVATE process used to update the sys\_MON\_LST flags used by the

;intermittent\_check process.

unconditionally ---------------------------------| CAT\_MON\_LST := CAT\_MON

| EGO\_MON\_LST := EGO\_MON

| SAIR\_MON\_LST := SAIR\_MON

| PURG\_MON\_LST := PURG\_MON

| CCM\_MON\_LST := CCM\_MON

| EGR\_MON\_LST := EGR\_MON

| MIS\_MON\_LST := MIS\_MON

| FUEL\_MON\_LST := FUEL\_MON

END: update\_mon\_lst\_flags

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OBDII STRATEGY, MIL CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.1.3 MIL CONTROLLER (CDAM0)

OVERVIEW

This logic is triggered by any of the eight OBDII systems at the time a

malfunction is detected, a trip is completed, power-up is encountered, or an

OBD-II scan tool reset occurs. The particular system and fault code are

indicated by sys and Pxxx respectively.

This module acts as a dispatcher to the rest of the MIL control strategy.

The rest of the MIL control logic is divided into logical objects. Those

objects represent MIL control finite state machine and associated data as

well as MIL output control and data, freeze frame control and data, OBD-II

trip monitoring and data, and fault code control and data.

The MIL control finite state machines are event driven, those events are

malfunction, trip\_complete, reset\_mil, and initialize\_mil. This module

processes incoming requests from the outside environment and makes calls to

the appropriate objects where the procedures and data are maintained.

In pictorial form the MIL controller interacts with the sys\_STATE\_CONTROL

modules as shown below:

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OBDII STRATEGY, MIL CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MIL Controller

+---------------------------+

| OBDII\_MIL\_CONTROLLER |

+---------------------------+

|.malfunction |

|.init\_mil |

|.check\_sys\_mon\_complete |

|.reset\_mil |

+-------------+-------------+

|

+--------------------------+ |

|OBDII\_TYPE1\_STATE\_CONTROL | |

+--------------------------+ |

| . type1\_malfunction |<----------|

| . type1\_init\_mil |<----------|

| . type1\_trip\_complete |<----------|

| . type1\_reset |<----------|

+--------------------------+ |

|

+--------------------------+ |

|OBDII\_MIS\_STATE\_CONTROL | |

+--------------------------+ |

| . mis\_malfunction |<----------|

| . mis\_init\_mil |<----------|

| . mis\_trip\_complete |<----------|

| . mis\_reset |<----------|

| . mis\_conds\_seen(Pxxx) | |

+--------------------------+ |

|

+--------------------------+ |

|OBDII\_FUEL\_STATE\_CONTROL | |

+--------------------------+ |

| . fuel\_malfunction |<----------|

| . fuel\_init\_mil |<----------|

| . fuel\_trip\_complete |<----------|

| . fuel\_reset |<----------|

| . fuel\_conds\_seen(Pxxx) | |

+--------------------------+ |

|

+--------------------------+ |

|OBDII\_CL\_STATE\_CONTROL | |

+--------------------------+ |

| . cl\_malfunction |<----------|

| . cl\_init\_mil |<----------|

| . cl\_trip\_complete |<----------|

| . cl\_reset |<----------+

+--------------------------+

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OBDII STRATEGY, MIL CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- FF\_CODE = Code number of fault for which freeze frame conditions are

stored. freeze frame is loaded.

- MIS\_FF\_CODE = Integer representation of the first misfire malfunction

code number after an unknown misfire.

- UNK\_MIS\_CODE = Integer representation of the unknown cylinder misfiring

fault code number.

Bit Flags:

- CAT\_MIL\_ON = MIL status flag for Catalyst system; 1 -> MIL required for

catalyst fault.

- CAT\_MON = OBDII monitor flag for catalyst; 1=>all catalyst faults have

been monitored since power-up.

- CAT\_MON\_LST = Last background pass value of CAT\_MON.

- CCM\_MON = Obdii monitor flag for comp components. 1=>all CCM faults have

been monitored since power-up.

- CCM\_MON\_LST = Last background pass value of CCM\_MON.

- COOL\_MIL\_ON = MIL status flag for fail safe cooling system; 1 -> MIL

required for fail safe cooling

- CAT\_MON = OBDII monitor flag for catalyst; 1 -> all catalyst faults have

been monitored since power-up.

- CAT\_MON\_LST = Last background pass value of CAT\_MON.

- CCM\_MIL\_ON = MIL status flag for Comprehensive Components; 1 -> MIL

required for CCM fault.

- CL\_MIL\_ON = MIL status flag for Closed Loop Entry; 1 -> MIL required for

Closed Loop Entry fault).

- DEMAND\_MODE = Flag set when an On-Demand self test mode is active.

- EGO\_MIL\_ON = MIL status flag for EGO; 1 -> MIL required for HEGO fault.

- EGR\_MIL\_ON = MIL status flag for EGR; 1 -> MIL required for EGR fault.

- EGR\_MON = Obdii monitor flag for EGR system; 1=> all EGR faults been

monitored since power-up.

- EGR\_MON\_LST = Last pass value of EGR\_MON.

- FF\_FUEL\_MIS = Freeze frame FUEL or MISFIRE data stored flag; 1 -> freeze

frame was stored due to FUEL or MISFIRE.

- FUEL\_MIL\_ON = MIL status flag for Fuel System; 1 -> MIL required for Fuel

System fault.

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OBDII STRATEGY, MIL CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FUEL\_MON = OBDII monitor flag for fuel system; 1 -> all fuel faults been

monitored since power-up.

- FUEL\_MON\_LST = Last background pass value of FUEL\_MON.

- MIS\_MIL\_ON = MIL status flag for Misfire; 1 -> MIL required for Misfire

fault.

- MIS\_MON = OBDII misfire test monior complete for trip indication.

- MIS\_MON\_LST = Last background pass value of MIS\_MON.

- PURG\_MIL\_ON = MIL status flag Purge; 1 -> MIL required for Purge fault.

- PURG\_MON = OBDII monitor flag for evaporative purge; 1 -> all purge

faults been monitored since power-up.

- SAIR\_MIL\_ON = MIL status flag for Secondary Air; 1 -> MIL required for

Secondary Air fault.

- SAIR\_MON = Secomdary air has been monitored for OBD-II trip.

- SAIR\_MON\_LST = Last background pass value of SAIR\_MON.

Calibration Constants:

- CAT\_TST\_SW = Cat test present calibration switch; 1 -> CAT present.

- EGO\_TST\_SW = Ego test present calibration switch; 1 -> EGO test present.

- EGR\_TST\_SW = Egr test present calibration switch; 1 -> EGR test present.

- FUEL\_TST\_SW = Fuel test present claibration switch; 1 -> FUEL test

present.

- MIS\_TST\_SW = Mis test present claibration switch; 1 -> MIS test present.

- PURG\_TST\_SW = Purg test present calibration switch; 1 -> PURG test

present.

- SAIR\_TST\_SW = Sair test present calibration switch; 1 -> SAIR test

present.

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OBDII STRATEGY, MIL CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: OBDII\_MIL\_CONTROLLER\_COM1

BEGIN: malfunction(sys,Pxxx)

;handle freeze frame

sys = mis -----------------|

|

MIS\_FF\_CODE = 0 -----------|AND -| MIS\_FF\_CODE = xxx

| | ;capture the first code number after an

xxx <> UNK\_MIS\_CODE -------| | ;unknown misfire event. This will be used

| ;later when misfire can detect which

| ;cylinder is misfiring.

DEMAND\_MODE = 0 -----------|

|

FF\_FUEL\_MIS = 0 -----------|AND -| Do: store\_ff(Pxxx)

| | FF\_FUEL\_MIS := 1

sys = fuel ----------| | |

|OR --| |

sys = mis -----------| |

| --- ELSE ---

DEMAND\_MODE = 0 -----------| |

|AND -| Do: store\_ff(Pxxx)

FF\_CODE = 0 ---------------|

;freeze frame is empty.

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OBDII STRATEGY, MIL CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

sys = fuel ----------------------| Do: fuel\_malfunction(FUEL\_MIL\_ON, Pxxx)

|

| --- ELSE ---

|

sys = mis -----------------------| Do: mis\_malfunction(MIS\_MIL\_ON, Pxxx)

|

| --- ELSE ---

|

sys = cat -----------------------| Do: type1\_malfunction(CAT\_MIL\_ON, Pxxx,

| cat)

| --- ELSE ---

|

sys = ccm -----------------------| Do: type1\_malfunction(CCM\_MIL\_ON, Pxxx,

| ccm)

| --- ELSE ---

|

sys = cool ----------------------| Do: type1\_malfunction(COOL\_MIL\_ON, Pxxx,

| cool)

|

| --- ELSE ---

|

sys = ego -----------------------| Do: type1\_malfunction(EGO\_MIL\_ON, Pxxx,

| ego)

| --- ELSE ---

|

sys = egr -----------------------| Do: type1\_malfunction(EGR\_MIL\_ON, Pxxx,

| egr)

| --- ELSE ---

|

sys = purg ----------------------| Do: type1\_malfunction(PURG\_MIL\_ON, Pxxx,

| purg)

|

| --- ELSE ---

|

sys = sair ----------------------| Do: type1\_malfunction(SAIR\_MIL\_ON, Pxxx,

| sair)

|

| --- ELSE ---

|

sys = cl ------------------------| Do: cl\_malfunction(CL\_MIL\_ON, Pxxx)

unconditionally -----------------| PxxxMALF := 1

END: malfunction(sys,Pxxx)

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OBDII STRATEGY, MIL CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: initialize\_mil

;Public procedure performed on power up initialization.

unconditionally -----------------| Do: fuel\_init\_mil(FUEL\_MIL\_ON)

| Do: mis\_init\_mil(MIS\_MIL\_ON)

| Do: type1\_init\_mil(cat)

| Do: type1\_init\_mil(ccm)

| Do: type1\_init\_mil(cool)

| Do: type1\_init\_mil(ego)

| Do: type1\_init\_mil(egr)

| Do: type1\_init\_mil(purg)

| Do: type1\_init\_mil(sair)

| Do: cl\_init\_mil(CL\_MIL\_ON)

| Do: cl\_seen\_init

END: initialize\_mil

BEGIN: check\_sys\_mon\_complete

;PRIVATE procedure used to update state machines, used by diagnostic

; scheduler control

FUEL\_MON <> FUEL\_MON\_LST ---------|

|OR --| Do: fuel\_trip\_complete

CCM\_MON <> CCM\_MON\_LST -----| |

|AND -|

FUEL\_TST\_SW = 0 ------------|

MIS\_MON <> MIS\_MON\_LST -----------|

|OR --| Do: mis\_trip\_complete

CCM\_MON <> CCM\_MON\_LST -----| |

|AND -|

MIS\_TST\_SW = 0 -------------|

CAT\_MON <> CAT\_MON\_LST -----------|

|OR --| Do:

CCM\_MON <> CCM\_MON\_LST -----| | | type1\_trip\_complete(cat,CAT\_MIL\_ON)

|AND -|

CAT\_TST\_SW = 0 -------------|

EGR\_MON <> EGR\_MON\_LST -----------|

|OR --| Do:

CCM\_MON <> CCM\_MON\_LST -----| | | type1\_trip\_complete(egr,EGR\_MIL\_ON)

|AND -|

EGR\_TST\_SW = 0 -------------|

CCM\_MON <> CCM\_MON\_LST -----------------| Do:

| type1\_trip\_complete(ccm,CCM\_MIL\_ON)

| Do: type1\_trip\_complete(cool,

| COOL\_MIL\_ON)

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OBDII STRATEGY, MIL CONTROLLER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO\_MON <> EGO\_MON\_LST -----------|

|OR --| Do:

CCM\_MON <> CCM\_MON\_LST -----| | | type1\_trip\_complete(ego,EGO\_MIL\_ON)

|AND -| | Do: cl\_trip\_complete(CL\_MIL\_ON)

EGO\_TST\_SW = 0 -------------|

SAIR\_MON <> SAIR\_MON\_LST ---------|

|OR --| Do: type1\_trip\_complete(sair,

CCM\_MON <> CCM\_MON\_LST -----| | | SAIR\_MIL\_ON)

|AND -|

SAIR\_TST\_SW = 0 ------------|

PURG\_MON <> PURG\_MON\_LST ---------|

|OR --| Do: type1\_trip\_complete(purg,

CCM\_MON <> CCM\_MON\_LST -----| | | PURG\_MIL\_ON)

|AND -|

PURG\_TST\_SW = 0 ------------|

END: check\_sys\_mon\_complete

BEGIN: reset\_mil

;Public process executed when an obdII reset message is received from

;the scan tool.

unconditionally -----------------| MIL\_ON := 0

| Do: fuel\_reset

| Do: mis\_reset

| Do: type1\_reset

| Do: cl\_reset

END: reset\_mil

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OBDII STRATEGY, FAULT CODES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.1.4 FAULT CODES (CDAM0)

OVERVIEW

+--------------------------------+

| OBDII\_CODES\_COM1 |

+--------------------------------+

| PUBLIC PROCESSES: |

| . check\_warmup\_counters |

| . store\_code(Pxxx) |

| . erase\_code(Pxxx) |

| . erase\_mis\_code(Pxxx) |

| . reset\_codes |

| . init\_codes |

| . inc\_warmup\_counters |

| . clear\_malf(Pxxx) |

+--------------------------------+

| PRIVATE PROCESSES: |

| . update\_warmup\_counters |

+--------------------------------+

This module handles all the actions having to do with fault codes. These

actions include the storing and erasing of codes, as well as reporting of

code status. Each fault code has associated with it, a warmup counter, which

is incremented each time a warmup cycle occurs. A code is erased when at

least 80 warmups have occurred since it was stored.

A specific fault code is referred to by the acronym, Pxxx. Where 'xxx' is

the fault code number, eg) fault code 131 is referred to as P0131. Special

sets of fault codes are referred to by labels, such as egr\_codes, purg\_codes,

etc. The label, egr\_codes, refers to the set of fault codes having to do

with EGR, while purg\_codes refers to the set of fault codes having to do with

the purge test.

The complete set of all fault codes is referred to as all\_codes. The set of

fault codes which affect the MIL is referred to as mil\_codes. The set

mil\_codes is a subset of all\_codes.

Each fault code which affects the MIL has the following block of parameters

associated with it.

All fault codes controlling the MIL light will be designated as MIL\_CODE

and have the following record structure:

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OBDII STRATEGY, FAULT CODES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MIL\_CODE = RECORD

PXXXMALF = [RAM] Malfunction flag for code Pxxx;

1 -> A malfunction currently exists

for fault Pxxx.

PXXXFAULT = [KAM] Fault flag for code Pxxx;

1 -> A fault has been stored for

code Pxxx.

PXXXFAULT\_A = [KAM] Duplicate fault flag for code Pxxx;

1 -> A fault has been stored for

code Pxxx.

PXXXCNT = [KAM] Warm-up counter for code Pxxx.

PXXXSTATE = [KAM] MIL state flag for code Pxxx.

PXXXMIL\_ON = [KAM] MIL flag for code Pxxx;

1 -> The MIL is required to be

on for code Pxxx.

PXXXUPDATED = [RAM] MIL state controller update

status flag for code Pxxx;

1 -> controller has been updated

since pwr-up.

END.

All fault codes NOT controlling the MIL light will be designated as

NO\_MIL\_CODE and have the following record structure:

NO\_MIL\_CODE = RECORD

PXXXMALF = See above.

PXXXFAULT = See above.

PXXXFAULT\_A = See above.

PXXXCNT = See above.

END.

This module provides certain services, for manipulating fault codes, which

are exported for use by other modules. These include:

- check\_warmup\_counters: This is a background task that checks and

increments each of the counters if a warm up has occured.

- erase\_code(Pxxx): Erases the fault code specified by Pxxx.

- initialize\_codes: This task is executed on power-up initialization and

clears the PxxxMALF and PxxxUPDATED flags.

- reset\_codes: This service performs fault code related actions in

response to a system reset message received from the obdII scan tool.

Each code is erased, and each warmup counter is set to 80 warmups.

- store\_code(Pxxx): Stores the fault code specified by Pxxx. For mil

codes, this service is used exclusively by the MIL Control module. It

may also be used by other diagnostic tests (for codes which do not affect

the mil).

- inc\_warmup\_counters: This service is exercised to increment all warm-up

counters by one. One place where this is used is when an on demand

diagnostic mode is entered. During the on demand mode PxxxFAULT and

PxxxFAULT\_A bits will NOT be set. When a fault is identified, the

warm-up counter will only be cleared. At the end of the on demand mode

diagnostic procedure, all fault code records with their warm-up counters

cleared will be reported.

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OBDII STRATEGY, FAULT CODES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- CODES\_COUNT = Count of total number of fault codes and pending codes (MIL

and NO\_MIL) stored by the EEC.

- ECT = Engine coolant temperature, deg F.

- FF\_CODE = Code number of fault for which freeze frame conditions are

stored, freeze frame is loaded.

- TCSTRT = Temperature of ECT at Cold Start, deg F.

- PxxxCNT = Warm-up counter for code Pxxx.

Bit Flags:

- CODES\_CHECKD = Flag indicating the warm-up counters for OBD-II codes have

been checked.

- CRKFLG = Engine Mode Flag; 1 -> Crank Mode, 0 -> not in Crank Mode.

- DEMAND\_MODE = Flag set when an On-Demand self test mode is active.

- PxxxFAULT = Fault flag for code Pxxx; 1 -> a fault has been stored for

code Pxxx.

- PxxxFAULT\_A = Duplicate fault flag for code Pxxx; 1 -> a fault has been

stored for code Pxxx.

- PXXXMIL\_ON = MIL flag for code Pxxx; 1 -> The MIL is required to be on

for code Pxxx.

- UNDSP = Run/Underspeed Flag; 1 -> Underspeed (or CRANK), 0 -> Run.

- OBDII\_WARMUP = Indicates engine warmup occured.

OUTPUTS

Registers:

- CODES\_COUNT = See above.

- NUM\_CODES = Number of OBD-II fault codes currently stored in memory.

- OD\_CODE\_CNT = Count of total number of on-demand codes currently stored.

- PxxxCNT = Warm-up counter for code Pxxx.

Bit Flags:

- CODES\_CHECKD = See above.

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OBDII STRATEGY, FAULT CODES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PxxxFAULT = See above.

- PxxxFAULT\_A = See above.

- PxxxMALF = Malfunction flag for code Pxxx; 1 -> a malfunction currently

exists for fault Pxxx.

- PxxxUPDATED = MIL state controller update status flag for code Pxxx; 1 ->

controller has been updated since PWR-UP.

- OBDII\_WARMUP = See above.

OTHER

- all\_codes = The set of all fault codes.

- cat\_codes = The set of fault codes for the obdII catalyst monitor test.

- ccm\_codes = The set of fault codes for the obdII comprehensive component

monitor test.

- cool\_codes = The set of fault codes for the fail safe cooling system

- ego\_codes = The set of fault codes for the obdII EGO monitor test.

- egr\_codes = The set of fault codes for the obdII EGR monitor test.

- fuel\_codes = The set of fault codes for the obdII fuel system test.

- mil\_codes = set of {cat\_codes,ccm\_codes,purg\_codes,sair\_codes,fuel\_codes,

ego\_codes,egr\_codes,mis\_codes}.

- mis\_codes = The set of fault codes for the obdII misfire monitor test.

- no\_mil\_codes = The subset of all\_codes that are not mil\_codes.

- purg\_codes = The set of fault codes for the obdII purge monitor test.

- sair\_codes = The set of fault codes for the obdII secondary air monitor

test.

- type1\_codes = set of

{ccm\_codes,purg\_codes,sair\_codes,ego\_codes,egr\_codes}.

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OBDII STRATEGY, FAULT CODES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: OBDII\_CODES\_COM1

BEGIN: check\_warmup\_counters

;background process

;increments all warmup counters once per power-up if the fault

;is not currently illuminating the MIL.

OBDII\_WARMUP = 0 -----------------|

|

ECT >= TCSTRT + 40 ---------------|AND -| OBDII\_WARMUP := 1

| | ;cleared on power-up

ECT >= 160 -----------------------|

OBDII\_WARMUP = 1 -----------------|

|

CODES\_CHECKD = 0 -----------------|AND -| CODES\_CHECKD := 1

| | ;cleared on power-up

DEMAND\_MODE = 0 ------------------| | Do: update\_warmup\_counters

|

| --- ELSE ---

|

DEMAND\_MODE = 1 ------------------------| CODES\_CHECKD := 1

END: check\_warmup\_counters

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OBDII STRATEGY, FAULT CODES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: update\_warmup\_counters

;private process, called by check\_warmup\_counters

;increments the warmup counters for all codes in the set "all\_codes"

;if the coresponding code is not currently illuminating the MIL.

For each Pxxx in the set mil\_codes loop:

PxxxMIL\_ON = 1 -----------------------| PxxxCNT := 0

|

| --- ELSE ---

|

PxxxCNT >= 39 ------------------------| Do: erase\_code(Pxxx)

|

| --- ELSE ---

|

| PxxxCNT := PxxxCNT + 1

End loop.

For each Pxxx in the set no\_mil\_codes loop:

PxxxCNT >= 39 ------------------------| Do: erase\_code(Pxxx)

|

| --- ELSE ---

|

| PxxxCNT := PxxxCNT + 1

End loop.

END: update\_warmup\_counters

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OBDII STRATEGY, FAULT CODES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The following services are exported by the fault code module. They may be

used by other modules to manipulate fault codes and warmup counters.

BEGIN: store\_code(Pxxx)

;public process

;stores the fault code specified by Pxxx

PxxxFAULT = 0 --------------------|

|

Pxxx is in the set of mil\_codes --|AND -| NUM\_CODES :=

| | min((NUM\_CODES+1), 127)

DEMAND\_MODE = 0 ------------------| |

| --- ELSE ---

|

PxxxFAULT = 0 --------------------| |

|AND -| CODES\_COUNT :=

DEMAND\_MODE = 0 ------------------| | min((CODES\_COUNT+1), 255)

PxxxCNT <> 0 ---------------------|

|AND -| OD\_CODE\_CNT :=

DEMAND\_MODE = 1 ------------------| | min((OD\_CODE\_CNT+1), 255)

DEMAND\_MODE = 0 ------------------------| PxxxFAULT := 1

| PxxxFAULT\_A := 1

| PxxxCNT := 0

| PxxxMALF := 1

|

| --- ELSE ---

|

| PxxxCNT := 0

| PxxxMALF := 1

END: store\_code

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OBDII STRATEGY, FAULT CODES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: erase\_code(Pxxx)

;public process, called by update\_warmup\_counters

;erases the fault code specified by Pxxx

PxxxFAULT = 1 --------------------|

|

Pxxx is in the set of mil\_codes --|AND -| NUM\_CODES :=

| | max((NUM\_CODES-1), 0)

DEMAND\_MODE = 0 ------------------|

Pxxx is in the set of mil\_codes --|

|

PxxxSTATE = 0 --------------------|

|

PxxxFAULT = 1 --------------------|AND -| CODES\_COUNT :=

| | max((CODES\_COUNT-1), 0)

DEMAND\_MODE = 0 ------------------| |

| --- ELSE ---

Pxxx in the set of non\_mil\_codes -| |

| |

PxxxFAULT = 1 --------------------|AND -| CODES\_COUNT :=

| | max((CODES\_COUNT-1), 0)

DEMAND\_MODE = 0 ------------------|

PxxxCNT = 0 ----------------------|

|AND -| OD\_CODE\_CNT :=

DEMAND\_MODE = 1 ------------------| | max((OD\_CODE\_CNT-1), 0)

23-60

OBDII STRATEGY, FAULT CODES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEMAND\_MODE = 0 ------------------------| PxxxFAULT := 0

| PxxxFAULT\_A := 0

| PxxxCNT := 40

|

| --- ELSE ---

|

| PxxxCNT := min((PxxxCNT+1), 40)

xxx = FF\_CODE --------------------------| Do: clear\_ff

END: erase\_code

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OBDII STRATEGY, FAULT CODES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: erase\_mis\_code(Pxxx)

;public process, called by the misfire state controller

;erases the fault code specified by Pxxx

PxxxFAULT = 1 --------------------|

|

Pxxx is in the set of mil\_codes --|AND -| NUM\_CODES :=

| | max((NUM\_CODES-1), 0)

DEMAND\_MODE = 0 ------------------|

Pxxx is in the set of mil\_codes --|

|

PxxxSTATE = 0 --------------------|

|

PxxxFAULT = 1 --------------------|AND -| CODES\_COUNT :=

| | max((CODES\_COUNT-1), 0)

DEMAND\_MODE = 0 ------------------| |

| --- ELSE ---

Pxxx in the set of non\_mil\_codes -| |

| |

PxxxFAULT = 1 --------------------|AND -| CODES\_COUNT :=

| | max((CODES\_COUNT-1), 0)

DEMAND\_MODE = 0 ------------------|

PxxxCNT = 0 ----------------------|

|AND -| OD\_CODE\_CNT :=

DEMAND\_MODE = 1 ------------------| | max((OD\_CODE\_CNT-1), 0)

DEMAND\_MODE = 0 ------------------------| PxxxFAULT := 0

| PxxxFAULT\_A := 0

| PxxxCNT := 40

|

| --- ELSE ---

|

| PxxxCNT := min((PxxxCNT+1), 40)

END: erase\_mis\_code

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OBDII STRATEGY, FAULT CODES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: reset\_codes

;public process

;resets all fault codes and counters to their initialization values

unconditionally ----------------------| NUM\_CODES := 0

| CODES\_COUNT := 0

| OD\_CODE\_CNT := 0

| CODES\_CHECKD := 0

For each Pxxx in the set all\_codes loop:

unconditionally ----------------------| PxxxFAULT := 0

| PxxxFAULT\_A := 0

| PxxxCNT := 40

| PxxxMALF := 0

End loop.

END: reset\_codes

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OBDII STRATEGY, FAULT CODES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: init\_codes

;public process, executed during power-up initialization

;initialize all malfunction flags and updated flags to their initialization

;values, as well as clearing the OBDII\_WARMUP and CODES\_CHECKD flags.

unconditionally ----------------------| CODES\_CHECKD := 0

| OBDII\_WARMUP := 0

For each Pxxx in the set mil\_codes loop:

unconditionally ----------------------| PxxxMALF := 0

| PxxxUPDATED := 0

End loop.

For each Pxxx in the set no\_mil\_codes loop:

unconditionally ----------------------| PxxxMALF := 0

End loop.

END: init\_codes

BEGIN: inc\_warmup\_counters

;public process, used to add one to each and every warmup counter.

unconditionally -------------------------| OD\_CODE\_CNT := 0

For each Pxxx in the set all\_codes loop:

PxxxCNT = 0 --------------------------| PxxxCNT := PxxxCNT + 1

End loop.

END: inc\_warmup\_counters

BEGIN: clear\_malf(Pxxx)

;PUBLIC process used to clear the PxxxMALF flag.

PxxxMALF = 1 ---------------------------| PxxxMALF := 0

END: clear\_malf

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OBDII STRATEGY, TRIPS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.1.5 TRIPS (CDAM0)

OVERVIEW

+--------------------------------+

| OBDII\_TRIPS\_COM1 |

+--------------------------------+

| PUBLIC PROCESSES: |

| . update\_trip\_flag |

| . update\_ready\_flags |

| . reset\_trips |

| . init\_trips |

+--------------------------------+

| PRIVATE PROCESSES: |

| . check\_readiness(sys) |

+--------------------------------+

The term "trip" was defined by CARB in order to specify the requirements for

obdII testing. A "trip" means vehicle operation (following an engine-off

period) of duration and driving mode such that all components and systems are

monitored at least once by the (obdII) diagnostic system. This definition is

subject to the limitation that the manufacturer-defined trip monitoring

conditions shall all be encountered at least once during a CVS-75 cycle.

Note that, because of the engine-off condition, this effectively means that

all obdII systems must be monitored during the 1st two bags of a CVS-75

cycle. All driving cycles are not trips. A driving cycle may be too short

to test all obdII systems.

The TRIP flag indicates that a trip has been completed. This flag is cleared

on power-up, and set when all systems are monitored. It can also be cleared

by a scan tool reset. Trips are used by the MIL module to extinguish the

MIL. It typically takes three trips without a malfunction, (for a given

fault code), to turn the MIL off (for that code).

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OBDII STRATEGY, TRIPS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- CAT\_COUNT = Count of the number of complete catalyst test since KAM

reset.

- EGO\_COUNT = Count of the number of complete EGO test since KAM reset.

- EGR\_COUNT = Count of the number of complete EGR test since KAM reset.

- PURG\_COUNT = Count of the number of complete PURGE test since KAM reset.

- PxxxSTATE = MIL state flag for code Pxxx.

- READY\_FLAGS = Bitmapped register containing OBDII ready flags and MIL\_ON

flag.

- SAIR\_COUNT = Count of the number of complete SAIR test since KAM reset.

- TRIP\_COUNT = Count of number of completed OBD-II Trips.

Bit Flags:

- CAT\_CHKD = Flag indicating CAT\_READY has been checked this power-up.

- CAT\_MON = OBDII monitor flag for catalyst; 1 -> all catalyst faults have

been monitored at least once since power-up.

- CAT\_READY = Catalyst obdII ready flag. Bit 0 of READY\_FLAGS; 1 ->

catalyst not monitored since kam reset.

- CCM\_MON = OBDII monitor flag for comprehensive components; 1 -> all

component faults have been monitored at least once since power-up.

- EGO\_CHKD = Flag indicating EGO\_READY has been checked this power-up.

- EGO\_MON = OBDII monitor flag for exhaust gas oxygen sensor; 1 -> all EGO

faults have been monitored at least once since power-up.

- EGO\_READY = EGO obdII ready flag. Bit 5 of READY\_FLAGS; 1 -> ego not

monitored since kam reset.

- EGR\_CHKD = Flag indicating EGR\_READY has been checked this power-up.

- EGR\_MON = OBDII monitor flag for exhaust gas recirculation; 1 -> all EGR

faults have been monitored at least once since power-up.

- EGR\_READY = EGR obdII ready flag. Bit 6 of READY\_FLAGS; 1 -> egr not

monitored since kam reset.

- EO\_MON = Flag indicating the engine off on-demand test is complete.

- ER\_MON = Flag indicating the engine running on-demand test is complete.

- FUEL\_MON = OBDII monitor flag for fuel; 1 -> all fuel faults have been

monitored at least once since power-up.

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OBDII STRATEGY, TRIPS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- MIS\_MON = OBDII monitor flag for misfire; 1 -> all misfire faults have

been monitored at least once since power-up.

- PURG\_CHKD = Flag indicating PURG\_READY has been checked this power-up.

- PURG\_MON = OBDII monitor flag for purge; 1 -> all purge faults have been

monitored at least once since power-up.

- PURG\_READY = Purge obdII ready flag. Bit 2 of READY\_FLAGS; 1 -> purge

not monitored since kam reset.

- SAIR\_CHKD = Flag indicating SAIR\_READY has been checked this power-up.

- SAIR\_MON = OBDII monitor flag for secondary air; 1 -> all secondary air

faults have been monitored at least once since power-up.

- SAIR\_READY = Secondary Air obdII ready flag. Bit 3 of READY\_FLAGS; 1 ->

secondary air not monitored since kam reset.

- TRIP = Flag indicating that an obdII trip has been completed; 1 -> trip

completed.

Calibration Constants:

- CAT\_TST\_SW = CAT st present calibration switch; 1 -> CAT present.

- CCM\_TST\_SW = CCM test present calibration switch; 1 -> CCM test present.

- EGO\_TST\_SW = EGO test present calibration switch; 1 ->EGO test present.

- EGR\_TST\_SW = EGR test present calibration switch; 1 -> EGR test present.

- FUEL\_TST\_SW = FUEL test present claibration switch; 1 -> FUEL test

present.

- MIS\_TST\_SW = MIS test present claibration switch; 1 -> MIS test present.

- PURG\_TST\_SW = PURG test present calibration switch; 1 -> PURG test

present.

- SAIR\_TST\_SW = SAIR test present calibration switch; 1 -> SAIR test

present.

23-67

OBDII STRATEGY, TRIPS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: OBDII\_TRIPS\_COM1

BEGIN: update\_trip\_flag

;executed each background loop

TRIP = 0 -------------------------|

|

CAT\_MON = 1 ----------------| |

|OR --|

CAT\_TST\_SW = 0 -------------| |

|

CCM\_MON = 1 ----------------| |

|OR --|

CCM\_TST\_SW = 0 -------------| |

|

PURG\_MON = 1 ---------------| |

|OR --|

PURG\_TST\_SW = 0 ------------| |

|

SAIR\_MON = 1 ---------------| |

|OR --|

SAIR\_TST\_SW = 0 ------------| |

|AND -| TRIP := 1

FUEL\_MON = 1 ---------------| | | ;global trip flag

|OR --| |

FUEL\_TST\_SW = 0 ------------| | | TRIP\_COUNT := TRIP\_COUNT + 1

|

EGO\_MON = 1 ----------------| |

|OR --|

EGO\_TST\_SW = 0 -------------| |

|

EGR\_MON = 1 ----------------| |

|OR --|

EGR\_TST\_SW = 0 -------------| |

|

MIS\_MON = 1 ----------------| |

|OR --|

MIS\_TST\_SW = 0 -------------|

END: update\_trip\_flag

23-68

OBDII STRATEGY, TRIPS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: update\_ready\_flags

;public process executed once per background pass to update the ready

;flags and store a code per CARB regulations if all system not ready.

CAT\_TST\_SW = 0 -------------------| CAT\_READY := 0

|

| --- ELSE ---

CAT\_MON = 1 ----------------| |

| |

CAT\_CHKD = 0 ---------------|AND -| CAT\_COUNT := CAT\_COUNT + 1

| | DO: check\_readiness(cat)

CAT\_READY = 1 --------------| | CAT\_CHKD := 1

PURG\_TST\_SW = 0 ------------------| PURG\_READY := 0

|

| --- ELSE ---

PURG\_MON = 1 ---------------| |

| |

PURG\_CHKD = 0 --------------|AND -| PURG\_COUNT := PURG\_COUNT + 1

| | DO: check\_readiness(purg)

PURG\_READY = 1 -------------| | PURG\_CHKD := 1

SAIR\_TST\_SW = 0 ------------------| SAIR\_READY := 0

|

| --- ELSE ---

SAIR\_MON = 1 ---------------| |

| |

SAIR\_CHKD = 0 --------------|AND -| SAIR\_COUNT := SAIR\_COUNT + 1

| | DO: check\_readiness(sair)

SAIR\_READY = 1 -------------| | SAIR\_CHKD := 1

EGO\_TST\_SW = 0 -------------------| EGO\_READY := 0

|

| --- ELSE ---

EGO\_MON = 1 ----------------| |

| |

EGO\_CHKD = 0 ---------------|AND -| EGO\_COUNT := EGO\_COUNT + 1

| | DO: check\_readiness(ego)

EGO\_READY = 1 --------------| | EGO\_CHKD := 1

EGR\_TST\_SW = 0 -------------------| EGR\_READY := 0

|

| --- ELSE ---

EGR\_MON = 1 ----------------| |

| |

EGR\_CHKD = 0 ---------------|AND -| EGR\_COUNT := EGR\_COUNT + 1

| | DO: check\_readiness(egr)

EGR\_READY = 1 --------------| | EGR\_CHKD := 1

23-69

OBDII STRATEGY, TRIPS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CAT\_READY = 0 --------------------|

|

PURG\_READY = 0 -------------------|

|

SAIR\_READY = 0 -------------------|AND -| Do: erase\_code(P1000)

| | ;signal all tests ready.

EGO\_READY = 0 --------------------| |

| |

EGR\_READY = 0 --------------------| |

| --- ELSE ---

|

| Do: store\_code(P1000)

| ;hold warmup counter at zero.

END: update\_ready\_flags

23-70

OBDII STRATEGY, TRIPS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TRIP INITIALIZATION/RESET

INITIALIZATION: The trip module is initialized on power-up. The trip and

monitor flags are cleared, indicating that no OBD-II system has been

monitored since power-up. The Ready flags are not affected.

RESET: The OBD-II scan tool can cause a reset of the trip module via the SCP

communications interface. An OBD-II reset performs the same actions as the

initialization above, and also sets the ready flags. A value of 1 for a

ready flag indicates that the particular system corresponding to that flag

has not been monitored since the last OBD-II reset.

BEGIN: reset\_trips

;executed when an obdII reset occurs

unconditionally ------------------------| CAT\_READY := 1

| PURG\_READY := 1

| SAIR\_READY := 1

| EGO\_READY := 1

| EGR\_READY := 1

| CAT\_COUNT := 0

| SAIR\_COUNT := 0

| PURG\_COUNT := 0

| EGO\_COUNT := 0

| EGR\_COUNT := 0

| TRIP\_COUNT := 0

| CAT\_CHKD := 0

| SAIR\_CHKD := 0

| PURG\_CHKD := 0

| EGO\_CHKD := 0

| EGR\_CHKD := 0

| Do: store\_code(P1000)

| ;indicate not ready for I/M test

unconditionally ------------------------| TRIP := 0

| CAT\_MON := 0

| CCM\_MON := 0

| PURG\_MON := 0

| SAIR\_MON := 0

| FUEL\_MON := 0

| EGO\_MON := 0

| EGR\_MON := 0

| MIS\_MON := 0

| EO\_MON := 0

| ER\_MON := 0

| CAT\_MON\_LST := 0

| EGO\_MON\_LST := 0

| SAIR\_MON\_LST := 0

| PURG\_MON\_LST := 0

| CCM\_MON\_LST := 0

| EGR\_MON\_LST := 0

| MIS\_MON\_LST := 0

| FUEL\_MON\_LST := 0

| ;indicate OBD-II trip not complete

END: reset\_trips

23-71

OBDII STRATEGY, TRIPS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: init\_trips

;executed during power-up

unconditionally ------------------------| TRIP := 0

| CAT\_MON := 0

| CCM\_MON := 0

| PURG\_MON := 0

| SAIR\_MON := 0

| FUEL\_MON := 0

| EGO\_MON := 0

| EGR\_MON := 0

| MIS\_MON := 0

| EO\_MON := 0

| ER\_MON := 0

| CAT\_MON\_LST := 0

| EGO\_MON\_LST := 0

| SAIR\_MON\_LST := 0

| PURG\_MON\_LST := 0

| CCM\_MON\_LST := 0

| EGR\_MON\_LST := 0

| MIS\_MON\_LST := 0

| FUEL\_MON\_LST := 0

| CAT\_CHKD := 0

| SAIR\_CHKD := 0

| PURG\_CHKD := 0

| EGO\_CHKD := 0

| EGR\_CHKD := 0

| ;indicate OBD-II trip not complete

END: init\_trips

BEGIN: check\_readiness(sys)

;PRIVATE process used to determine if a system has been monitored enough

;times to illuminate the MIL,if appropriate. In the case of the Catalyst

;monitor this would be three checks, in the case of the other monitors, it

;would be two. The number of trips can be overridden if the first (or

second

;in the case of the Catalyst monitor) does not set any fault codes.

unconditionally ---------------------| sys\_ready := 0

For each Pxxx in the set of sys\_codes loop:

PxxxSTATE <> 0 ----------------------| sys\_ready := 1

End loop.

unconditionally ---------------------| sys\_READY := sys\_ready

sys\_COUNT >= 2 ----------------------| sys\_READY := 0

| ;system monitor is ready.

END: check\_readiness(sys)

23-72

OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-TYPE 1 - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.1.6 STATE CONTROL-TYPE 1 (CDAK0)

OVERVIEW

This module contains the OBD-II MIL control procedures for the type 1 (egr,

purg, ego, ccm, sair ,fail safe cooling) monitors. A pictorial

representation of what this object holds is shown below:

Type 1 State Controller

+------------------------------+

| OBDII\_TYPE1\_STATE\_CONTROLLER |

+------------------------------+

| . type1\_malfunction |

| . type1\_init\_mil |

| . type1\_trip\_complete |

| . type1\_reset |

+------------------------------+

The state controller is a realization of a finite state machine. It is

purely event driven, those events being malfunctions, trip completion,

power-up initialization, and OBDII reset commands from the external

environment. There are no background tasks associated with the MIL state

controllers.

The next page shows the operation of the finite state machine to control the

type1 mil structures.

23-73

OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-TYPE 1 - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Below is a description of how a finite state machine functions.

A finite state machine is a way to graphically illustrate the functioning of

a system or process that can be in a set of DISCRETE states. The diagram

shows how and when transitions can occur between the states.

+----------------------+

| |

| STATE X |<-------------------

| | condition

+-----+----------A-----+ ---------

| | action

| |

condition | | condition

--------- | | ---------

action | | action

| |

| |

+-----V----------+-----+

| |

| STATE Y |

| |

+----------------------+

CONVENTIONS:

· BOXES represent STATES of the system.

· ARROWS represent TRANSITIONS between states.

· CONDITIONS will CAUSE a transition to be taken.

· ACTIONS are done WHEN a transition is taken.

RULES:

· The system can be in only one state at a time.

· The system remains in a given state until an event

occurs to cause a transition.

· No other transitions than those shown can be taken.

23-74

OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-TYPE 1 - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Type1 State Controller

+---------------------+

+------------------------ | state 0 | <--------------------

| | NO | reset\_mil

| +--------------------| MALFUNCTIONS | -----------

| | malfunction & | ( mil flag off ) | <----+ PxxxSTATE=0

| | DEMAND\_MODE=0 +---A-----------------+ | PxxxMIL\_ON=0

| | ------------ | power\_up |

| | PxxxSTATE=1 | ----------- |

| | PxxxUPDATED=1 | PxxxSTATE=0 | trip\_complete

| | inc(CODES\_COUNT) | dec(CODES\_COUNT) | &

| | +--------------------+ | PxxxUPDATED=0

| | | state 2 | | -------------

| | | ONE TRIP WITHOUT | | PxxxSTATE=0

| | | MALFUNCTION |--------+ | PxxxMIL\_ON=0

| | | ( mil flag off ) | | |

| | +---A----------------+ | |

| | | | +---------------------+

| | | | | state 5 |

| | | trip\_complete | | TWO TRIPS WITHOUT |

| | | & | | MALFUNCTIONS |

| | | PxxxUPDATED=0 |<------| ( mil flag on ) |

| | | ------------- malfunction & +---A-----------------+

| | | PxxxSTATE=2 DEMAND\_MODE=0 |

| +--V------------------+ ------------- | trip\_complete

| | state 1 | PxxxSTATE=3 | &

| | ONE | PxxxUPDATED=1 | PxxxUPDATED=0

| | MALFUNCTION | PxxxMIL\_ON=1 | -------------

| | ( mil flag off ) | store\_code | PxxxSTATE=5

| +---------------------+ sys\_MIL\_ON = 1 | PxxxUPDATED=1

| | malfunction & | +---------------------+

| | DEMAND\_MODE=0 & | | state 4 |

| | PxxxUPDATED=0 | | ONE TRIP WITHOUT |

| | ------------- | | MALFUNCTION |

| | PxxxSTATE=3 |<------| ( mil flag on ) |

| | PxxxUPDATED=1 | +-------A-------------+

| | PxxxMIL\_ON=1 | |

| | store\_code | |

| | sys\_MIL\_ON = 1 +-------------V-------+ |

| +-----------------> | state 3 |-------+ trip\_complete

| | TWO OR MORE | &

|+---------------------> | MALFUNCTIONS | PxxxUPDATED=0

malfunction & | ( mil flag on ) | -------------

DEMAND\_MODE=0 & +---A-----------------+ PxxxSTATE=4

sys = cool | | PxxxUPDATED=1

------------- | |

PxxxSTATE=3 +-------------+

PxxxUPDATED=1 malfunction &

PxxxMIL\_ON=1 DEMAND\_MODE=0

store\_code -------------

sys\_MIL\_ON=1 PxxxUPDATED=1

inc(CODES\_COUNT)

23-75

OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-TYPE 1 - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Bit Flags:

- DEMAND\_MODE = Flag set when an On-Demand self test mode is active.

- PxxxMIL\_ON = MIL flag for code Pxxx; 1 -> the MIL is required to be on

for code Pxxx.

- PxxxSTATE = MIL state flag for code Pxxx.

- PxxxUPDATED = MIL state controller update status flag for code Pxxx; 1 ->

controller has been updated since power-up.

OUTPUTS

Bit Flags:

- CCM\_MIL\_ON = MIL status flag for Comprehensive Components; 1 -> MIL

required for CCM fault.

- CODES\_COUNT = Count of total number of fault codes and pending codes (MIL

and NO\_MIL) stored by the EEC.

- CAT\_MIL\_ON = MIL status flag for Catalyst system; 1 -> MIL required for

catalyst fault.

- COOL\_MIL\_ON = MIL status flag for fail safe cooling; 1 -> MIL required

for fail safe cooling

- EGR\_MIL\_ON = MIL status flag for EGR; 1 -> MIL required for EGR fault.

- PxxxMIL\_ON = See above.

- PxxxSTATE = See above.

- PxxxUPDATED = See above.

- PURG\_MIL\_ON = MIL status flag Purge; 1 -> MIL required for Purge fault.

- SAIR\_MIL\_ON = MIL status flag for Secondary Air; 1 -> MIL required for

Secondary Air fault.

23-76

OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-TYPE 1 - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: OBDII\_TYPE1\_STATE\_CONTROL\_COM1

BEGIN: type1\_malfunction(sys\_mil\_on, Pxxx, sys)

;This logic implements malfunction transitions for the type1 state

;machine.

DEMAND\_MODE = 1 -------------------| Do: store\_code(Pxxx)

|

| --- ELSE ---

PxxxSTATE = 0 ---------------| |

| |

sys = cool ------------------|AND -| PxxxSTATE := 3

| | PxxxUPDATED := 1

PxxxFAULT = 0 ---------------| | CODES\_COUNT :=

| min((CODES\_COUNT + 1), 255)

| PxxxMIL\_ON := 1

| Do: store\_code(Pxxx)

| sys\_mil\_on := 1

|

| \_\_\_ ELSE ---

PxxxSTATE = 0 ---------------| |

|AND -| PxxxSTATE := 3

sys = cool ------------------| | PxxxUPDATED := 1

| PxxxMIL\_ON := 1

| Do: store\_code(Pxxx)

| sys\_mil\_on := 1

|

| \_\_\_ ELSE ---

PxxxSTATE = 0 ---------------| |

|AND -| PxxxSTATE := 1

PxxxFAULT = 0 ---------------| | PxxxUPDATED := 1

| CODES\_COUNT :=

| min((CODES\_COUNT + 1), 255)

|

| --- ELSE ---

|

PxxxSTATE = 0 ---------------------| PxxxSTATE := 1

| PxxxUPDATED := 1

|

| --- ELSE ---

PxxxSTATE = 1 ---------------| |

|AND -| PxxxSTATE := 3

PxxxUPDATED = 0 -------------| | PxxxUPDATED := 1

| PxxxMIL\_ON := 1

| Do: store\_code(Pxxx)

| sys\_mil\_on := 1

|

| --- ELSE ---

(continued on next page)

23-77

OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-TYPE 1 - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

PxxxSTATE = 2 ---------------| |

| |

PxxxSTATE = 4 ---------------|OR --| PxxxSTATE := 3

| | PxxxUPDATED := 1

PxxxSTATE = 5 ---------------| | PxxxMIL\_ON := 1

| Do: store\_code(Pxxx)

| sys\_mil\_on := 1

|

| --- ELSE ---

|

PxxxSTATE = 3 ---------------------| PxxxUPDATED := 1

END: type1\_malfunction(sys\_mil\_on, Pxxx, sys)

BEGIN: type1\_init\_mil(sys)

;Private procedure performed upon request from the initialize\_mil

;procedure.

For each Pxxx in the set of sys\_codes loop:

PxxxSTATE = 2 ---------------|

|AND -| PxxxSTATE := 0

PxxxFAULT = 0 ---------------| | CODES\_COUNT :=

| max((CODES\_COUNT-1), 0)

|

| --- ELSE ---

|

PxxxSTATE = 2 ---------------------| PxxxSTATE := 0

End loop.

END: type1\_init\_mil(sys)

23-78

OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-TYPE 1 - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: type1\_trip\_complete(sys, sys\_mil\_on)

; this logic updates the type1 state machines for each Pxxx in sys.

unconditionally -------------------| sys\_mil\_on := 0

For each Pxxx in the set of sys\_codes loop:

PxxxSTATE = 1 ---------|

|

PxxxSTATE = 3 ---------|OR --|

| |

PxxxSTATE = 4 ---------| |AND -| PxxxSTATE := PxxxSTATE + 1

| | PxxxUPDATED := 1

PxxxUPDATED = 0 -------------| |

| --- ELSE ---

PxxxSTATE = 5 ---------------| |

|AND -| PxxxSTATE := 0

PxxxUPDATED = 0 -------------| | PxxxMIL\_ON := 0

PxxxMIL\_ON = 1 --------------------| sys\_mil\_on := 1

End loop.

END: type1\_trip\_complete(sys, sys\_mil\_on)

BEGIN: type1\_reset

;executed when an obdII reset message is received from the scan tool

For all codes in the set of type1\_codes loop:

unconditionally --------------------| PxxxUPDATED := 0

| PxxxSTATE := 0

| PxxxMIL\_ON := 0

End loop.

unconditionally ----------------------| CCM\_MIL\_ON := 0

| COOL\_MIL\_ON := 0

| PURG\_MIL\_ON := 0

| SAIR\_MIL\_ON := 0

| EGO\_MIL\_ON := 0

| EGR\_MIL\_ON := 0

| CAT\_MIL\_ON := 0

END: type1\_reset

23-79

OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.1.7 STATE CONTROL-FUEL (CDAK0)

OVERVIEW

This module contains the OBD-II MIL control procedures for the fuel system

monitor. A pictorial representation of what this object holds is shown

below:

Fuel system State Controller

+------------------------------+

| OBDII\_FUEL\_STATE\_CONTROLLER |

+------------------------------+

| . fuel\_malfunction |

| . fuel\_init\_mil |

| . fuel\_trip\_complete |

| . fuel\_reset |

| . fuel\_conds\_seen |

+------------------------------+

The state controller is a realization of a finite state machine. It is

purely event driven, those events being malfunctions, trip completion,

power-up initialization, and OBDII reset commands from the external

environment. There are no background tasks associated with the MIL state

controllers.

The next page shows the operation of the finite state machine to control the

fuel mil structures.

23-80

OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Below is a description of how a finite state machine functions.

A finite state machine is a way to graphically illustrate the functioning of

a system or process that can be in a set of DISCRETE states. The diagram

shows how and when transitions can occur between the states.

+----------------------+

| |

| STATE X |<-------------------

| | condition

+-----+----------A-----+ ---------

| | action

| |

condition | | condition

--------- | | ---------

action | | action

| |

| |

+-----V----------+-----+

| |

| STATE Y |

| |

+----------------------+

CONVENTIONS:

· BOXES represent STATES of the system.

· ARROWS represent TRANSITIONS between states.

· CONDITIONS will CAUSE a transition to be taken.

· ACTIONS are done WHEN a transition is taken.

RULES:

· The system can be in only one state at a time.

· The system remains in a given state until an event

occurs to cause a transition.

· No other transitions than those shown can be taken.

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Fuel System State Controller

+-------------------+

| state 0 | <-----------------------

| NO | reset\_mil

| MALFUNCTIONS | -----------

+----------------------| ( mil flag off ) | <---+ PxxxSTATE=0

| malfunction & +------------A------+ | PxxxMIL\_ON=0

| DEMAND\_MODE=0 | | clear\_conds

| -------------- fuel\_conds\_seen +----+

| PxxxSTATE=1 OR | power\_up &

| PxxxUPDATED=1 (power\_up & | PxxxSEEN=1 &

| get\_conds PxxxACTIVE=1 & | CL\_SEEN=1

| inc(CODES\_COUNT) PxxxTRIP\_CT=79) | -----------

| ---------------- | PxxxSTATE=0

| PxxxSTATE=0 | PxxxMIL\_ON=0

| clear\_similar\_conds | clear\_conds

| dec(CODES\_COUNT) |

| | +---------------+

| +-+power\_up & | | state 5 |

| | |PxxxACTIVE=1 | | 3RD DRIVING |

| | |& PxxxTRIP\_CT<79 | | CYCLE |

| | |------------ | +-------| (mil flag on) |-------+

| | |PxxxUPDATED=0 | | +-----A---------+ |

| | |PxxxTRIP\_FG=0 | | | power\_up & |

| | |update\_pxxxtrip\_ct | | | PxxxSEEN=1 & |

| | | | | | CL\_SEEN=1 |

| | | +-+ power\_up & | | | ------------ |

| | | | | PxxxACTIVE=0 | | | PxxxSTATE=5 |

| | | | | --------- | | | PxxxSEEN=0 |

+V-------V-+-------V+| PxxxUPDATED=0 | | +---------------+ |

| state 1 || PxxxACTIVE=1 | | | state 4 | |

| VERIFYING || PxxxTRIP\_FG=0 | | | 2ND DRIVING | |

| MALFUNCTION |+ PxxxTRIP\_CT=0 | |<------| CYCLE |------>|

| ( mil flag off )|----------------+ | | (mil flag on) | |

+---+-----A-----+---+ | +-----A---------+ |

| | | trip\_complete | | power\_up & |

| | | ------------- malfunction & | PxxxSEEN=1 |

| +-----+ PxxxTRIP\_FG=1 DEMAND\_MODE=0 | CL\_SEEN=1 |

| ------------- | ----------- |

| malfunction & PxxxSTATE=2 | PxxxSTATE=4 |

| DEMAND\_MODE=0 & | | PxxxSEEN=0 |

| PxxxUPDATED=0 | +---------------+ |

| ------------- | | state 3 | |

| PxxxSTATE=2 | | 1ST DRIVING | |

| PxxxMIL\_ON=1 | | CYCLE | |

| store\_code |<------| (mil flag on) | |

| FUEL\_MIL\_ON = 1 | +-----A-------A-+ |

| +--------------V------+ | | |

+-------------------> | state 2 |------+ +---------+

| MALFUNCTION | power\_up power\_up &

| PRESENT | ---------- PxxxSEEN=0 &

| ( mil flag on ) | PxxxSTATE=3 CL\_SEEN=1

+---------------------+ PxxxSEEN=0 ----------

PxxxSTATE=3

23-82

OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- CODES\_COUNT = Count of total number of fault codes and pending codes (MIL

and NO\_MIL) stored by the EEC.

Bit Flags:

- CL\_SEEN = Flag indicating if closed-loop fuel operation has been seen

this driving cycle.

- DEMAND\_MODE = Flag set when an On-Demand self test mode is active.

- PxxxACTIVE = Similar conditions active flag; 1 -> conditons active.

- PxxxMIL\_ON = MIL flag for code Pxxx; 1 -> the MIL is required to be on

for code Pxxx.

- PxxxSEEN = Similar conditions seen flag; 1 -> conditions seen.

- PxxxSTATE = MIL state flag for code Pxxx.

- PxxxTRIP\_CT = Similar conditions trip counter (0 - 80).

- PxxxTRIP\_FG = Similar conditions trip flag; 1 -> trip occured.

- PxxxUPDATED = MIL state controller update status flag for code Pxxx; 1 ->

controller has been updated since power-up.

OUTPUTS

Registers:

- CODES\_COUNT = See above.

Bit Flags:

- FUEL\_MIL\_ON = MIL status flag for Fuel System; 1 -> MIL required for Fuel

System fault.

- PxxxACTIVE = See above.

- PxxxMIL\_ON = See above.

- PxxxSEEN = See above.

- PxxxSTATE = See above.

- PxxxTRIP\_CT = See above.

- PxxxTRIP\_FG = See above.

23-83

OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PxxxUPDATED = See above.

PROCESS

STRATEGY MODULE: OBDII\_FUEL\_STATE\_CONTROL\_COM1

BEGIN: fuel\_malfunction(sys\_mil\_on, Pxxx)

;This logic implements malfunction transitions for the fuel state machine

DEMAND\_MODE = 1 -------------------| Do: store\_code(Pxxx)

|

| --- ELSE ---

PxxxSTATE = 0 ---------------| |

|AND -| PxxxSTATE := 1

PxxxFAULT = 0 ---------------| | PxxxUPDATED := 1

| Do: get\_similar\_conds(Pxxx)

| CODES\_COUNT :=

| min((CODES\_COUNT+1), 255)

|

| --- ELSE ---

PxxxSTATE = 0 ---------------------| PxxxSTATE := 1

| PxxxUPDATED := 1

| Do: get\_similar\_conds(Pxxx)

|

| --- ELSE ---

PxxxSTATE = 1 ---------------| |

|AND -| PxxxSTATE := 2

PxxxUPDATED = 0 -------------| | PxxxMIL\_ON := 1

| Do: store\_code(Pxxx)

| sys\_mil\_on := 1

|

| --- ELSE ---

PxxxSTATE = 3 ---------------| |

| |

PxxxSTATE = 4 ---------------|OR --| PxxxSTATE := 2

|

PxxxSTATE = 5 ---------------|

END: fuel\_malfunction(sys\_mil\_on, Pxxx)

23-84

OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: fuel\_init\_mil(sys\_mil\_on)

;Private procedure performed upon request from the initialize\_mil

;procedure. sys\_mil\_on symbolically represents the flag for the

;mil controller for this system.

unconditionally -------------------| sys\_mil\_on := 0

For each Pxxx in the set of fuel\_codes loop:

PxxxSTATE = 1 ---------------|

|

PxxxTRIP\_CT = 79 ------------|AND -| PxxxSTATE := 0

| | Do: clear\_similar\_conds(Pxxx)

PxxxFAULT = 0 ---------------| | CODES\_COUNT :=

| max((CODES\_COUNT-1), 0)

|

| --- ELSE ---

PxxxSTATE = 1 ---------------| |

|AND -| PxxxSTATE := 0

PxxxTRIP\_CT = 79 ------------| | Do: clear\_similar\_conds(Pxxx)

|

| --- ELSE ---

PxxxSTATE = 1 ---------------| |

|AND -| PxxxUPDATED := 0

PxxxACTIVE = 0 --------------| | PxxxACTIVE := 1

| PxxxTRIP\_FG := 0

| PxxxTRIP\_CT := 0

|

| --- ELSE ---

PxxxSTATE = 1 ---------------| |

|AND -| PxxxUPDATED := 0

PxxxTRIP\_FG = 1 -------------| | PxxxTRIP\_FG := 0

| PxxxTRIP\_CT := PxxxTRIP\_CT + 1

|

| --- ELSE ---

|

PxxxSTATE = 1 ---------------------| PxxxUPDATED := 0

| PxxxTRIP\_FG := 0

|

| --- ELSE ---

|

PxxxSTATE = 2 ---------------------| PxxxSTATE := 3

| PxxxSEEN := 0

|

| --- ELSE ---

(continued on next page)

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

PxxxSTATE = 3 ---------| |

|OR --| |

PxxxSTATE = 4 ---------| | |

|AND -| PxxxSTATE := PxxxSTATE + 1

PxxxSEEN = 1 ----------------| | PxxxSEEN := 0

| |

CL\_SEEN = 1 -----------------| |

| --- ELSE ---

PxxxSTATE = 4 ---------------| |

|AND -| PxxxSTATE := 3

CL\_SEEN = 1 -----------------| |

| --- ELSE ---

PxxxSTATE = 5 ---------------| |

| |

PxxxSEEN = 1 ----------------|AND -| PxxxSTATE := 0

| | PxxxMIL\_ON := 0

CL\_SEEN = 1 -----------------| | Do: clear\_similar\_conds(Pxxx)

|

| --- ELSE ---

PxxxSTATE = 5 ---------------| |

|AND -| PxxxSTATE := 3

CL\_SEEN = 1 -----------------|

PxxxMIL\_ON = 1 --------------------| sys\_mil\_on := 1

End loop.

END: fuel\_init\_mil

BEGIN: fuel\_trip\_complete

;This logic updates the fuel system state machines for each fuel system

;Pxxx.

For each Pxxx in the set of fuel\_codes loop:

PxxxSTATE = 1 ---------------------| PxxxTRIP\_FG := 1

End loop.

END: fuel\_trip\_complete

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-FUEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: fuel\_reset

;executed when an obdII reset message is received from the scan tool

For all codes in the set of fuel\_codes loop:

unconditionally -------------------| PxxxUPDATED := 0

| PxxxSTATE := 0

| PxxxMIL\_ON := 0

| Do: clear\_similar\_conds(Pxxx)

End loop.

unconditionally -------------------| FUEL\_MIL\_ON := 0

END: fuel\_reset

BEGIN: fuel\_conds\_seen(Pxxx)

;PUBLIC process called on demand from the SIMILAR CONDITIONS module when

;similar conditions have been encountered without a malfunction.

PxxxSTATE = 1 ---------------|

|AND -| PxxxSTATE := 0

PxxxFAULT = 0 ---------------| | Do: clear\_similar\_conditions(Pxxx)

| CODES\_COUNT := max((CODES\_COUNT-1),0)

|

| --- ELSE ---

|

PxxxSTATE = 1 ---------------------| PxxxSTATE := 0

| Do: clear\_similar\_conditions(Pxxx)

END: fuel\_conds\_seen(Pxxx)

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-MISFIRE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.1.8 STATE CONTROL-MISFIRE (CDAK0)

OVERVIEW

This module contains the OBD-II MIL control procedures for the misfire

monitor. A pictorial representation of what this object holds is shown

below:

Mis system State Controller

+------------------------------+

| OBDII\_MIS\_STATE\_CONTROLLER |

+------------------------------+

| . mis\_malfunction |

| . mis\_init\_mil |

| . mis\_trip\_complete |

| . mis\_reset |

| . unknown\_misfire |

| . known\_misfire |

| . mis\_conds\_seen |

+------------------------------+

The state controller is a realization of a finite state machine. It is

purely event driven, those events being malfunctions, trip completion,

power-up initialization, and OBDII reset commands from the external

environment. There are no background tasks associated with the MIL state

controllers.

The next page shows the operation of the finite state machine to control the

fuel mil structures.

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-MISFIRE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Below is a description of how a finite state machine functions.

A finite state machine is a way to graphically illustrate the functioning of

a system or process that can be in a set of DISCRETE states. The diagram

shows how and when transitions can occur between the states.

+----------------------+

| |

| STATE X |<-------------------

| | condition

+-----+----------A-----+ ---------

| | action

| |

condition | | condition

--------- | | ---------

action | | action

| |

| |

+-----V----------+-----+

| |

| STATE Y |

| |

+----------------------+

CONVENTIONS:

· BOXES represent STATES of the system.

· ARROWS represent TRANSITIONS between states.

· CONDITIONS will CAUSE a transition to be taken.

· ACTIONS are done WHEN a transition is taken.

RULES:

· The system can be in only one state at a time.

· The system remains in a given state until an event

occurs to cause a transition.

· No other transitions than those shown can be taken.

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-MISFIRE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Misfire State Controller

+-----------------+

+---------------------------| state 0 | <---------------------

| | NO | reset\_mil OR known\_misfire

| +------------------------| MALFUNCTIONS | --------------------------

| | malfunction & | (mil flag off) | <-----+ PxxxSTATE=0

| | DEMAND\_MODE=0 & +--------A--------+ | PxxxMIL\_ON=0

| | TYPE\_A\_MIS=0 | | clear\_similar\_conds

| | -------------- mis\_conds\_seen() +---+

| | PxxxSTATE=1 OR | power\_up &

| | PxxxUPDATED=1 (power\_up & | PxxxSEEN=1 &

| | get\_similar\_conds PxxxACTIVE=1 & | CL\_SEEN=1

| | inc(CODES\_COUNT) PxxxTRIP\_CT=79) | -----------

| | ---------------- | PxxxSTATE=0

| | PxxxSTATE=0 | PxxxMIL\_ON=0

| | +---+ power\_up & clear\_similar\_conds | clear\_similar\_

| | | | PxxxACTIVE=1 dec(CODES\_COUNT) | conds

| | | | & PxxxTRIP\_CT<79 | +--------+------+

| | | | ------------ | | state 5 |

| | | | PxxxUPDATED=0 | | 3RD DRIVING |

| | | | PxxxTRIP\_FG=0 | | CYCLE |

| | | | update\_pxxxtrip\_ct | +-------| (mil flag on) |-------+

| | | | | | +-------A-------+ |

| | | | +-----+power\_up & | | | power\_up & |

| | | | | |PXXXACTIVE=0 | | | PxxxSEEN=1 & |

| | | | | |---------- | | | CL\_SEEN=1 |

| | | | | |PxxxUPDATED=0 | | | ----------- |

| | | | | |PxxxACTIVE=1 | | | PxxxSTATE=5 |

|+-V----V---+---V--+ |PxxxTRIP\_FG=0 | | | PxxxSEEN=0 |

|| state 1 |--+PxxxTRIP\_CT=0 | | +-------+-------+ |

|| VERIFYING | | | | state 4 | |

|| MALFUNCTION | | | | 2ND DRIVING | |

|| (mil flag off) |-----------------+ | | CYCLE | |

|+---+-----A---+---+ |<------| (mil flag on) |------>|

| | | | trip\_complete | +-------A-------+ |

| | | | ------------- | | power\_up & |

| | +---+ PxxxTRIP\_FG=1 | | PxxxSEEN=1 & |

| | malfunction & malfunction & | CL\_SEEN=1 |

| | DEMAND\_MODE=0 & DEMAND\_MODE=0 | ----------- |

| | ((PxxxUPDATED=0) OR ------------- | PxxxSTATE=4 |

| | (TYPE\_A\_MIS=1)) PxxxSTATE=2 | PxxxSEEN=0 |

| | ------------- | +-------+-------+ |

| | PxxxSTATE=2 | | state 3 | |

| | PxxxMIL\_ON=1 | | 1ST DRIVING | |

| | store\_code | | CYCLE | |

| | MIS\_MIL\_ON=1 |<------| (mil flag on) | |

| | | +-----A-------A-+ |

| +---------------------->+-----------V---+ | | |

| unknown\_misfire OR | state 2 |---------+ +---------+

|(malfunction & DEMAND\_MODE=0| MALFUNCTION | power\_up power\_up &

+- & TYPE\_A\_MIS=1)---------->| PRESENT | ----------- PxxxSEEN=0 &

------------- |(mil flag on) | PxxxSTATE=3 CL\_SEEN = 1

PxxxSTATE=2 +---------------+ PxxxSEEN=0 ------------

PxxxMIL\_ON=1 PxxxSTATE=3

MIS\_MIL\_ON=1

\*get\_similar\_conds

\*PxxxACTIVE=1 \*Sequence of these two actions is critical.

store\_code & inc(CODES\_COUNT)

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-MISFIRE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- CODES\_COUNT = Count of total number of fault codes and pending codes (MIL

and NO\_MIL) stored by the EEC.

- FF\_CODE = Code number of fault for which freeze frame conditions are

stored. freeze frame is loaded.

Bit Flags:

- CL\_SEEN = Flag indicating if closed-loop fuel operation has been seen

this driving cycle.

- DEMAND\_MODE = Flag set when an On-Demand self test mode is active.

- PxxxACTIVE = Similar conditions active flag; 1 -> conditons active.

- PXXXMIL\_ON = MIL flag for code PXXX: 1 -> the MIL in required to be on

for code PXXX.

- PxxxSEEN = Similar conditions seen flag; 1 -> conditions seen.

- PxxxSTATE = MIL state flag for code Pxxx.

- PxxxTRIP\_CT = Similar conditions trip counter (0 - 80).

- PxxxTRIP\_FG = Similar conditions trip flag; 1 -> trip occured.

- PxxxUPDATED = MIL state controller update status flag for code Pxxx; 1 ->

controller has been updated since power-up.

- TYPE\_A\_MIS = Indicates to executive which misfire criteria.

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-MISFIRE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- CODES\_COUNT = See above.

- MIS\_FF\_CODE = Integer representation of the first misfire malfunction

code number after an unknown misfire.

- UNK\_MIS\_CODE = Integer representation of the unknown cylinder misfiring

fault code number.

Bit Flags:

- MIS\_MIL\_ON = MIL status flag for Misfire; 1 -> MIL required for Misfire

fault.

- PxxxACTIVE = See above.

- PXXXMIL\_ON = See above.

- PxxxSEEN = See above.

- PxxxSTATE = See above.

- PxxxTRIP\_CT = See above.

- PxxxTRIP\_FG = See above.

- PxxxUPDATED = See above.

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-MISFIRE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: OBDII\_MIS\_STATE\_CONTROL\_COM1

BEGIN mis\_malfunction(sys\_mil\_on, Pxxx)

;This logic implements malfunction transitions for the misfire state

;machine

DEMAND\_MODE = 1 -------------------| Do: store\_code(Pxxx)

|

PxxxSTATE = 0 ---------------| | --- ELSE ---

| |

TYPE\_A\_MIS = 1 --------------|AND -| PxxxSTATE := 2

| | PxxxMIL\_ON := 1

PxxxFAULT = 0 ---------------| | Do: get\_similar\_conds(Pxxx)

| PxxxACTIVE := 1

| ;sequence of the above two actions

| ;is critical.

| Do: store\_code(Pxxx)

| sys\_mil\_on := 1

| CODES\_COUNT :=

| min((CODES\_COUNT+1), 255)

|

| --- ELSE ---

PxxxSTATE = 0 ---------------| |

|AND -| PxxxSTATE := 2

TYPE\_A\_MIS = 1 --------------| | PxxxMIL\_ON := 1

| Do: get\_similar\_conds(Pxxx)

| PxxxACTIVE := 1

| ;sequence of the above two actions

| ;is critical.

| Do: store\_code(Pxxx)

| sys\_mil\_on := 1

|

| --- ELSE ---

PxxxSTATE = 0 ---------------| |

| |

TYPE\_A\_MIS = 0 --------------|AND -| PxxxSTATE := 1

| | PxxxUPDATED := 1

PxxxFAULT = 0 ---------------| | Do: get\_similar\_conds(Pxxx)

| CODES\_COUNT :=

| min((CODES\_COUNT+1), 255)

|

| --- ELSE ---

PxxxSTATE = 0 ---------------| |

|AND -| PxxxSTATE := 1

TYPE\_A\_MIS = 0 --------------| | PxxxUPDATED := 1

| Do: get\_similar\_conds(Pxxx)

|

(continued on next page)

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-MISFIRE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

| --- ELSE ---

PxxxSTATE = 1 ---------------| |

|AND -| PxxxSTATE := 2

TYPE\_A\_MIS = 1 --------| | | PxxxMIL\_ON := 1

|OR --| | Do: store\_code(Pxxx)

PxxxUPDATED = 0 -------| | sys\_mil\_on := 1

|

| --- ELSE ---

PxxxSTATE = 3 ---------------| |

| |

PxxxSTATE = 4 ---------------|OR --| PxxxSTATE := 2

|

PxxxSTATE = 5 ---------------|

END mis\_malfunction(sys\_mil\_on, Pxxx)

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-MISFIRE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: mis\_init\_mil(sys\_mil\_on)

;Private procedure performed upon request from the initialize\_mil

;procedure. sys\_mil\_on symbolically represents the flag for the

;mil controller for this system.

unconditionally -------------------| sys\_mil\_on := 0

For each Pxxx in the set of mis\_codes loop:

PxxxSTATE = 1 ---------------|

|

PxxxTRIP\_CT = 79 ------------|AND -| PxxxSTATE := 0

| | Do: clear\_similar\_conds(Pxxx)

PxxxFAULT = 0 ---------------| | CODES\_COUNT :=

| max((CODES\_COUNT-1), 0)

|

| --- ELSE ---

PxxxSTATE = 1 ---------------| |

|AND -| PxxxSTATE := 0

PxxxTRIP\_CT = 79 ------------| | Do: clear\_similar\_conds(Pxxx)

|

| --- ELSE ---

PxxxSTATE = 1 ---------------| |

|AND -| PxxxUPDATED := 0

PxxxACTIVE = 0 --------------| | PxxxACTIVE := 1

| PxxxTRIP\_FG := 0

| PxxxTRIP\_CT := 0

|

| --- ELSE ---

PxxxSTATE = 1 ---------------| |

|AND -| PxxxUPDATED := 0

PxxxTRIP\_FG = 1 -------------| | PxxxTRIP\_FG := 0

| PxxxTRIP\_CT := PxxxTRIP\_CT + 1

|

| --- ELSE ---

|

PxxxSTATE = 1 ---------------------| PxxxUPDATED := 0

| PxxxTRIP\_FG := 0

|

| --- ELSE ---

|

PxxxSTATE = 2 ---------------------| PxxxSTATE := 3

| PxxxSEEN := 0

|

| --- ELSE ---

(continued on next page)

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-MISFIRE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

PxxxSTATE = 3 ---------| |

|OR --| |

PxxxSTATE = 4 ---------| | |

|AND -| PxxxSTATE := PxxxSTATE + 1

PxxxSEEN = 1 ----------------| | PxxxSEEN := 0

| |

CL\_SEEN = 1 -----------------| |

| --- ELSE ---

|

PxxxSTATE = 4 ---------------------| PxxxSTATE := 3

|

| --- ELSE ---

PxxxSTATE = 5 ---------------| |

| |

PxxxSEEN = 1 ----------------|AND -| PxxxSTATE := 0

| | PxxxMIL\_ON := 0

CL\_SEEN = 1 -----------------| | Do: clear\_similar\_conds(Pxxx)

|

| --- ELSE ---

|

PxxxSTATE = 5 ---------------------| PxxxSTATE := 3

PxxxMIL\_ON = 1 --------------------| sys\_mil\_on := 1

End loop.

END: mis\_init\_mil

BEGIN: mis\_trip\_complete

; this logic updates the misfire state machines for each misfire Pxxx

For each Pxxx in the set of mis\_codes loop:

PxxxSTATE = 1 ---------------------| PxxxTRIP\_FG := 1

End loop.

END: mis\_trip\_complete

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-MISFIRE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: mis\_reset

;executed when an obdII reset message is received from the scan tool

For all codes in the set of mis\_codes loop:

unconditionally -----------------| PxxxUPDATED := 0

| PxxxSTATE := 0

| PxxxMIL\_ON := 0

| Do: clear\_similar\_conds(Pxxx)

End loop.

unconditionally -------------------| MIS\_MIL\_ON := 0

| UNK\_MIS\_CODE := 0

| MIS\_FF\_CODE := 0

END: mis\_reset

BEGIN: unknown\_misfire(Pxxx)

;This procedure is called when misfire is detected, but the specific

;misfiring cylinder cannot be identified.

unconditionally -------------------| Do: mis\_reset

| PxxxSTATE := 2

| PxxxMIL\_ON := 1

| MIS\_MIL\_ON := 1

| Do: get\_similar\_conds(Pxxx)

| PxxxACTIVE := 1

| Do: store\_code(Pxxx)

| UNK\_MIS\_CODE := xxx

For each Pyyy in the set of mis\_codes loop:

yyy <> xxx ------------------------| Do: erase\_mis\_code(Pyyy)

yyy = FF\_CODE ---------------|

|AND -| MIS\_FF\_CODE := 0

yyy <> xxx ------------------| | ;reset the misfire code

| ;first seen after code

| ;this process is executed.

| Do: swap\_ff\_code(xxx)

| ;overwrite freeze frame code

| ;number.

End loop.

END: unknown\_misfire(Pxxx)

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OBDII DIAGNOSTIC EXECUTIVE, STATE CONTROL-MISFIRE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: known\_misfire(Pxxx)

;This procedure is used to reset the state machines for the misfire system

;when misfire is occuring and the misfiring cylinder can be identified and

;previously, misire occured where the misfiring cylinder could not be

;identified.

unconditionally -------------------| PxxxUPDATED := 0

| PxxxSTATE := 0

| PxxxMIL\_ON := 0

| Do: clear\_similar\_conds(Pxxx)

| Do: erase\_mis\_code(Pxxx)

FF\_CODE = xxx ---------------------| Do: swap\_ff\_code(MIS\_FF\_CODE)

END: known\_misfire(Pxxx)

BEGIN: mis\_conds\_seen(Pxxx)

;This process is called from within the similar conditions module when

;misfire similar conditions have been observed.

PxxxSTATE = 1 ---------------|

|AND -| PxxxSTATE := 0

PxxxFAULT = 0 ---------------| | DO: clear\_similar\_conds(Pxxx)

| CODES\_COUNT :=

| max((CODES\_COUNT-1), 0)

|

| --- ELSE ---

|

PxxxSTATE = 1 ---------------------| PxxxSTATE := 0

| DO: clear\_similar\_conds(Pxxx)

END: mis\_conds\_seen(Pxxx)

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OBDII DIAGNOSTIC EXECUTIVE, CLOSED LOOP ENTRY MIL CONTORL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.1.9 CLOSED LOOP ENTRY MIL CONTROL (CDAK0)

OVERVIEW

+------------------------------+

| OBDII\_CL\_STATE\_CONTROLLER |

+------------------------------+

| . cl\_malfunction |

| . cl\_init\_mil |

| . cl\_trip\_complete |

| . cl\_reset |

+------------------------------+

This module define the state transitions to control the single fault code

that gets set whne the engine control system fails to enter closed loop

within a manufacturer specified minimum time.

Below is a description of how a finite state machine functions.

A finite state machine is a way to graphically illustrate the functioning of

a system or process that can be in a set of DISCRETE states. The diagram

shows how and when transitions can occur between the states.

+----------------------+

| |

| STATE X |<-------------------

| | condition

+-----+----------A-----+ ---------

| | action

| |

condition | | condition

--------- | | ---------

action | | action

| |

| |

+-----V----------+-----+

| |

| STATE Y |

| |

+----------------------+

CONVENTIONS:

· BOXES represent STATES of the system.

· ARROWS represent TRANSITIONS between states.

· CONDITIONS will CAUSE a transition to be taken.

· ACTIONS are done WHEN a transition is taken.

RULES:

· The system can be in only one state at a time.

· The system remains in a given state until an event

occurs to cause a transition.

· No other transitions than those shown can be taken.

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OBDII DIAGNOSTIC EXECUTIVE, CLOSED LOOP ENTRY MIL CONTORL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FAILURE TO ENTER CLOSED LOOP

MIL STATE CONTROL

NOTE: The calibration switch CL\_OBDI\_SW must be set (=1) in order to use

the MIL control strategy shown below. If the switch is clear (=0), the

normal TYPE1 (ego) MIL control strategy will be used.

+-------------+ power\_up OR

| State 0 | reset\_mil

| NO |<----- -------------

| MALFUNCTIONS| PxxxSTATE=0

+------+------+ PxxxMIL\_ON=0

| PxxxUPDATED=0

| CL\_MIL\_ON=0

|

| malfunction &

| DEMAND\_MODE=0 &

| PxxxUPDATED=0

| ----------------

| PxxxSTATE=1

| PxxxMIL\_ON=1

| CL\_MIL\_ON=1

| store\_code(Pxxx)

| CODES\_COUNT=CODES\_COUNT+1

|

+--------V--------+

| State 1 |

| FAILED TO ENTER |

| CLOSED LOOP |

+-----------------+

DEFINITIONS

INPUTS

Registers:

- CODES\_COUNT = Count of total number of fault codes and pending codes (MIL

and NO\_MIL) stored by the EEC.

Bit Flags:

- DEMAND\_MODE = Flag set when an on-demand self test mode is active.

- PxxxFAULT = Fault flag for code Pxxx. 1 => a fault has been stored for

code Pxxx.

- PxxxSTATE = MIL state flag for code Pxxx.

- PxxxUPDATED = MIL state controller update status flag for code Pxxx; 1 ->

controller has been updated since power-up.

Calibration Constants:

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OBDII DIAGNOSTIC EXECUTIVE, CLOSED LOOP ENTRY MIL CONTORL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- CL\_OBDI\_SW = Closed Loop Entry OBD-I MIL control select switch; 1 -> use

OBD-I MIL control for closed loop entry.

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OBDII DIAGNOSTIC EXECUTIVE, CLOSED LOOP ENTRY MIL CONTORL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- CODES\_COUNT = See above.

Bit Flags:

- CL\_MIL\_ON = MIL status flag for Closed Loop Entry; 1 -> MIL required for

Closed Loop Entry fault.

- PxxxMIL\_ON = MIL flag for code Pxxx; 1 -> the MIL is required to be on

for code Pxxx.

- PxxxSTATE = See above.

- PxxxUPDATED = See above.

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OBDII DIAGNOSTIC EXECUTIVE, CLOSED LOOP ENTRY MIL CONTORL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: OBDII\_CL\_STATE\_CONTROL\_COM1

BEGIN: cl\_malfunction(CL\_MIL\_ON, Pxxx)

;public process, executed when a malfunction(cl,Pxxx) call is made.

;This state machine will illuminate the MIL and store a code if the

;vehicle fails to enter closed loop within a manufacturers specified

;minimum time interval.

CL\_OBDI\_SW = 0 ----------------| Do: type1\_malfunction(CL\_MIL\_ON, Pxxx)

;use OBDII MIL control. |

|--- ELSE ---

DEMAND\_MODE = 0 ---------| |

| |

PxxxUPDATED = 0 ---------|AND -| PxxxSTATE := 1

| | PxxxMIL\_ON := 1

PxxxFAULT = 0 -----------| | PxxxUPDATED := 1

| Do: store\_code(Pxxx)

| CODES\_COUNT :=

| min((CODES\_COUNT+1), 255)

| CL\_MIL\_ON := 1

|

|--- ELSE ---

DEMAND\_MODE = 0 ---------| |

|AND -| PxxxSTATE := 1

PxxxUPDATED = 0 ---------| | PxxxMIL\_ON := 1

| PxxxUPDATED := 1

| Do: store\_code(Pxxx)

| CL\_MIL\_ON := 1

END: cl\_malfunction

BEGIN: cl\_reset

;public process, executed on-demand to reset the MIL state machine

;related to time to enter closed loop fuel control.

For each Pxxx in the set cl\_codes loop:

unconditionally ---------------| PxxxUPDATED := 0

| PxxxSTATE := 0

| PxxxMIL\_ON := 0

End loop.

unconditionally ---------------| CL\_MIL\_ON := 0

END: cl\_reset

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OBDII DIAGNOSTIC EXECUTIVE, CLOSED LOOP ENTRY MIL CONTORL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: cl\_init\_mil(CL\_MIL\_ON)

;public process used to initialize the closed loop entry fault codes.

CL\_OBDI\_SW = 1 ----------------| Do: cl\_reset

;OBD-I MIL control. | Exit this process.

For each Pxxx in the set cl\_codes loop:

PxxxSTATE = 2 -----------|

|AND -| PxxxSTATE := 0

PxxxFAULT = 0 -----------| | CODES\_COUNT :=

| max((CODES\_COUNT-1), 0)

|

| --- ELSE ---

|

PxxxSTATE = 2 -----------------| PxxxSTATE := 0

End loop.

END: cl\_init\_mil

BEGIN: cl\_trip\_complete(CL\_MIL\_ON)

;public process executed when commanded to after completion of a TRIP.

CL\_OBDI\_SW = 0 ----------------| Do: type1\_trip\_complete(cl, CL\_MIL\_ON)

;OBDII MIL control.

END: cl\_trip\_complete(CL\_MIL\_ON)

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OBDII STRATEGY, MIL OUTPUT CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.1.10 MIL OUTPUT CONTROL (CDAM0)

OVERVIEW

+--------------------------------+

| OBDII\_MIL\_OUTPUT\_COM1 |

+--------------------------------+

| PUBLIC PROCESSES: |

| . pid\_definitions |

| . mil\_output |

+--------------------------------+

The purpose of the Malfunction Indicator Light (MIL) is to alert the driver

that the computer has detected an OBDII malfunction with the EEC-IV system.

If the MIL were not present, the driver may not be aware that a problem

exists because The Failure Mode Effects Management (FMEM) strategy is capable

of maintaining good drive characteristics with a fault present. However, the

vehicle may not be operating at an optimum point with regard to emissions,

economy and performance. When the MIL is on, the driver of the vehicle

should seek service at his earliest convenience. It is not necessary to

immediately shut the vehicle down and have it towed in for service.

The malfunction indicator light (MIL) warning system has been revised to

comply with OBDII regulations for the 1994 and beyond model years.

The light, which is labeled "Check Engine" or "Service Engine Soon" is

located on the dashboard such that the driver can see it. Power is supplied

to the light whenever the ignition switch is in the run or crank position.

The ground circuit for the light is provided through the EEC module self test

output (STO). Whenever the EEC-IV strategy determines that the light should

be on, the STO output driver is turned on (STO voltage will be low).

The light will be turned on by the EEC module whenever an OBDII fault is

detected for any of the monitored systems.

If the light is on due to an OBDII malfunction, an OBDII fault code will

always be present. The light may also be on due to an intermittent short to

ground of the STO wire, or intermittent operation in HLOS.

The check engine light is turned on in the crank mode until a PIP signal is

detected as a bulb check. The bulb check can be disabled by setting MILLIM

to zero. If the light does not turn off while the engine is cranking, it

indicates that the EEC module is not receiving PIP signals.

The calibration parameter MIL\_SW can take values of 0, 1 or 2. If MIL\_SW is

set to zero, the MIL light is not activated by the MIL logic. Note that the

MIL light will still turn on whenever STO is grounded (HLOS, self test).

Production calibrations must have MIL\_SW set to 1 to meet OBDII regulations.

When MIL\_SW is set to 2, the MIL light will activate whenever any fault code

is present. Note that, when MIL\_SW is set to 1, the light may be off even

though there are OBDII fault codes present.

There is also a calibration parameter, OBDII\_MIL\_SW, which is used to

configure the OBDII systems with respect to control of the MIL light. The

parameter is a mapped byte of calibration switches, one per OBDII system in

the order from bit 0 to 8 {CAT\_MIL\_SW, CCM\_MIL\_SW, PURG\_MIL\_SW, SAIR\_MIL\_SW,

FUEL\_MIL\_SW, EGO\_MIL\_SW, EGR\_MIL\_SW, MIS\_MIL\_SW}. If an OBDII system

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OBDII STRATEGY, MIL OUTPUT CONTROL - CDAN2

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monitors corresponding bit is clear it will not control the mil.

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OBDII STRATEGY, MIL OUTPUT CONTROL - CDAN2

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DEFINITIONS

Registers:

- CODES\_COUNT = Count of total number of fault codes and pending codes (MIL

and NO\_MIL) stored by the EEC.

- READY\_FLAGS = Bitmapped register containing OBDII ready flags and MIL\_ON

flag.

- TYPE\_A\_MIS = Indicates to executive which misfire criteria.

Bit Flags:

- CAT\_MIL\_ON = MIL status flag for Catalyst system; 1 -> MIL required for

catalyst fault.

- CCM\_MIL\_ON = MIL status flag for Comprehensive Components; 1 -> MIL

required for CCM fault.

- COOL\_MIL\_ON = MIL status flag for fail safe cooling; 1 -> MIL required

for fail safe cooling fault.

- CL\_MIL\_ON = MIL status flag for Closed Loop Entry; 1 -> MIL required for

Closed Loop Entry fault).

- CRKFLG = Flag indicating status of CRANK MODE; 1 -> in CRANK MODE, 0 ->

not in CRANK MODE.

- EGO\_MIL\_ON = MIL status flag for EGO; 1 -> MIL required for HEGO fault.

- EGR\_MIL\_ON = MIL status flag for EGR; 1 -> MIL required for EGR fault.

- FIRST\_PIP = Flag set to 1 when the first PIP is detected. Reset to zero

on power-up or stall.

- FUEL\_MIL\_ON = MIL status flag for Fuel System; 1 -> MIL required for Fuel

System fault.

- MIL\_ON = OBDII MIL status flag (bit 7 of READY\_FLAGS); 1 -> MIL is on.

- MIS\_FCO\_FLG = Flag indicating FMEM action is being taken during type A

misfire.

- MISFIRING = Misfire status flag; 1 -> misfire currently occurring.

- MIS\_MIL\_ON = MIL status flag for Misfire; 1 -> MIL required for Misfire

fault.

- PURG\_MIL\_ON = MIL status flag Purge; 1 -> MIL required for Purge fault.

- PxxxFAULT = Fault flag for code Pxxx; 1 -> a fault has been stored for

code Pxxx.

- SAIR\_MIL\_ON = MIL status flag for Secondary Air; 1 -> MIL required for

Secondary Air fault.

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OBDII STRATEGY, MIL OUTPUT CONTROL - CDAN2

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Calibration Constants:

- CCM\_MIL\_SW = CCM MIL enable switch; 1 -> connect CCM test to the MIL.

- CL\_MIL\_SW = Closed Loop Entry MIL enable switch; 1 -> connect the Closed

loop entry test to the MIL.

- COOL\_MIL\_SW = fail safe cooling MIL enable switch; 1 -> connect fail safe

cooling test to the MIL.

- EGO\_MIL\_SW = EGO MIL enable switch; 1 -> connect the EGO test to the MIL.

- EGR\_MIL\_SW = EGR MIL enable switch; 1 -> connect the EGR test to the MIL.

- FUEL\_MIL\_SW = FUEL MIL enable switch; 1 -> connect the FUEL test to the

MIL.

- MILLIM = Software switch to enable/disable bulb check, unitless; 1 ->

enable, 0 -> disable.

- MIL\_SW = MIL enable switch, unitless;

0 -> Do not turn on MIL,

1 -> Do MIL logic to meet OBDII regulation, must be 1 for

production,

2 -> Turn MIL light on for any continuous fault, development

calibration only.

- MIS\_MIL\_SW = MIS MIL enable switch; 1 -> connect the MIS test to the MIL.

- PURG\_MIL\_SW = PURG MIL enable switch; 1 -> connect the PURG test to the

MIL.

- SAIR\_MIL\_SW = SAIR MIL enable switch; 1 -> connect the SAIR test to the

MIL.

OTHER

- P1000 = Additional mixed city and highway driving required to complete

OBD-II system check-out.

CALIBRATION INFORMATION

MIL\_SW must be set to 1 for production calibration.

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OBDII STRATEGY, MIL OUTPUT CONTROL - CDAN2

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PROCESS

STRATEGY MODULE: OBDII\_MIL\_OUTPUT\_COM1

BEGIN: pid\_definitions

;Define J1979 PIDs related to the fault codes.

MIL\_SW = 1 ------------------|

;production setting |AND -|

| |

MIL\_ON = 1 ------------------| |

;MIL required for OBDII |

|OR --| mil\_state := 1

MIL\_SW = 2 ------------------| | |

;on with fault present | | |

|AND -| |

CODES\_COUNT > 1 -------| | |

|OR --| |

CODES\_COUNT = 1 -| | |

|AND -| |

P1000FAULT = 0 --| |

| --- ELSE ---

|

| mil\_state := 0

pid\_def(j1979\_01\_011, b0-b6: (b0-b6 of NUM\_CODES),

b7: mil\_state)

END: pid\_definitions

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OBDII STRATEGY, MIL OUTPUT CONTROL - CDAN2

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BEGIN: mil\_output

;executed each background loop

;Update MIL\_ON flag:

CAT\_MIL\_ON = 1 --------|

;catalyst |AND -|

| |

CAT\_MIL\_SW = 1 --------| |

|

CCM\_MIL\_ON = 1 --------| |

;comprehensive comp. |AND -|

| |

CCM\_MIL\_SW = 1 --------| |

|

COOL\_MIL\_ON = 1 -------| |

;fail safe cooling |AND -|

| |

COOL\_MIL\_SW = 1 -------| |

|

PURG\_MIL\_ON = 1 -------| |

;purge |AND -|

| |

PURG\_MIL\_SW = 1 -------| |

|

SAIR\_MIL\_ON = 1 -------| |

;secondary air |AND -|

| |

SAIR\_MIL\_SW = 1 -------| |OR --| new\_mil\_on = 1

| | ;mil required for OBDII

EGO\_MIL\_ON = 1 --------| | |

;hego |AND -| |

| | |

EGO\_MIL\_SW = 1 --------| | |

| |

EGR\_MIL\_ON = 1 --------| | |

;egr |AND -| |

| | |

EGR\_MIL\_SW = 1 --------| | |

| |

MIS\_MIL\_ON = 1 --------| | |

;misfire |AND -| |

| | |

MIS\_MIL\_SW = 1 --------| | |

| |

FUEL\_MIL\_ON = 1 -------| | |

;fuel system |AND -| |

| | |

FUEL\_MIL\_SW = 1 -------| | |

| |

CL\_MIL\_ON = 1 ---------| | |

;cl system |AND -| |

| |

CL\_MIL\_SW = 1 ---------| |

| --- ELSE ---

|

| new\_mil\_on = 0

| ;mil not required for OBDII

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OBDII STRATEGY, MIL OUTPUT CONTROL - CDAN2

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MIL\_ON = 1 ------------|

|AND -| Do: mil\_off\_verification(new\_mil\_on)

new\_mil\_on = 0 --------| | ;this will overwrite new\_mil\_on if

| ;if the MIL should stay on.

| MIL\_ON := new\_mil\_on

|

| --- ELSE ---

MIL\_ON = 0 ------------| |

|AND -| Do: mil\_on\_verification(new\_mil\_on)

new\_mil\_on = 1 --------| | ;this will overwrite new\_mil\_on if

| ;if the MIL should stay off. .

| MIL\_ON := new\_mil\_on

|

| --- ELSE ---

|

| MIL\_ON := new\_mil\_on

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OBDII STRATEGY, MIL OUTPUT CONTROL - CDAN2

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;Update bulb\_check flag:

CRKFLG = 1 ------------------|

;crank mode |

|

FIRST\_PIP = 0 ---------------|AND -| bulb\_check := 1

;no PIPS yet | | ;do check

| |

MILLIM = 1 ------------------| |

;bulb check enabled |

| --- ELSE ---

|

| bulb\_check := 0

| ;don't do check

;Control the light:

MIS\_MIL\_SW = 1 --------------------|

|

MIS\_FCO\_FLG = 0 -------------| |

;not doing fuel cutout |OR --|

| |

TYPEA\_FL\_MIL = 1 ------------| |

|AND -| flash mil

MISFIRING = 1 ---------------------| | ;freq = 1 Hz +/-10%

;misfire occurring | | ;duty cycle = 50% +/-10%

| |

TYPE\_A\_MIS = 1 --------------------| |

| --- ELSE ---

bulb\_check = 1 --------------------| |

;bulb check requested | |

| |

MIL\_SW = 1 ------------------| | |

;production setting |AND -| |

| |OR --| turn on mil

MIL\_ON = 1 ------------------| | |

;MIL required for OBDII | |

| |

MIL\_SW = 2 ------------------| | |

;on with fault present | | |

|AND -| |

CODES\_COUNT > 1 -------| | |

|OR --| |

CODES\_COUNT = 1 -| | |

|AND -| |

P1000FAULT = 0 --| |

| --- ELSE ---

|

| turn mil off

END: mil\_output

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OBDII STRATEGY, KAM VERIFICATION - CDAN2

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23.1.11 KAM VERIFICATION (CDAM0)

OVERVIEW

+--------------------------------+

| OBDII\_KAM\_VERIFICATION\_COM1 |

+--------------------------------+

| PUBLIC PROCESSES: |

| . mil\_on\_verification |

| . mil\_off\_verification |

| . power\_up\_verification |

+--------------------------------+

This module is used to verify the fault code data in the OBD-II system. It

has been discovered that KAM can be corrupted due to flaws in the hardware

design of the RAM/CART/EBC chip. If a write is in progress and the module is

powered down, the contents of the memory location being written to will

likely be corrupted.

Given this fact, the following comprehensive verification of the data that

illuminates the Malfunction Indicator Lamp (MIL) has been designed. These

routine will be invoked when a change in the state of the MIL is required.

The underlying fault code data will be examined for rationality. If a fault

is discovered, the corrupted location will be reset and the code P1000 will

be stored, requiring a full check of the OBD-II diagnostic system prior to

passing the Inspection Maintenance test.

A test is also performed once per power-up to verify all fault code data and

reset the corrupted locations, store the P1000 and reset the code couting

variables, NUM\_CODES and CODES\_COUNT.

DEFINITIONS

Bit Flags:

- CODES\_COUNT = Count of total number of fault codes and pending codes (MIL

and NO\_MIL) stored by the EEC.

- NUM\_CODES = Number of OBD\_II fault codes currently stored in memory.

- PxxxCNT = Warm-up counter for code Pxxx.

- PxxxFAULT = Fault flag for code Pxxx. 1 => a fault has been stored for

code Pxxx.

- PxxxFAULT\_A = Fault flag for code Pxxx. 1 => a fault has been stored for

code Pxxx.

- PxxxMIL\_ON = MIL flag for code Pxxx; 1 -> the MIL is required to be on

for code Pxxx.

- PxxxSTATE = MIL state flag for code Pxxx.

- PxxxUPDATED = MIL state controller update status flag for code Pxx; 1 ->

controller has been updated since power-up.

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OBDII STRATEGY, KAM VERIFICATION - CDAN2

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Calibration Constants:

- CL\_OBDI\_SW = Closed loop Entry OBDI MIL control select switch; 1 -> use

OBDI MIL control for closed loop entry.

PROCESS

STRATEGY MODULE: OBDII\_KAM\_VERIFICATION\_COM1

BEGIN: mil\_on\_verification(new\_mil\_on)

;The following process is executed when the strategy is about to command

;the MIL to turn on. The KAM fault code data will be examined to ensure

;a valid reason exists to turn on the MIL.

unconditionally ----------------| valid\_mil := false

For sys := (purg,sair,ego,egr,ccm,cat,cl,mis,fuel,cool) perform the

following:

unconditionally ----------------| Do: mil\_integrity\_check(sys)

| ;this will set valid\_mil := true if

| ;data to support the decision to

| ;illuminate the MIL is found.

End For loop.

valid\_mil = false --------------| Do: power\_up\_verification

| ;this will reset the corrupted locations.

unconditionally ----------------| new\_mil\_on := valid\_mil

END: mil\_on\_verification

BEGIN: mil\_off\_verification(new\_mil\_on)

;The following process is executed when the strategy is about to command

;the MIL to turn off. The KAM fault code data will be examined to ensure

;a valid reason exists to turn off the MIL.

unconditionally ----------------| valid\_mil := false

For sys := (purg,sair,ego,egr,ccm,cat,cl,mis,fuel,cool) perform the

following:

unconditionally ----------------| Do: mil\_integrity\_check(sys)

| ;this will set valid\_mil := true if

| ;data to support the decision to

| ;illuminate the MIL is found.

End For loop.

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OBDII STRATEGY, KAM VERIFICATION - CDAN2

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valid\_mil = true ---------------| Do: power\_up\_verification

| ;this will reset the corrupted locations.

unconditionally ----------------| new\_mil\_on := valid\_mil

END: mil\_off\_verification

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OBDII STRATEGY, KAM VERIFICATION - CDAN2

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BEGIN: mil\_integrity\_check(sys)

;This process will examine the PxxxMIL\_ON and PxxxFAULT flags and

;the PxxxSTATE register in the set of sys\_codes. At least one

;PxxxMIL\_ON should be set and the corresponding PxxxFAULT and PxxxFAULT\_A

;should also be set and the PxxxSTATE should be in a state that says the

;MIL is about to be turned on or has been on for some time.

For each Pxxx in the set of sys\_codes perform the following:

sys\_MIL\_SW = 1 --------------------------|

|

Pxxx is in set of mil\_codes -------------|

|

PxxxMIL\_ON = 1 --------------------------|

|

PxxxFAULT = 1 ---------------------------|

|

PxxxFAULT\_A = 1 -------------------------|

|

PxxxCNT < 40 ----------------------------|

|

PxxxSTATE = 3 ---------| |

| |

PxxxSTATE = 4 ---------|OR --| |AND -| valid\_mil := true

| | |

PxxxSTATE = 5 ---------| |AND -| |

| | |

sys <> cl -------------| | | |

|OR --| | |

sys = cl --------| | | |

|AND -| | |

CL\_OBDI\_SW = 0 --| | |

| |

PxxxSTATE = 2 ---------------| |OR --|

|AND -|

sys = fuel ------------| | |

|OR --| |

sys= mis --------------| |

|

PxxxSTATE = 1 ---------------| |

| |

sys = cl --------------------|AND -|

|

CL\_OBDI\_SW = 1 --------------|

END: mil\_integrity\_check(sys)

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OBDII STRATEGY, KAM VERIFICATION - CDAN2

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BEGIN: power\_up\_verification

;The following process is executed when the strategy calls it and during

;power-up initialization. Thee KAM fault code data will be examined to

;ensure consistent data. If corrupted data is found, it will be reset to

;a erased code state and a non-mil code will be set indicating KAM

;corruption has occured.

For each Pxxx in the set of non\_mil\_codes perform the following:

PxxxFAULT = 1 -------|

|AND -|

PxxxCNT = 40 --------| |

|OR --| Do: erase\_code(Pxxx)

PxxxCNT > 40 --------------| | Do: reset\_trips

|

PxxxFAULT <> PxxxFAULT\_A --|

For each Pxxx in the set of mil\_codes perform the following:

PxxxSTATE > 5 --------------------------------|

|

PxxxCNT > 40 ---------------------------------|

|

PxxxFAULT <> PxxxFAULT\_A ---------------------|

|

PxxxFAULT = 0 --------------------------| |

|AND -|

PxxxMIL\_ON = 1 -------------------------| |

|

PxxxMIL\_ON = 1 -------------------------| |

| |

PxxxSTATE = 0 --------------------------| |

|AND -|

Pxxx is in set of cl\_codes -------------| |

| |

CL\_ODBI\_SW = 1 -------------------------| |

|

PxxxMIL\_ON = 1 -------------------------| |

| |

PxxxSTATE <= 2 -------------------------| |

|AND -|

Pxxx is in set of type1\_codes ----| | |OR --| PxxxMIL\_ON := 0

|OR --| | | PxxxSTATE := 0

Pxxx is in set of cl\_codes -| | | | PxxxMALF := 0

|AND -| | | PxxxUPDATED := 0

CL\_OBDI\_SW = 0 -------------| | | Do: erase\_code(Pxxx)

| | Do: reset\_trips

PxxxMIL\_ON = 1 -------------------------| |

| |

PxxxSTATE <= 1 -------------------------| |

|AND -|

Pxxx is in set | |

of mis\_codes ---------------------| | |

|OR --| |

Pxxx is in set | |

of fuel\_codes --------------------| |

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OBDII STRATEGY, KAM VERIFICATION - CDAN2

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(continued from previous page)

|

PxxxFAULT = 1 --------------------| |

|OR --| |

PxxxMIL\_ON = 1 -------------------| |AND -|

| |

PxxxCNT = 40 ---------------------------| |

|

PxxxCNT > 1 ---------------------| |

|OR --| |

PxxxMIL\_ON = 0 -------------------| | |

| |

PxxxSTATE > 2 --------------| | |

| | |

Pxxx is NOT in set |AND -| | |

of cl\_codes ----------| | | | |

| | | |AND -|

Pxxx is in |OR --| | |

set of cl\_codes | | | |

|AND -| | |

CL\_OBDI\_SW = 0 -| | |

| |

PxxxSTATE = 2 --------------| | |

| | |

Pxxx is in set |AND -|OR --|

of fuel\_codes --------| | |

|OR --| |

Pxxx is in set | |

of mis\_codes ---------| |

|

PxxxSTATE = 1 --------------| |

| |

Pxxx is in set of |AND -|

cl\_codes -------------------|

|

CL\_OBDI\_SW = 1 -------------|

End For loop.

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OBDII STRATEGY, KAM VERIFICATION - CDAN2

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;Next, verify the sys\_MIL\_ON flags assuming all fault code data is correct.

For sys := (purg,sair,ego,egr,ccm,cat,cl,mis,fuel,cool) perform the

following:

unconditionally ----------| valid\_mil := false

For each Pxxx in the set of sys\_codes perform the following:

Pxxx is in the set

of mil\_codes --------|

|AND -| valid\_mil := true

PxxxMIL\_ON = 1 ------|

END For loop.

valid\_mil <> sys\_MIL\_ON --| sys\_MIL\_ON := valid\_mil

| Do: reset\_trips

END For loop.

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OBDII STRATEGY, KAM VERIFICATION - CDAN2

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;Finally, verify NUM\_CODES and CODES\_COUNT assuming all the fault code

;data is correct.

unconditionally ----------| new\_num\_codes := 0

| new\_codes\_count := 0

For each Pxxx in the set of mil\_codes perform the following:

PxxxFAULT = 1 ------------| new\_num\_codes := min((new\_num\_codes+1),255)

| new\_codes\_count := min((new\_codes\_count+1),255)

|

| --- ELSE ---

|

PxxxSTATE > 0 ------------| new\_codes\_count := min((new\_codes\_count+1),255)

END For loop.

For each Pxxx in the set of non\_mil\_codes perform the following:

PxxxFAULT = 1 ------------| new\_codes\_count := min((new\_codes\_count+1,255)

END For loop.

unconditionally ------------------| reset\_trips\_temp := false

new\_codes\_count <> CODES\_COUNT ---| CODES\_COUNT := new\_codes\_count

| reset\_trips\_temp := true

new\_num\_codes <> NUM\_CODES -------| NUM\_CODES := new\_num\_codes

| reset\_trips\_temp := true

reset\_trips\_temp = true ----------| Do: reset\_trips

END: power\_up\_verification

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OBDII STRATEGY, FREEZE FRAME - CDAN2

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23.1.12 FREEZE FRAME (CDAM0)

OVERVIEW

This module is used to store and clear the freeze frame conditions (N, LOAD,

ECT, VSBAR, OLFLG, LAMBSE1, LAMBSE2, KAMRF1, KAMRF2) as required by OBD-II

regulations.

There are two seperate entry points contained in the module. One is used to

store the freeze frame conditions, the other is used to clear the freeze

frame conditions.

There is ONE data structure in memory that holds the freeze frame conditions.

The first time a malfunction occurs for any MIL code, the freeze frame

conditions are stored. If the malfunction was not a FUEL or MISFIRE

malfunction, the freeze frame conditions can be overwritten by a subsequent

FUEL or MISFIRE malfunction. FUEL and MISFIRE malfunctions can not overwrite

one another.

The freeze frame conditions are cleared on OBD-II reset or when the fault for

which they are stored is erased.

The freeze frame data structure is a record as shown below:

freeze\_frame RECORD

FF\_CODE = [KAM] Code number of

fault for which freeze frame

conditions are stored.

FF\_N = [KAM] Engine speed when

fault occured.

FF\_LOAD = [KAM] Load when fault

occured.

FF\_ECT = [KAM] Engine coolant

temperature when fault occured.

FF\_VSBAR = [KAM] Filtered vehicle

speed when fault occured.

FF\_OL\_HOLD = [KAM] - Not yet met conditions to go

closed loop open loop flag when

fault occured.

FF\_OL\_FDBACK = [KAM] Closed loop feedback fuel

control flag when fault occured.

FF\_OL\_DM = [KAM] Open loop due to driving

conditions flag when fault occured.

FF\_OL\_FMEM = [KAM] Open loop due to detected

system fault flag when fault occured.

FF\_OL\_FAULT = [KAM] Closed loop but fault with at

least one oxygen sensor flag when

fault occured.

FF\_LAMBSE1 = [KAM] LAMBSE1 - short

term fuel trim when fault occured.

FF\_LAMBSE2 = [KAM] LAMBSE2 - short

term fuel trim when fault occured.

FF\_KAMREF1 = [KAM] KAMRF1 - adaptive

correction when fault occured.

FF\_KAMREF2 = [KAM] KAMRF2 - adaptive

correction when fault occured.

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OBDII STRATEGY, FREEZE FRAME - CDAN2

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END.

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OBDII STRATEGY, FREEZE FRAME - CDAN2

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DEFINITIONS

INPUTS

Registers:

- ECT = Engine coolant temperature, degrees F.

- ECT\_ENG = Engine coolant temperature without any FMEM modifications.

- KAMRF1 = Adaptive fuel correction for bank 1.

- KAMRF2 = Adaptive fuel correction for bank 2.

- LAMBSE1 = Lambda equivalence ratio for bank 1.

- LAMBSE2 = Lambda equivalence ratio for bank 2.

- LOAD = Universal load as ratio of air charge over standard.

- N = Engine RPM.

- OL\_DRIVE = Open loop due to driving conditions (not FMEM or HOLD

related).

- LOAD\_SAE = Engine load as required by SAE standard J1979.

- VSBAR = Filtered vehicle speed.

Bit Flags:

- HEGO\_FAULT = Closed loop but fault with at least one oxygen sensor flag

when fault occured.

- HEGO\_FDBACK = Closed loop feedback fuel control flag when fault occured.

- OLFLG = Open loop flag.

- OL\_FMEM = Open loop due to detected system fault flag, 1 -> open loop due

to FMEM.

- OL\_HOLD = Percent conditions not satisfied to go close loop flag, 1 ->

hold in open loop.

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OBDII STRATEGY, FREEZE FRAME - CDAN2

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OUTPUTS

Registers:

- FF\_CODE = Code number of fault for which freeze frame conditions are

stored.

- FF\_N = Value of Engine speed at the time the freeze frame was stored.

- FF\_LOAD = Value of Load at the time the freeze frame was stored.

- FF\_ECT = Value of Engine coolant temperature at the time the freeze frame

was stored.

- FF\_VSBAR = Value of Filtered vehicle speed at the time the freeze frame

was stored.

- FF\_LAMBSE1 = Value of LAMBSE1 (short term fuel trim) at the time the

freeze frame was stored.

- FF\_LAMBSE2 = Value of LAMBSE2 (short term fuel trim) at the time the

freeze frame was stored.

- FF\_KAMREF1 = Value of KAMRF1 (adaptive correction) at the time the freeze

frame was stored.

- FF\_KAMREF2 = Value of KAMRF2 (adaptive correction) at the time the freeze

frame was stored.

Bit Flags:

- FF\_FUEL\_MIS = Freeze frame FUEL or MISFIRE data stored flag. 1 -> freeze

frame was stored due to Fuel or Misfire malfunction.

- FF\_OL\_FAULT = Closed loop but fault with at least one oxygen sensor flag

when fault occured.

- FF\_OL\_FDBACK = Closed loop feedback fuel control flag when fault occured.

- FF\_OL\_FMEM = Open loop due to detected system fault flag when fault

occured.

- FF\_OL\_HOLD = Not yet met conditions to go closed loop open loop flag when

fault occured.

- FF\_OL\_DM = Open loop due to driving conditions flag when fault occured.

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OBDII STRATEGY, FREEZE FRAME - CDAN2

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PROCESS

STRATEGY MODULE: OBDII\_FREEZE\_FRAME\_COM1

BEGIN: pid\_definitions

;This process is used to define the PIDs related to the FREEZE

;FRAME as required by SAE standard J1979.

pid\_def(j1979\_02\_00, PIDMAP\_1,PIDMAP\_2)

pid\_def(j1979\_02\_02, FF\_CODE)

pid\_def(j1979\_02\_031, b0:FF\_OL\_HOLD,

b1:FF\_OL\_FDBACK,

b2:FF\_OL\_DM,

b3:FF\_OL\_FMEM,

b4:FF\_OL\_FAULT

b5:0,

b6:0,

b7:0)

pid\_def(j1979\_02\_04, (FF\_LOAD \* 255))

pid\_def(j1979\_02\_05, (((FF\_ECT - 32) \* 5/9) + 40))

pid\_def(j1979\_02\_06, (128 / FF\_LAMBSE1))

pid\_def(j1979\_02\_07, (128 \* FF\_KAMREF1))

pid\_def(j1979\_02\_08, (128 / FF\_LAMBSE2))

pid\_def(j1979\_02\_09, (128 \* FF\_KAMREF2))

pid\_def(j1979\_02\_0C, FF\_N)

pid\_def(j1979\_02\_0D, (FF\_VSBAR \* 1.609))

END: pid\_definitions

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OBDII STRATEGY, FREEZE FRAME - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: store\_ff(Pxxx)

;This procedure called by the MIL controller to store the

;freeze frame conditions. Pxxx is the code which causes the

;freeze frame storage.

unconditionally ------------------| FF\_CODE := xxx

| ;BCD representation of code

| ;number.

| FF\_N := N

| FF\_LOAD := LOAD\_SAE

| FF\_ECT := ECT\_ENG

| FF\_VSBAR := VSBAR

| FF\_OL\_HOLD := OL\_HOLD

| FF\_OL\_FDBACK := HEGO\_FDBACK

| FF\_OL\_DM := OL\_DRIVE

| FF\_OL\_FMEM := OL\_FMEM

| FF\_OL\_FAULT := HEGO\_FAULT

| FF\_LAMBSE1 := LAMBSE1

| FF\_LAMBSE2 := LAMBSE2

| FF\_KAMREF1 := KAMRF1

| FF\_KAMREF2 := KAMRF2

END: store\_ff(Pxxx)

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OBDII STRATEGY, FREEZE FRAME - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: clear\_ff

;this procedure called by the MIL controller to clear the

;freeze frame conditions.

unconditionally ------------------| FF\_CODE := 0

| ;BCD nil code.

| FF\_N := 0

| FF\_LOAD := 0

| FF\_ECT := 0

| FF\_VSBAR := 0

| FF\_OL\_HOLD := 0

| FF\_OL\_FDBACK := 0

| FF\_OL\_DM := 0

| FF\_OL\_FMEM := 0

| FF\_OL\_FAULT := 0

| FF\_LAMBSE1 := 1.0

| FF\_LAMBSE2 := 1.0

| FF\_KAMREF1 := 1.0

| FF\_KAMREF2 := 1.0

| FF\_FUEL\_MIS := 0

END: clear\_ff

BEGIN: swap\_ff\_code(code\_number)

;This process is called from the misfire state controller to change the

;code number of the freeze frame when unabled to detect which cylinder

;is misfiring because of loss of sync.

unconditionally ------------------| FF\_CODE := code\_number

END: swap\_ff\_code(code\_number)

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OBD-II DIAGNOSTIC EXECUTIVE, SIMILAR CONDITIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.1.13 SIMILAR CONDITIONS (CDAK0)

OVERVIEW

+--------------------------------+

| OBDII\_SIMILAR\_CONDS\_COM1 |

+--------------------------------+

| PUBLIC PROCESSES: |

| . get\_similar\_conds(Pxxx) |

| . clear\_similar\_conds(Pxxx) |

| . check\_fuel\_conds(Pxxx) |

| . check\_mis\_conds |

+--------------------------------+

This module is used within the OBD-II diagnostic executive to manipulate the

similar conditions data structure. Similar conditions records are maintained

for each fault code associated with the FUEL and MISFIRE monitors.

The similar conditions and related data are stored in a record data

structure. There is one record for each Pxxx in the sets mis\_codes and

fuel\_codes.

The record holds the following information:

similar\_cond RECORD

PxxxACTIVE = [KAM] Flag. 1 -> conditions active.

PxxxSEEN = [KAM] Flag. 1 -> conditions seen.

PxxxTRIP\_FG = [KAM] Flag. 1 -> trip completed.

PxxxTRIP\_CT = [KAM] Trips completed (0 - 80).

PxxxN = [KAM] Stored engine RPM.

PxxxLOAD = [KAM] Stored PCT\_LOAD.

PxxxSTATUS = [KAM] Flag. 1 -> warm engine.

END.

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OBD-II DIAGNOSTIC EXECUTIVE, SIMILAR CONDITIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- ECT = Engine Coolant Temperature, degrees F.

- N = Engine speed, RPM.

- PCT\_LOAD = Percent inferred load (altitude independent).

Bit Flags:

- PxxxLOAD = Similar conditions engine load.

- PxxxMALF = Malfunction flag for code Pxxx; 1 -> a malfunction currently

exists for fault Pxxx.

- PxxxN = Similar conditions engine speed.

- PxxxSTATUS = Similar conditions warm-up status flag; 1 -> warm-up

completed.

Calibration Constants:

- ECT\_WARM = Temperature above which the engine is considered warm for the

purposes of OBDII similar conditions.

OUTPUTS

Bit Flags:

- PxxxACTIVE = Similar conditions active flag; 1 -> conditons active.

- PxxxLOAD = See above.

- PxxxN = See above.

- PxxxSEEN = Similar conditions seen flag; 1 -> conditions seen.

- PxxxSTATUS = See above.

- PxxxTRIP\_CT = Similar conditions trip counter (0 - 80).

- PxxxTRIP\_FG = Similar conditions trip flag; 1 -> trip occured.

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OBD-II DIAGNOSTIC EXECUTIVE, SIMILAR CONDITIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: OBDII\_SIMILAR\_CONDS\_COM1

BEGIN: get\_similar\_conds(Pxxx)

;This procedure is used to save the similar conditions information for a

;particular code . It is called by the MIL controller.

unconditionally ---------------| PxxxACTIVE := 0

| PxxxSEEN := 0

| PxxxTRIP\_FG := 0

| PxxxTRIP\_CT := 0

| PxxxN := N

| PxxxLOAD := PCT\_LOAD

ECT > ECT\_WARM ----------------| PxxxSTATUS := 1

| ;warm engine.

|

| --- ELSE ---

|

| PxxxSTATUS := 0

| ;cold engine.

END: get\_similar\_conds(Pxxx)

BEGIN: clear\_similar\_conds(Pxxx)

;This procedure is used to clear the similar conditions information for a

;particular code. It is called by the MIL controller.

unconditionally ---------------| PxxxACTIVE := 0

| PxxxSEEN := 0

| PxxxTRIP\_FG := 0

| PxxxTRIP\_CT := 0

| PxxxN := 0

| PxxxLOAD := 0

| PxxxSTATUS := 0

END: clear\_similar\_conds(Pxxx)

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OBD-II DIAGNOSTIC EXECUTIVE, SIMILAR CONDITIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: check\_fuel\_conds(Pxxx)

;This process is called from within the fuel monitor to determine if the

;similar conditons have been seen yet this driving cycle.

ECT > ECT\_WARM -------------------------| status := 1

|

| --- ELSE ---

|

| status := 0

abs(N - PxxxN) <= 375 ------------|

|

abs(PCT\_LOAD - PxxxLOAD) <= 0.10 -|AND -| PxxxSEEN := 1

| | Do: fuel\_conds\_seen(Pxxx)

PxxxSTATUS = status --------------|

END: check\_fuel\_conds

BEGIN: check\_mis\_conds

;This process is called from within the misfire monitor when not

;misfiring to determine if similar conditions have been met.

ECT > ECT\_WARM -------------------------| status := 1

|

| --- ELSE ---

|

| status := 0

For each Pxxx in the set mis\_codes Do:

abs(N - PxxxN) <= 375 ------------|

|

abs(PCT\_LOAD - PxxxLOAD) <= 0.10 -|AND -| PxxxSEEN := 1

| | Do: mis\_conds\_seen(Pxxx)

PxxxSTATUS = status --------------|

END loop.

END: check\_mis\_conds

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OBDII DIAGNOSTIC EXECUTIVE, DRIVING CYCLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.1.14 DRIVING CYCLE (CDAF0)

OVERVIEW

+--------------------------------+

| OBDII\_DRIVE\_CYCLE\_COM1 |

+--------------------------------+

| PUBLIC PROCESSES: |

| . bg\_check\_for\_closed\_loop |

| . cl\_seen\_init |

| . reset\_drive\_cycle |

+--------------------------------+

This module is used to determine if an OBD-II driving cycle has been

performed. This is defined by CARB as:

Engine startup, vehicle operation beyond the beginning of closed loop

operation, and engine shut off.

This module will maintain a flag in KAM called CL\_SEEN. When closed loop

fuel control is entered this flag will get set. A utility will be provided

to clear the CL\_SEEN after the information stored in it has been used during

RAM initilization.

Additionally a utility is provided to take KAM reset actions on the CL\_SEEN

flag.

DEFINITIONS

INPUTS

Registers:

- ATMR3 = Time in RUN mode, sec.

- DRIVE\_COUNT = Count of number of OBD-II drive cycles completed.

Bit Flags:

- CL\_SEEN = Flag indicating if closed-loop fuel operation has been seen

this driving cycle.

- OLFLG = Open loop flag.

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OBDII DIAGNOSTIC EXECUTIVE, DRIVING CYCLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- DRIVE\_COUNT = See above.

Bit Flags:

- CL\_SEEN = See above.

PROCESS

STRATEGY MODULE: OBDII\_DRIVE\_CYCLE\_COM1

BEGIN: bg\_check\_for\_closed\_loop

;public process, executed once per background loop to determine if

;closed loop fuel control has been entered.

CL\_SEEN = 0 ---------------------|

|

OLFLG = 0 -----------------------|AND -| CL\_SEEN := 1

| | DRIVE\_COUNT := DRIVE\_COUNT + 1

ATMR3 > 4 -----------------------|

END: bg\_check\_for\_closed\_loop

BEGIN: cl\_seen\_init

;public process executed to initialize the CL\_SEEN flag.

unconditionally -----------------------| CL\_SEEN := 0

END: cl\_seen\_init

BEGIN: reset\_drive\_cycle

;public process used to reset the CL\_SEEN flag and the DRIVE\_COUNT counter.

unconditionally -----------------------| CL\_SEEN := 0

| DRIVE\_COUNT := 0

END: reset\_drive\_cycle

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OBDII STRATEGY, J1979 PIDS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.1.15 J1979 PIDS (CDAM0)

OVERVIEW

+--------------------------------+

| OBDII\_J1979\_PIDS\_COM1 |

+--------------------------------+

| PUBLIC PROCESSES: |

| . pid\_definitions |

+--------------------------------+

This module is used to define parameter identification codes numbers as

required by SAE standard J1979. These PIDs are to be accessed by the generic

scan tool as set forth in the CARB regulations. These PIDs are grouped here

in this module as there is no other spot in the strategy where it would make

sense to do so.

DEFINITIONS

INPUTS

Bit Flags:

- CAT\_READY = Catalyst OBDII ready flag (bit 0 of READY\_FLAGS); 1 ->

catalyst NOT monitored since kam reset.

- EGO\_READY = EGO OBDII ready flag (bit 5 of READY\_FLAGS); 1 -> HEGOs NOT

monitored since kam reset.

- EGR\_READY = EGR OBDII ready flag (bit 6 of READY\_FLAGS); 1 -> EGR NOT

monitored since kam reset.

- PURG\_READY = Purge OBDII ready flag (bit 2 of READY\_FLAGS); 1 -> Purge

NOT monitored since kam reset.

- SAIR\_READY = Secondary Air OBDII ready flag (bit 3 of READY\_FLAGS); 1 ->

Secondary Air NOT monitored since kam reset.

Calibration Constants:

- CAT\_TST\_SW = CAT test present claibration switch; 1 -> CAT test present.

- CCM\_TST\_SW = CCM test present claibration switch; 1 -> CCM test present.

- EGO\_TST\_SW = EGO test present claibration switch; 1 -> EGO test present.

- EGR\_TST\_SW = EGR test present claibration switch; 1 -> EGR test present.

- FUEL\_TST\_SW = Fuel test present claibration switch; 1 -> fuel test

present.

- J1979\_01\_1C = OBD requirements to which vehicle is designed, where:

01 - OBD II (California ARB)

02 - OBD (Federal EPA)

03 - OBD and OBD II

04 - OBD I

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OBDII STRATEGY, J1979 PIDS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

05 - Not intended to meet any OBD requirements

- MIS\_TST\_SW = MIS test present claibration switch; 1 -> MIS test present.

- PURG\_TST\_SW = PURG test present claibration switch; 1 -> PURG test

present.

- SAIR\_TST\_SW = SAIR test present claibration switch; 1 -> SAIR test

present.

PROCESS

STRATEGY MODULE: OBDII\_J1979\_PIDS\_COM1

BEGIN: pid\_definitions

;Define J1979 PIDs related to the OBD-II executive, not specifically

;associated with any portion of the Diagnostic Executive.

pid\_def(j1979\_01\_00, PIDMAP\_3,PIDMAP\_4)

pid\_def(j1979\_01\_012, b0: MIS\_TST\_SW,

b1: FUEL\_TST\_SW,

b2: CCM\_TST\_SW,

b3: 0,

b4: 0,

B5: 0,

b6: 0,

b7: 0)

pid\_def(j1979\_01\_013, b0: CAT\_TST\_SW,

b1: 0,

b2: PURG\_TST\_SW,

b3: SAIR\_TST\_SW,

b4: 0,

b5: EGO\_TST\_SW,

b6: EGO\_TST\_SW,

b7: EGR\_TST\_SW)

pid\_def(j1979\_01\_014, b0: CAT\_READY,

b1: 0,

b2: PURG\_READY,

b3: SAIR\_READY,

b4: 0,

b5: EGO\_READY,

b6: EGO\_READY,

b7: EGR\_READY)

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OBDII STRATEGY, J1979 PIDS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continue with pid\_definitions)

pid\_def(j1979\_01\_1C, J1979\_01\_1C)

;SAE RECOMMENDED PRACTICE J1979 E/E DIAGNOSTIC TEST MODES" revised 2/7/94

;has added the requirement for a new J1979 PID 1C to MODE 01 (defined on

;page 14):

; j1979\_01\_1C OBD requirements to which vehicle is designed, where:

; 01 - OBD II (California ARB)

; 02 - OBD (Federal EPA)

; 03 - OBD and OBD II

; 04 - OBD I

; 05 - Not intended to meet any OBD requirements

; Although only vehicles meeting California ARB OBD II and Federal OBD

; regulations are required to support this document, manufacturers of

; other vehicles may choose to support this request for the convenience

; of service technicians.

END: pid\_definitions

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OBD-II COMPREHENSIVE COMPONENT MONITOR OVERVIEW - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.2 COMPREHENSIVE COMPONENTS - MONITOR FLAG AND FAULT CODE SET (CDAF0)

OVERVIEW

Most A/D inputs and some outputs such as the fuel pump do not contain a

specific monitor flag for input into the OBD-II Trip flag. It is assumed

that when CCM\_MON\_TM is reached, a failure of these components (if present)

would have been detected.

DEFINITIONS

INPUTS

Registers:

- ATMR1 = Time since engine start.

Bit Flags:

- CCM\_ECT\_MON = OBD-II monitor flag for ECT; 1 -> ECT monitored for this

OBD-II trip.

- CCM\_IAC\_MON = Monitor Flag for IAC; 1 -> all IAC faults have been

monitored at least once since power-up.

- CCM\_TRNS\_MON = Transmission monitor flag; 1 -> All transmission

electrical components have been monitored at least once this power-up.

OUTPUTS

Bit Flags:

- CCM\_MON = OBD-II monitor flag for comprehensive components.

- CCM\_TST\_RDY = Comprehensive Components ready to test.

OTHER

- ccm\_codes = SET OF {act\_codes, ect\_codes, iac\_codes, maf\_codes, tp\_codes,

tot\_codes}

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OBD-II COMPREHENSIVE COMPONENT MONITOR OVERVIEW - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: OBDII\_CCM\_MON\_COM1

always -----------------------------| CCM\_TST\_RDY = 1

| (ccm test is always ready)

ATMR1 > CCM\_MON\_TM -----------------| ccm\_mon\_flg = 1

(enough time for sufficient | (A/D inputs considered

A/D readings) | monitored)

ccm\_mon\_flg = 1 --------------|

(enough time for A/D) |

|

CCM\_TRNS\_MON = 1 -------------|

(Trans components monitored) |

|

CCM\_ECT\_MON = 1 --------------|AND -| CCM\_MON = 1

(ECT monitored) | | (Comprehensive component monitoring

| | complete for trip)

CCM\_IAC\_MON = 1 --------------|

(Idle Air Control monitored)

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OBDII DIAGNOSTIC EXECUTIVE, FAULT FILTER AND FAULT CODE LOGIC- CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.3 FAULT FILTER AND FAULT MONITOR LOGIC (CDAI0)

OVERVIEW

This strategy module contains the fault\_filter routine and the

fault\_filter\_clear routine.

It calls the OBDII malfunction, store\_code, and clear\_malf routines when

neccessary.

It is availiable for use by any part of the OBDII diagnostic strategy.

Note that each of the four routines are only called "on demand" and

individually, by the diagnostic strategies.

DEFINITIONS

INPUTS

Registers:

- CxxxMON = Filter to count how many times the associated fault has been

monitored.

- ERROR\_DETECTED = Error detected by continuous VIP.

Calibration Constants:

- CxxxUP = The amount by which CxxxFIL will increment every time it detects

an error (ERROR\_DETECTED = 1) w/ fault xxx. [up count for xxx].

- FILHYS = FMEM filter count hysteresis, filter counts.

- MONxxxUP = The amount by which the Code: xxx monitor filter (CxxxMON)

gets incremented each time the test is monitored [upcount for CxxxMON].

(equal to CxxxUP).

OUTPUTS

Registers:

- ERROR\_DETECTED = See above.

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OBDII DIAGNOSTIC EXECUTIVE, FAULT FILTER AND FAULT CODE LOGIC- CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- PxxxMALF = Malfunction flag for fault xxx; 1 -> malfunction currently

exists for fault xxx.

OTHER

- malfunction(egr,Pxxxx)= Public procedure updating the MIL control status

provided by the MIL control module.

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OBDII DIAGNOSTIC EXECUTIVE, FAULT FILTER AND FAULT CODE LOGIC- CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: OBDII\_FAULT\_FILTER\_COM1

BEGIN: fault\_filter(Pxxxx)

ERROR\_DETECTED = 1 ---------------------| CxxxxFIL = CxxxxFIL + CxxxxUP

|

| --- ELSE ---

|

| CxxxxFIL = CxxxxFIL - 1

always ---------------------------------| CxxxxMON = CxxxxMON + MONxxxxUP

If filter has exceeded the level then there is a malfunction. If not

inhibited, the malfuction or store\_code routine is called. If the fault

filter has dropped enough to clear the fault then clear\_malf is called.

CxxxxFIL > CxxxxLVL --------------|

|

ERROR\_DETECTED = 1 ---------------|AND -| Do: malfunction(sys,Pxxxx)

| | ERROR\_DETECTED = 0

Pxxxx is a MIL code --------------| |

| --- ELSE ---

CxxxxFIL > CxxxxLVL --------------| |

| |

ERROR\_DETECTED = 1 ---------------|AND -| Do: store\_code(Pxxxx)

| | ERROR\_DETECTED = 0

Pxxxx is not a MIL code ----------| |

| --- ELSE ---

|

CxxxxFIL < CxxxxLVL - FILHYS -----------| Do: clear\_malf(Pxxxx)

| ERROR\_DETECTED = 0

|

| --- ELSE ---

|

| ERROR\_DETECTED = 0

END: fault\_filter

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OBDII DIAGNOSTIC EXECUTIVE, FAULT FILTER AND FAULT CODE LOGIC- CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: fault\_filter\_clear(Pxxxx)

CxxxxFIL <= CxxxxLVL - FILHYS ----------| CxxxxFIL = 0

|

| --- ELSE ---

|

| make no change to CxxxxFIL

CxxxxMON <= CxxxxLVL -------------------| CxxxxMON = 0

|

| --- ELSE ---

|

| make no change to CxxxxMON

END: fault\_filter\_clear

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.4 OUTPUT SUBSTITUTION CONTROL (CDAN2)

OVERVIEW

+-----------------------------------+

| OBDII\_OSC\_COM |

+-----------------------------------+

| PUBLIC PROCESSES: |

| . definitions |

| . substitute |

| . osc\_initialization |

| . osc\_background\_maintainence |

+-----------------------------------+

|PRIVATE PROCESSES: |

| . transform |

| . init\_osc\_table |

| . get\_osc\_allowed\_flag |

| . get\_vehicle\_state |

| . set\_osc\_flags |

+-----------------------------------+

The following strategy is used to allow an Off-board Diagnostic Unit (ODU) to

override the "normal" output control for a set of parameters under EEEC

control. These parameters are mapped to a set of channel numbers. These

channel numbers will be the same in every strategy. If a specific strategy

does not have the parameter associated with a specific channel number, that

channel will not function, but will still be present in the documentation.

The output state control is exercised by using a logic process located in the

diagnostic executive called 'substitute(channel\_number,parameter)'. This

logic process is called from within the background loop at each point when a

parameter is written to which SBDS has requested access to via output state

control. The substitution() process determines if output state control value

substitution should be performed, and if so overrides the normal value with

one given by SBDS. Pictorially, the scheme looks like the following small

segment of the background loop.

.

.

.

.

condition --| X := Y

| Do: substitute(n,X) ---> IF (substitution allowed AND

<--+ substitution requested)

. | THEN

. | override X with OSC\_VALUE[n]

. | ELSE

| do not override X -+

| |

+------------------------+

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

There is a four layer security scheme in place to prevent inadvertent

substitution. It is extremely important that the substitution of values in

the control strategy never occurs unless the vehicle is in the service bay

and being worked on by the service technician. The security scheme has been

designed to ensure this. The implementation in the strategy has been

designed to prevent activation by any means other than through the SCP

interface with an authorized ODU.

The first layer requires an ODU to transmit a TESTER PRESENT message

periodically. This tells the strategy an ODU is currently on the network and

actively communicating.

The second layer requires the ODU to request a seed (randomly generated)

value from the PCM and succesfully transform it via a proprietary

transformation algorithm. The ODU then returns the transformed value. If it

matches the internally calculated value, this layer's requirements have been

met. This ensures only authorized ODUs gain access to the OSC mode.

The third layer requires the ODU to transmit an enable mask and requested

substitution value for the channel it wishes to override. The enable mask

must match the predetermined enable mask that is coded into the PCM. This

allows for unlocking of each individual channel number in the OSC table

seperately, thus minimizing the risk that other channels get overridden when

not requested.

The final layer verifies, each background loop when the parameter is written

to, that the vehicle is in an operational state that allows the override of

the requested channel(s) and that the override value is within some

guidelines. If the override value is acceptable and the enable mask is

correct the channel's normal value will be overridden and will remain in that

state until one of the security layers is breached or the ODU changes the

value. This layer ensures that the ODU will not damage the vehicle or place

the vehicle in an unsuitable operating state.

Pictorially the security scheme looks something like the following:

|.ODU present

+----V---------------------+

| |

| |.key is correct |

|+---V--------------------+|

|| ||

|| |.enable mask O.K. ||

||+--V-------------------+||

||| |||

||| |.override currently|||

||| | allowed |||

||| +V--------------+ |||

||| | OSC enabled | |||

||| +---------------+ |||

||+----------------------+||

|+------------------------+|

+--------------------------+

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Below is a description of how a finite state machine functions.

A finite state machine representation of how the strategy is activated and

used is shown below, along with a description of how the finite state

machine

functions.

A finite state machine is a way to graphically illustrate the functioning of

a system or process that can be in a set of DISCRETE states. The diagram

shows how and when transitions can occur between the states.

+----------------------+

| |

| STATE X |<-------------------

| | condition

+-----+----------A-----+ ---------

| | action

| |

condition | | condition

--------- | | ---------

action | | action

| |

| |

+-----V----------+-----+

| |

| STATE Y |

| |

+----------------------+

CONVENTIONS:

· BOXES represent STATES of the system.

· ARROWS represent TRANSITIONS between states.

· CONDITIONS will CAUSE a transition to be taken.

· ACTIONS are done WHEN a transition is taken.

RULES:

· The system can be in only one state at a time.

· The system remains in a given state until an event

occurs to cause a transition.

· No other transitions than those shown can be taken.

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUT SUBSTITUTION CONTROL FINITE STATE MACHINE

·once per b.g.

--------------- \*key<- OR

·init\_osc\_table \*heartbeat<- \*override<- ·power-up

·OSC\_SEED=0 ------------ ----------------- +--- ---------------

·ODU\_KEY=0 \*ODU\_UP\_TMR=0 \*sequence\_error-> | ·init\_osc\_table

+-----+ +--+ +--+ | ·OSC\_SEED=0

| | | | | | | ·ODU\_KEY=0

| +-V------------+--V------------+--V---------+ |

+---| |<-+

| osc\_initial\_state |<-----------------------+

+-------| | |

| +----------A-----------------A--------------+ |

|\*ODU\_UP\_TMR < | |\*key<- & |

| ODU\_TIMEOUT & |·ODU\_UP\_TMR >= | |

|\*send\_seed<- | ODU\_TIMEOUT |\*ODU\_KEY<>eec\_key |

|-------------- |------------- |----------------- |

|\*OSC\_SEED=random |·change state |\*error-> |

|\*seed-> | | |

| +----------+-----------------+--------------+ |

+------>| | |

| osc\_seed\_sent |------+\*heartbeat<- |

| | |------------ |

+-------| |<-----+\*ODU\_UP\_TMR=0 |

| +-------------------------------------------+ |

| |

| +---------------------------+

| |[{\*override<- OR

| | \*heartbeat<-} &

|\*ODU\_UP\_TMR<ODU\_TIMEOUT & \*key<- OR | \*ODU\_KEY<>eec\_key OR

|\*key<- & \*send\_seed<- | \*ODU\_KEY=0] OR

|\*ODU\_KEY=eec\_key ------------ | ·ODU\_UP\_TMR>=ODU\_TIMEOUT

|-------------------- \*sequence\_error-> | ------------------------

|\*general\_response-> +--+ | ·\*change state

| | | | \*general\_response->

| +-----------------------+--V-------------+--+

+------>| |

| key\_received |---+\*heartbeat<- &

| (substitutions allowed) | |\*ODU\_KEY=eec\_key

+-------| |<--+--------------------

| +-A------------------+--A-------------+--A--+ \*ODU\_UP\_TMR=0

| | | | | |

+---------+ | | +--+

·substitution() & | | \*override<- &

·ODU\_UP\_TMR<ODU\_TIMEOUT & | | \*ODU\_KEY=eec\_key

·OSC\_ENA[no.]=OSC\_MASK & | | --------------

·osc\_allowed\_flg=1 | | \*update OSC\_ENA[no.]

-------------------------- | | \*update OSC\_VALUE[no.]

·override channel no. with | | \*general\_response->

OSC\_VALUE[no.] +--+

·substitution() &

[·OSC\_ENA[no.]<>OSC\_MASK OR

·osc\_allowed\_flg=0]

------------------------

·do not override channel no.

KEY:

message<- : incoming message to the EEEC. \* : action taken in SCP strategy.

message-> : outgoing message from the EEEC. · : action taken in OSC strategy.

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

There exists a table of values related to the Output State Control function

in the PCM that is located in the HWINT\_IO\_GP module. This table is used to

hold the actual values that the offboard diagnostic unit wishes to use in

palce of those calculated by the strategy. This table is also used to hold

the enable mask transmitted from the offboard diagnostic unit to the PCM to

unlock the individual channels. The enable mask is to be compared to a

predetermined, hardcoded enable bit pattern. This acts as a key to unlock

each individual channel in the table. There are currently 28 channels

substitution is allowed to be performed on. These are shown in a diagram

below. If one or more of these parameters are not present in a given

strategy, a request from the ODU to override would have no external effect.

This is because the substitute() process would never be invoked with the

channel number that does not exist in the strategy.

Implementation note: The OSC\_VALUE[] parameters will have binary scaling to

match the parameter they will be used to override. This implies that each

OSC\_VALUE[] will have its own unique scaling. The OSC\_VAULE[] parameters

have been created in the EDTS parameter dictionary as OSC\_VALUE0,

OSC\_VALUE1... with the appropriate scaling. The binary scaling information

is also to be provided to the ODU designers so that they will load a bit

pattern into OSC\_VALUE[] that is scaled properly and no further action will

be required by the EEEC once the value has been transmitted and loaded into

the table.

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OSC CHANNEL NUMBERS: The actual OSC table is located in the HWINT\_OSC\_xx

module. The following list is for documentation only and

provides the OSC channel numbers and their associated parameter.

+----------+--------------+

| channel\* | parameter |

+----------+--------------+

| 0 | ISCDTY |

| 1 | EAM |

| 2 | AM1 |

| 3 | AM2 |

| 4 | LAMBSE1 |

| 5 | LAMBSE2 |

| 6 | PUMP |

| 7 | EGRDC |

| 8 | GR\_CM |

| 9 | PG\_DC |

| 10 | PGM\_CVS\_DC |

| 11 | FLG\_SS\_1 |

| 12 | FLG\_SS\_2 |

| 13 | FLG\_SS\_3 |

| 14 | FLG\_SS\_4 |

| 15 | BCSDC\_OUT |

| 16 | TV\_PRES\_BAR |

| 17 | SAF |

| 18 | TRAC\_DC |

| 19 | FPUMP\_DC |

| 20 | FP\_2SPD\_ON |

| 21 | IMRC\_CMND |

| 22 | SS3L\_OUT |

| 23 | FLG\_CS\_CM |

| 24 | FLG\_LK\_CM |

| 25 | HEGOHTR11 |

| 26 | HEGOHTR12 |

| 27 | HEGOHTR21 |

| 28 | HEGOHTR22 |

+----------+--------------+

'\*'...Channel numbers shown are offset 128 from SCP hex values.

Output state control will be invoked from throughout the strategy at the

point the final calculation is made for each one of the parameters listed

above. A typical example, using channel number 0 (ISCDTY) is shown in the

logic fragment shown below:

condition -------------------| ISCDTY := X + Y

| Do: substitute(0,ISCDTY)

| ;check to see if value is to be overridden

| ;by an Offboard Diagnostic Unit.

| ;ISCDTY will be overwritten, if conditions

| ;are appropriate and a request has been made

| ;by the ODU.

If the control strategy requires to know if the value was substituted, the

parameter's value can be compared before and after the substitute() is

executed. If the value has changed, it is because the ODU has overridden the

normal value.

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- GR\_CM = Commanded gear for shift solenoids.

- GR\_CM\_LST = Commanded gear for shift solenoids last background pass.

- N = Engine speed, RPM.

- ODU\_KEY = Key value received from ODU to unlock OSC.

- ODU\_UP\_TMR = ODU tester present timer (free run up counter).

- OSC\_ENAx = Output State Control enable mask, where "x" = channel number

(1-17).

- OSC\_SEED = Randomly generated seed value transmitted to ODU.

- OSC\_STATE = Output state control state variable. (1-17).

- OSC\_VALUEx = Output State Control substitution value, where "x" = channel

number.

- PDL = PRNDL position - from A to D conversions.

| - PGM\_TANK\_PRS = Purge monitor tank pressure, inches of water.

- SPD\_RATIO = Speed ratio across torque converter (output/input).

- TOT = Transmission oil temperature, (degrees F).

- TV\_PRES = TV pressure.

- VSBAR = Filtered vehicle speed for transmission.

Bit Flags:

- CRANKING = Engine cranking flag.

- DEMAND\_MODE = Flag set when an On-Demand selt test mode is active.

- NDSFLG = Neutral/Drive flag; 1 -> Drive.

- OSC\_OL = Flag to force open loop during LAMBSE substitution.

- OSC\_SAF\_FLG = Output state control substitution of spark advance -> 1 =

substitution performed

- OSC\_SS\_FLG = Output state control substitution of a shift solenoid -> 1 =

substition performed

- PDL\_ERROR = MLPS fault detected flag; 1 -> Fault detected.

- SUBST\_REQ[x] = Substitution Requested flag, where "x" = channel number

(1-28).

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- UNDSP = Run/Underspeed Flag; 1 -> Underspeed (or CRANK), 0 -> Run.

- VSFMFLG = Vehicle speed sensor FMEM flag.

Calibration Constants:

- MIN\_IMRC\_RPM = Minimum engine RPM to perform IMRC OSC substitution.

- MLUS\_MX\_TOT = TOT high temp limit to test MLUS.

- NUMEGO = Number of EGO sensors.

| - OSC\_TANK\_MIN = Minimum tank pressure to allow OCS substitution of PG\_DC

| and PGM\_CVS\_DC parameters.

- ODU\_TIMEOUT = Time-out value for certain offboard diagnostic routines.

- OSC\_MASK = Key to unlock each OSC channel.

- TSTRAT = Transmission strategy switch; 0 -> No transmission control (man,

AOD, ATX, etc.), 1 -> shift indicator.

| - VSBAR\_MIN = Minimum value of VSBAR necessary for vehicle to be considered

| moving.

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

| STRATEGY MODULE: OBDII\_OSC\_COM2

BEGIN: definitions

;This process is used to define symbols used locally to make

;the strategy more easy to read. It is not intended to be executed

unconditionally -----------------------| osc\_initial\_state := 0

| osc\_seed\_sent := 1

| key\_received := 2

| no\_of\_channels := 28

| engine\_off := 0

| engine\_on\_pn := 1

| engine\_on\_gear := 2

| vehicle\_moving :=3

| unknown := 4

| true := 1

| false := 0

END: definitions

BEGIN: osc\_initialization

;This process is executed during RAM initialization to make the

;OSC parameters ready. It is also called once per background

;when the OSC mode is not active.

unconditionally -----------------------| Do: init\_osc\_table

| OSC\_SEED := 0

| ODU\_KEY := 0

| OSC\_OL := 0

| OSC\_SAF\_FLG := 0

| OSC\_STATE := osc\_initial\_state

| OSC\_SS\_FLG := 0

END: osc\_initialization

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: substitute(channel\_number,parameter)

;PUBLIC process used to override parameter values during output

;state control from SBDS/EOL off board diagnostic testing. This function

;is called from multiple spots in the strategy when a parameter is

;written to to decide if it should be overridden. The argument 'parameter'

;is the name of the parameter that a substitution request is being made for.

;IMPLEMENTATION NOTE: this process can be either inline code or subroutine

;call. The strategy does not require one implementation over the other.

ODU\_UP\_TMR >= ODU\_TIMEOUT ----------|

;ODU offline. |OR --| Exit.

| | ;no change to parameter.

OSC\_STATE <> key\_received ----------| |

(State Machine is in State=2) | --- ELSE ---

|

TSTRAT > 3 -------------------------------| Do: get\_vehicle\_state\_auto

| Do: get\_osc\_allowed\_flg

| Do: set\_osc\_flags

|

| --- ELSE ---

|

| Do: get\_vehicle\_state\_manual

| Do: get\_osc\_allowed\_flg

| Do: set\_osc\_flags

OSC\_ENA[channel\_number] = OSC\_MASK -|

;enable mask correct. |

|

osc\_allowed\_flg = true ------------|AND -| parameter :=

;substitution allowed based on | | OSC\_VALUE[channel\_number]

;state of vehicle operation. | |

| | ;overwrite the parameter with

SUBST\_REQ[channel\_number] = 1 ------| | ;value from the OSC table.

| Do: OSC\_RESPONSE(channel number,

| 00h)

| ; send general affirmative

|

| --- ELSE ---

OSC\_ENA[channel\_number] = OSC\_MASK -| |

;enable mask correct. |AND -| parameter :=

| | OSC\_VALUE[channel\_number]

osc\_allowed\_flg = true -------------| | ;overwrite the parameter with

;substitution allowed based on | ;value from the OSC table.

;state of vehicle operation. |

|

| --- ELSE ---

|

SUBST\_REQ[channel\_number] = 1 ------------| Do: OSC\_RESPONSE(channel number,

| 22h)

| ; send general reject

| Exit

| ; no change to parameter

| --- ELSE ---

|

| Exit

| ; no change to parameter

END: substitute

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: set\_osc\_flags

PRIVATE process used to set and clear OSC flags to notify other parts of the

strategy whether or not Output State Control is taking place.

channel\_number = 4 -----------|

|OR --|

channel\_number = 5 -----------| |

|

OSC\_ENA[4] = OSC\_MASK --------| |

|OR --|

OSC\_ENA[5] = OSC\_MASK --| | |AND -| OSC\_OL := true

;enable mask correct. |AND -| | | ; force open loop fuel

| | |

NUMEGO = 2 -------------| | |

| |

osc\_allowed\_flg = true -------------| |

| --- ELSE ---

channel\_number = 4 -----------------| |

|OR --| OSC\_OL := false

channel\_number = 5 -----------------| | ; allow closed loop fuel

|

| --- ELSE ---

channel\_number = 17 ----------------| |

| |

OSC\_ENA[17] = OSC\_MASK -------------|AND -| OSC\_SAF\_FLG := true

;enable mask correct. | |

| |

osc\_allowed\_flg = true -------------| |

| --- ELSE ---

|

channel\_number = 17 ----------------------| OSC\_SAF\_FLG := false

|

| --- ELSE ---

channel\_number = 11 ----------| |

| |

channel\_number = 12 ----------| |

|OR --| |

channel\_number = 13 ----------| | |

| | |

channel\_number = 14 ----------| | |

|AND -| OSC\_SS\_FLG := true

OSC\_ENA[channel\_number] = OSC\_MASK -|

;enable mask correct. |

|

osc\_allowed\_flg = true -------------|

END: set\_osc\_flags

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: osc\_background\_maintainence

;PUBLIC process executed once per background pass to ensure the OSC table

;and SBDS\_KEY do not get corrupted by some external source (RCON, noise).

OSC\_STATE = osc\_initial\_state ---|

(State Machine is in State=0) |OR --| Do: osc\_initialization

|

ODU\_UP\_TMR >= ODU\_TIMEOUT -------|

END: osc\_background\_maintainence

BEGIN: init\_osc\_table

;PRIVATE process used to initialize the output state control table. Each

;enable mask in the table will be put into a disabled state and each

;substitution value will be cleared.

For x := 0 to no\_of\_channels execute the following:

unconditionally -----------------------| OSC\_VALUE[x] := 0

| OSC\_ENA[x] := 0

| SUBST\_REQ[x] := 0

END: init\_osc\_table

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: get\_osc\_allowed\_flg

;PRIVATE process used to decide if vehicle operational conditions

;are correct to allow substitution of the specified parameter.

channel\_number > no\_of\_channels -------|

|

DEMAND\_MODE = 1 -----------------------|OR --| osc\_allowed\_flg := false

| |

OBDII\_RESET = 1 -----------------------| |

| --- ELSE ---

channel\_number <> 8 -------------------| |

|AND -| osc\_allowed\_flg := true

vehicle\_state = engine\_off ------| | |

|OR --| |

vehicle\_state = engine\_on\_pn ----| |

| --- ELSE ---

| channel\_number <> 0 -------------------| |

| | |

| channel\_number <> 6 -------------------| |

| | |

channel\_number <> 8 -------------------| |

| |

channel\_number <> 11 ------------------| |

| |

channel\_number <> 12 ------------------| |

| |

channel\_number <> 13 ------------------| |

| |

channel\_number <> 14 ------------------| |

| |

channel\_number <> 15 ------------------| |

| |

channel\_number <> 16 ------------------| |

|AND -| osc\_allowed\_flg := true

| channel\_number <> 17 ------------------| |

| | |

| channel\_number <> 19 ------------------| |

| | |

| channel\_number <> 20 ------------------| |

| | |

channel\_number <> 21 ------------------| |

| |

channel\_number <> 22 ------------------| |

| |

channel\_number <> 23 ------------------| |

| |

channel\_number <> 24 ------------------| |

| |

vehicle\_state = engine\_on\_gear --------| |

| --- ELSE ---

| (continued on next page)

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| (continued from previous page)

channel\_number = 4 --------------| |

| |

channel\_number = 5 --------------| |

| |

channel\_number = 25 -------------| |

|OR --| |

channel\_number = 26 -------------| |AND -| osc\_allowed\_flg := true

| | |

channel\_number = 27 -------------| | |

| | |

channel\_number = 28 -------------| | |

| |

vehicle\_state <> unknown --------------| |

| --- ELSE ---

| channel\_number = 9 --------------------| |

| | |

| vehicle\_state <> unknown --------------| |

| |AND -| osc\_allowed\_flg := true

| vehicle\_state <> vehicle\_moving -| | |

| |OR --| |

| OSC\_VALUE[9] = 0 ----------------| |

| | --- ELSE ---

| channel\_number = 10 -------------------| |

| | |

| PGM\_TANK\_PRS > OSC\_TANK\_MIN -----------|AND -| osc\_allowed\_flg := true

| | |

| vehicle\_state <> unknown --------------| |

| | --- ELSE ---

channel\_number <> 8 -------------------| |

| |

channel\_number <> 15 ------------------| | osc\_allowed\_flg := false

| |

channel\_number <> 16 ------------------|AND -|

| |

channel\_number <> 21 ------------------| |

| |

channel\_number <> 24 ------------------| |

| --- ELSE ---

channel\_number = 8 --------------------| |

| |

OSC\_VALUE[channel\_number] > 0 ---------| |

| |

OSC\_VALUE[channel\_number] < 5 ---------|AND -| osc\_allowed\_flg := true

| |

abs(OSC\_VALUE[channel\_number] | |

- GR\_CM\_LST ) <= 1 --| |

| |

vehicle\_state = vehicle\_moving --------| |

| --- ELSE ---

| (continued on next page)

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| (continued from previous page)

|

channel\_number = 8 --------------------------| osc\_allowed\_flg := false

|

| --- ELSE ---

channel\_number = 15 -------------| |

|OR --| |

channel\_number = 24 -------------| | |

| |

vehicle\_state = vehicle\_moving --------| |

|AND -| osc\_allowed\_flg := true

OSC\_VALUE[channel\_number] = 0.0 -| | |

| | |

OSC\_VALUE[channel\_number] | | |

= 1.0 -| | | |

| |OR --| |

TOT > 60 ------------------| | |

| | |

TOT < MLUS\_MX\_TOT ---------|AND -| |

| |

GR\_CM > 1 -----------------| |

| |

SPD\_RATIO > 0.7 -----------| |

| --- ELSE ---

channel\_number = 15 -------------------| |

|OR --| osc\_allowed\_flg := false

channel\_number = 24 -------------------| |

| --- ELSE ---

channel\_number = 16 ------------------| |

| |

vehicle\_state = vehicle\_moving --------| | osc\_allowed\_flg := true

| |

OSC\_VALUE[channel\_number] > TV\_PRES ---|AND -|

| |

OSC\_VALUE[channel\_number] > 0 ---------| |

| |

OSC\_VALUE[channel\_number] < 127 -------| |

| --- ELSE ---

channel\_number = 21 -------------------| |

| |

vehicle\_state = engine\_on\_pn ----| | |

|OR --|AND -| osc\_allowed\_flg := true

vehicle\_state = engine\_on\_gear --| | |

| |

N > MIN\_IMRC\_RPM ----------------------| |

| --- ELSE ---

|

| osc\_allowed\_flg := false

END: get\_osc\_allowed\_flg

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: get\_vehicle\_state\_auto

;PRIVATE process used to determine what operational state the vehicle is in.

CRANKING = 1 ---------------|

|

PDL\_ERROR = 0 --------------|AND -| vehicle\_state := engine\_off

| |

PDL = 5 --------------| | |

|OR --| |

| PDL = 7 --------------| |

| --- ELSE ---

UNDSP = 0 ------------------| |

| |

| VSBAR <= VSBAR\_MIN ---------| |

| |

VSFMFLG = 0 ----------------|AND -| vehicle\_state := engine\_on\_pn

| |

PDL\_ERROR = 0 --------------| |

| |

PDL = 5 --------------| | |

|OR --| |

| PDL = 7 --------------| |

| --- ELSE ---

UNDSP = 0 ------------------| |

| |

| VSBAR <= VSBAR\_MIN ---------| |

| |

VSFMFLG = 0 ----------------|AND -| vehicle\_state := engine\_on\_gear

| |

PDL\_ERROR = 0 --------------| |

| |

PDL = 6 --------------| | |

|OR --| |

PDL <= 4 -------------| |

| --- ELSE ---

UNDSP = 0 ------------------| |

| |

| VSBAR > VSBAR\_MIN ----------| |

| |

VSFMFLG = 0 ----------------|AND -| vehicle\_state := vehicle\_moving

| |

PDL\_ERROR = 0 --------------| |

| |

PDL = 4 --------------------| |

| --- ELSE ---

|

| vehicle\_state := unknown

END: vehicle\_state\_auto

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OBDII STRATEGY, OUTPUT SUBSTITUTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: get\_vehicle\_state\_manual

;PRIVATE process used to determine what operational state the vehicle is in

for

; an automatic transmission.

CRANKING = 1 ---------------|

|AND -| vehicle\_state := engine\_off

NDSFLG = 0 -----------------| |

| --- ELSE ---

UNDSP = 0 ------------------| |

| |

| VSBAR <= VSBAR\_MIN ---------| |

|AND -| vehicle\_state := engine\_on\_pn

NDSFLG = 0 -----------------| |

| |

VSFMFLG = 0 ----------------| |

| --- ELSE ---

UNDSP = 0 ------------------| |

| |

| VSBAR <= VSBAR\_MIN ---------| |

|AND -| vehicle\_state := engine\_on\_gear

NDSFLG = 1 -----------------| |

| |

VSFMFLG = 0 ----------------| |

| --- ELSE ---

UNDSP = 0 ------------------| |

| |

NDSFLG = 1 -----------------| |

|AND -| vehicle\_state := vehicle\_moving

| VSBAR > VSBAR\_MIN ----------| |

| |

VSFMFLG = 0 ----------------| |

| --- ELSE ---

|

| vehicle\_state := unknown

END: vehicle\_state\_manual

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OBDII STRATEGY, TRANSMISSION COMPRESHENSIVE COMPONENT MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.5 TRANSMISSION COMPREHENSIVE COMPONENT MONITOR (CDAK0)

OVERVIEW

This module determines when all of the transmission electrical components

have been monitored for this "trip". This information is then passed to the

CCM monitor module, which then informs the system when all Comprehensive

Component Monitoring is complete.

A "trip" is defined as "vehicle operation of duration and driving mode such

that all components and systems are monitored at least once". OBD-II

regulations require that a "trip" be completed during the CVS-72 cycle.

Transmission CCM works as follows - each component fault that requires MIL

illumination carries two flags:

1) PxxxMON - Fault xxx monitor flag; 1 -> fault xxx has been monitored

at least once this power-up.

2) PxxxMALF - Fault xxx malfunction flag; 1 -> fault xxx has been

detected and currently exits.

Once the monitor flag for each Transmission Electrical Component is set, the

CCM\_TRNS\_MON flag will be set to signify compeltion of Transmission CCM for

this "trip".

NOTE: For manual transmission applications, the CCM\_TRNS\_MON flag will be

set once the vehicle speed sensor (VSS) has been monitored.

DEFINITIONS

INPUTS

Registers:

- TSTRAT = Transmission Strategy Switch; The TSTRAT software switch

controls which transmission control strategy is executed:

0 -> No transmission control (Manual transmission, AOD, ATX, C6,

C3, etc.)

1 -> SIL (Shift indicator light)

2 -> A4LD with 3-4 shift control and converter clutch control

3 -> AXOD

4 -> C64E (E4OD)

5 -> A41DE

6 -> FAX-4

7 -> AOD-E (AOD-I)

8 -> 4EAT

9 -> CD4E

Bit Flags:

- PDL\_MON = MLPS monitored flag; 1 -> MLPS has been monitored at least once

this power-up.

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OBDII STRATEGY, TRANSMISSION COMPRESHENSIVE COMPONENT MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PxxxMON = OBDII monitor flag for fault xxx; 1 -> fault xxx has been

monitored at least once this power-up.

Calibration Constants:

- CC\_TRIP\_SW = Calibration switch used to enable/disable counting the

converter clutch functional test as part of a "trip"; 1 -> enabled.

- SS\_TRIP\_SW = Calibration switch used to enable/disable counting the shift

solenoid functional test as part of a "trip"; 1 -> enabled.

OUTPUTS

Bit Flags:

- CCM\_TRNS\_MON = Transmission monitor flag; 1 -> All transmission

electrical components have been monitored at least once this power-up.

- CC\_TRIP\_DONE = Converter clutch functional "trip" flag; 1 -> the

Converter clutch has been functionally monitored for this "trip".

- SS\_TRIP\_DONE = Shift Solenoid functional "trip" flag; 1 -> the Shift

Solenoids have been functionally monitored for this "trip".

OTHER

- P0500 = Fault code for vss failure.

- P0720 = OBDII fault code - Output Speed Sensor Malfunction.

- P0743 = Torque converter clutch system electrical.

- P0750 = OBD-II fault code for SSA circuit malfunction.

- P0755 = OBD-II fault code for SSB circuit malfunction.

- P1747 = Fault code; EPC VFS short to ground.

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OBDII STRATEGY, TRANSMISSION COMPRESHENSIVE COMPONENT MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: OBDII\_TRANS\_MON\_COM1

Transmission portion of the CCM is complete when each transmission electrical

component has been monitored at least once this power-up (the monitor flag

for that component is set).

SS\_TRIP\_SW = 0 -------------------|

|

SS\_MALF\_FLG = 1 ------------------|OR --| SS\_TRIP\_DONE = 1

| | (Either counting shift solenoids

FLG\_SS\_MON = 1 -------------------| | as part of a trip is cal'ed out,

| or a malfunction is present, or

| the solenoids have been monitored

| as "good", set the shift solenoid

| "trip" done flag)

CC\_TRIP\_SW = 0 -------------------|

|

SS\_MALF\_FLG = 1 ------------------|OR --| CC\_TRIP\_DONE = 1

| | (Either counting converter clutch

FLG\_PWM\_MON = 1 ------------| | | as part of a trip is cal'ed out,

|AND -| | or a shift solenoid malfunction

P1744MON = 1 ---------------| | is present - can't test

| converter, or the solenoid has

| been monitored as "good", set

| the converter clutch "trip"

| done flag)

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OBDII STRATEGY, TRANSMISSION COMPRESHENSIVE COMPONENT MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P0500MON = 1 ---------------------|

(VSS has been monitored) |

|

TSTRAT <= 3 ----------------| |

(Manual/non-electric | |

transmission) | |AND -| CCM\_TRNS\_MON = 1

| | | (All transmission

PDL\_MON = 1 ----------| | | | electrical compnents

(MLPS has been | | | | have been monitored

monitored) | | | | once this power-up)

| |OR --|

P0720MON = 1 ---------| |

(OSS has been | |

monitored) | |

| |

CC\_TRIP\_DONE = 1 -----| |

(CC functionally | |

monitored) | |

| |

P0743MON = 1 ---------| |

(Converter Clutch | |

has been monitored) |AND -|

|

SS\_TRIP\_DONE = 1 -----|

(SS functionally |

monitored) |

|

P0750MON = 1 ---------|

(SS1 has been |

monitored) |

|

P0755MON = 1 ---------|

(SS2 has been |

monitored) |

|

P1747MON = 1 ---------|

(EPC VFS has been monitored

for a short circuit)

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OBDII STRATEGY, TRANSMISSION COMPRESHENSIVE COMPONENT MONITOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.6 FEATURE: SELF TEST CONTROL - V1.8\_OBDII\_SELF\_TEST\_CONTROL (CDAN2)

23.6.1 ENGINE OFF SEQUENCE CONTROLER (CDAB0)

OVERVIEW

The Key On engine off (EO) On-Demand Test sequence is enabled in the same

manner as other OBD-II monitors. When the local conditions (key on, engine

not running) are met, the flag EO\_TST\_RDY is set. When requested (via Scan

Tool) the OBD-II executive will set the flag EO\_TST\_ENA to initiate the

engine off Sequence.

The control of the test sequence is documented by use of a state pointer

called "EO\_STATUS". This parameter is compared to and assigned the value of

non-modifiable calibration constants to control the progress through the test

sequence.

DEFINITIONS

INPUTS

Registers:

- EO\_STATUS = State pointer that indicates current state of engine off on

demand test sequence.

- DEMAND\_TIMER = Self Test utility timer.

Bit Flags:

- CRKFLG = Crank flag.

- DEMAND\_ABORT = Flag to indicate that the on-demand test is in the process

of an abort.

- DEMAND\_MODE = Flag set when an On-Demand self test mode is active.

- EO\_ACTIVE = Flag to indicate that the engine off on-demand test is in

progress.

- EO\_TST\_ENA = Flag that signals the engine off on-demand test to run.

- EO\_TST\_RDY = Flag to signal OBD-II executive that conditions to run the

engine off on-demand test are met.

Calibration Constants:

- CCM\_EO\_DONE = Value of EO\_STATUS when CCM on-demand engine off test is

complete.

- CCM\_EO\_WAIT = Value of EO\_STATUS when waiting for engine off CCM test to

complete.

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ENGINE OFF SELF TEST, ENGINE OFF SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- ECU\_EO\_DONE = Value of EO\_STATUS to when ECU test is done during Engine

off on-demand sequence.

- ECU\_EO\_INIT = Value of EO\_STATUS to signal for ECU test (Instruction,

KAM, RAM, ROM).

- EO\_DONE = Value of EO\_status when engine off on-demand test is complete.

- EO\_INACTIVE = Value of ER\_STATUS when engine off on-demand test is

inactive.

- OSM\_EO\_DONE = Value of EO\_STATUS when OSM on test is complete.

- OSM\_EO\_INIT = Value of EO\_STATUS when OSM test is initialized.

- OSM\_EO\_WAIT = Value of EO\_STATUS when waiting for OSM test to complete

during engine off on-demand test.

OUTPUTS

Registers:

- EO\_STATUS = See above.

- DEMAND\_TIMER = See above.

Bit Flags:

- CCM\_EO\_ENA = Comprehensive Componant engine off tests enabled.

- DEMAND\_ABORT = See above.

- EO\_ACTIVE = See above.

- EO\_DONE = Value of EO\_STATUS when engine off on-demand test is complete.

- EO\_TST\_ENA = See above.

- EO\_TST\_RDY = See above.

- OSM\_EDF\_OFF = Request for EDF Off from OSM or OTM test.

- OSM\_EDF\_ON = Request for EDF on from OSM or OTM test.

- OSM\_EO\_ON = On state requested for for engine off OSM test; 1 -> test on

state.

- OSM\_EO\_OFF = Off State requested for for engine off OSM test; 1 -> test

off state.

- OSM\_HEDF\_OFF = Request for HEDF Off from OSM or OTM test.

- OSM\_HEDF\_ON = Request for HEDF on from OSM or OTM test.

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ENGINE OFF SELF TEST, ENGINE OFF SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VO\_OBDII\_SEQUENCER\_COM1

This diagram provides for some "bullet proofing" when none of the demand mode

tests are active (engine running, engine off, or output test mode).

DEMAND\_MODE = 0 ------------------------------| OSM\_EO\_ON := 0

(None of the on demand tests are activated | OSM\_EO\_OFF := 0

by the OBD-II exec) | OSM\_EDF\_ON := 0

| OSM\_EDF\_OFF := 0

| OSM\_HEDF\_ON := 0

| OSM\_HEDF\_OFF := 0

| (end request for OSM tests)

|

| CCM\_EO\_ENA := 0

| (End EO CCM test)

This diagram detects if an abort has been requested (either by the OBD-II

executive or by this sequencer). If an abort has been initiated, this

diagram will insure that it is completed and then send the appropriate

response on the SCP interface to the diagnostic tools. Then, this diagram

determines if the engine off on demand test is able to and should be running

now. And, once activated, the test sequence is controlled by this diagram.

DEMAND\_ABORT = 1 -----------------------|

(Abort requested) |

|

EO\_STATUS = EO\_INACTIVE ----------------|AND -| DEMAND\_ABORT := 0

(abort complete) | | (Abort complete)

| |

EO\_ACTIVE = 1 --------------------------| | EO\_TST\_RDY = 0

(Abort of engine off test in progress) | (Abort done, not running

| now)

|

| EO\_STATUS :=

| EO\_INACTIVE

|

| EO\_ACTIVE := 0

| (test no longer active)

|

| --- ELSE ---

(continued on next page)

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ENGINE OFF SELF TEST, ENGINE OFF SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

DEMAND\_ABORT = 1 -----------------------| |

(Abort requested) |AND -| EO\_STATUS := EO\_INACTIVE

| | (abort of individual test

EO\_ACTIVE = 1 --------------------------| | complete)

(Abort of engine off test in progress) | OSM\_EO\_ON := 0

| OSM\_EO\_OFF := 0

|

| OSM\_EDF\_ON := 0

| OSM\_EDF\_OFF := 0

| OSM\_HEDF\_ON := 0

| OSM\_HEDF\_OFF := 0

| (end request for OSM tests)

|

| CCM\_EO\_ENA := 0

| (End EO CCM test)

|

| --- ELSE ---

EO\_ACTIVE = 1 --------------------------| |

(test in progress) | |

|AND -| DEMAND\_ABORT := 1

EO\_TST\_ENA = 0 -------------------| | | (Test no longer able to run,

(test not enabled by exec) |OR --| | time to bail out...)

| |

CRKFLG = 0 -----------------------| | EO\_TST\_RDY := 1

(not in crank) | (abort in progress)

|

| (Either the test was running

| and the OBD-II exec. cancled

| the test or the local

| conditions (engine not

| running) were violated.)

|

| --- ELSE ---

EO\_ACTIVE = 0 --------------------------| |

(test not in progress | |

| |

EO\_TST\_ENA = 1 -------------------------|AND -| EO\_TST\_RDY := 0

(test is enabled by exec) | | (For some strange reason,

| | the test is enabled by

CRKFLG = 0 -----------------------------| | the exec but can not now

(not in crank) | run. Don't start.)

| (This is not an abort

| because the test was not

| in progress the last

| background loop.)

|

| EO\_STATUS := EO\_INACTIVE

|

| --- ELSE ---

(continued on next page)

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ENGINE OFF SELF TEST, ENGINE OFF SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

EO\_TST\_ENA = 0 -------------------------| |

(test not enabled by OBD-II exec) |AND -| EO\_STATUS := EO\_INACTIVE

| |

CRKFLG = 1 -----------------------------| | EO\_TST\_RDY := 1

(crank mode) | (Signal OBD-II exec that

| EO test could run if

| enabled)

|

| EO\_ACTIVE := 0

| (test not active)

|

| --- ELSE ---

|

EO\_TST\_ENA = 0 -------------------------------| EO\_STATUS := EO\_INACTIVE

(test not enabled) |

(note that any subsequent logic in this | EO\_TST\_RDY := 0

chart will execute only if EO is | (test is not currently

enabled by OBD-II exec. and is able to | enabled by OBD-II and is

run.) | not ready to run, exit.)

|

| EO\_ACTIVE := 0

| (test not active)

|

| --- ELSE ---

|

EO\_STATUS = EO\_INACTIVE ----------------------| EO\_STATUS :=

(test not yet started) | ECU\_EO\_INIT

| (test RAM / KAM / ROM and

| instruction set.)

|

| EO\_ACTIVE := 1

| (test now active)

|

| --- ELSE ---

(continued on next page)

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ENGINE OFF SELF TEST, ENGINE OFF SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

EO\_STATUS = ECU\_EO\_DONE ----------------------| EO\_STATUS :=

| CCM\_EO\_WAIT

| (setup to start test)

| OSM\_EO\_ON := 0

| OSM\_EO\_OFF := 1

| OSM\_EDF\_ON := 0

| OSM\_EDF\_OFF := 1

| OSM\_HEDF\_ON := 0

| OSM\_HEDF\_OFF := 1

| (start OSM off tests)

| CCM\_EO\_ENA := 1

| (Enable CCM test)

| DEMAND\_TIMER := 0

| (set up time delay for

| CCM tests.)

|

| --- ELSE ---

EO\_STATUS = CCM\_EO\_WAIT ----------------| |

|AND -| EO\_STATUS :=

DEMAND\_TIMER > EO\_CCM\_DLY --------------| | CCM\_EO\_DONE

(enough time has passed for CCM test.) |

| --- ELSE ---

|

EO\_STATUS = CCM\_EO\_WAIT ----------------------| EO\_STATUS :=

| CCM\_EO\_WAIT

| (Just sit tight, wait for

| time delay, allow

| DEMAND\_TIMER to run)

|

| --- ELSE ---

|

EO\_STATUS = CCM\_EO\_DONE ----------------------| EO\_STATUS :=

| OSM\_EO\_WAIT

|

| OSM\_EO\_OFF = 0

| OSM\_EO\_ON = 1

| OSM\_EDF\_ON := 1

| OSM\_EDF\_OFF := 0

| OSM\_HEDF\_ON := 1

| OSM\_HEDF\_OFF := 0

| (start OSM on tests)

| DEMAND\_TIMER := 0

| (set up time delay to allow

| OSMs to settle.)

|

| --- ELSE ---

EO\_STATUS = OSM\_EO\_WAIT ----------------| |

|AND -| EO\_STATUS :=

DEMAND\_TIMER > EO\_OSM\_DLY --------------| | OSM\_EO\_DONE

(enough time has passed for OSM test.) |

| --- ELSE ---

(continued on next page)

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ENGINE OFF SELF TEST, ENGINE OFF SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

EO\_STATUS = OSM\_EO\_WAIT ----------------------| EO\_STATUS :=

| OSM\_EO\_WAIT

| (Just sit tight, wait for

| time delay, allow

| DEMAND\_TIMER to run)

|

| --- ELSE ---

|

EO\_STATUS = OSM\_EO\_DONE ----------------------| EO\_STATUS :=

| EO\_DONE

|

| OSM\_EO\_OFF := 1

| OSM\_EO\_ON := 0

| OSM\_EDF\_ON := 0

| OSM\_EDF\_OFF := 1

| OSM\_HEDF\_ON := 0

| OSM\_HEDF\_OFF := 1

| (turn outputs back off)

|

| CCM\_EO\_ENA := 0

| (End EO CCM test)

|

| --- ELSE ---

|

EO\_STATUS = EO\_DONE --------------------------| EO\_STATUS =

| EO\_INACTIVE

| (done with test)

|

| EO\_MON := 1

| (signal exec)

|

| OSM\_EO\_OFF := 0

| OSM\_EO\_ON := 0

| OSM\_EDF\_ON := 0

| OSM\_EDF\_OFF := 0

| OSM\_HEDF\_ON := 0

| OSM\_HEDF\_OFF := 0

| (end OSM requests)

|

| EO\_ACTIVE := 0

| (No longer runing test)

|

| --- ELSE ----

|

| (no action)

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ENGINE OFF SELF TEST, OUTPUT TEST MODE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.6.2 OUTPUT TEST MODE CONTROLLER (CDAF0)

OVERVIEW

The output test mode allows service technitions to control the state of

certian EEC outputs for diagnostic purpouses. There are four possible output

modes: all off, OSM outputs on, EDF on, and HEDF on.

The Output Test Mode (OTM) On-Demand Test sequence is enabled in the same

manner as other OBD-II monitors. When the local conditions (key on, engine

not running) are met, the flag OTM\_TST\_RDY is set. When requested (via Scan

Tool) the OBD-II executive will set the flag OTM\_TST\_ENA to initiate the

engine off Sequence. The scan tool will also set one of four flags:

OSM\_ON\_REQ, OSM\_OFF\_REQ, OSM\_EDF\_REQ, and OSM\_HEDF\_REQ to indicate the

requested state. A timer is used to return the outputs to the off / normal

state and exit the OTM if the requested state is not changed in a

calibratible ammount of time.

DEFINITIONS

INPUTS

Registers:

- OTM\_STATE = Current State of Output Test Mode Controller (Inactive, Off,

On, EDF On...).

- OTM\_TIMER = Output Test Mode Time out timer.

- OUTPUT\_MODE = Output Test Mode State requested by SCP. (Inactive, Off,

On, EDF on ...).

Bit Flags:

- CRANKING = Engine mode flag; 1 -> crank mode, 0 -> underspeed/run mode.

- DEMAND\_MODE = Flag set when an On-Demand self test mode is active.

- OTM\_TST\_ENA = Output Test Mode Enabled by OBD-II Exec.

Calibration Constants:

- OTM\_MAX\_TM = Maximum time in Output Test Mode without changing states.

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ENGINE OFF SELF TEST, OUTPUT TEST MODE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- OTM\_STATE = See above.

Bit Flags:

- OSM\_EDF\_OFF = Request for EDF Off from OSM or OTM test.

- OSM\_EDF\_ON = Request for EDF on from OSM or OTM test.

- OSM\_EO\_OFF = Off state requested for OSM outputs during engine off on

demand test.

- OSM\_EO\_ON = ON state requested for OSM outputs during engine off on

demand test.

- OSM\_HEDF\_OFF = Request for HEDF Off from OSM or OTM test.

- OSM\_HEDF\_ON = Request for HEDF On from OSM or OTM test.

- OTM\_TST\_RDY = Signal OBD-II Exec. that Output Test Mode is able to run.

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ENGINE OFF SELF TEST, OUTPUT TEST MODE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VO\_OBDII\_OTM\_COM1

DEMAND\_MODE = 0 ------------------------| OSM\_EO\_ON := 0

| OSM\_EO\_OFF := 0

| OSM\_EDF\_ON := 0

| OSM\_EDF\_OFF := 0

| OSM\_HEDF\_ON := 0

| OSM\_HEDF\_OFF := 0

| (insure that demand mode

| flags are not set when

| no test is in progress.)

OTM\_TST\_ENA = 0 ------------------|

(test not enabled by OBD-II |

exec) |

|AND -| OTM\_TST\_RDY := 1

CRANKING = 1 ---------------------| | (Signal OBD-II exec that

(crank mode) | | EO test could run if enabled)

| | run\_otm\_mode := 0

OTM\_STATE = 0 --------------------| | (done with OTM)

(test not active) |

| --- ELSE ---

OTM\_TST\_ENA = 0 ------------------| |

(test not enabled) |AND -| OTM\_TST\_RDY := 0

| | (test is not currently

OTM\_STATE = 0 --------------------| | enabled by OBD-II and is

(test not active) | not ready to run, exit.)

| run\_otm\_mode := 0

| (done with OTM)

|

| --- ELSE ---

CRANKING <> 1 --------------------| |

(not in crank mode) | |

| |

OTM\_TIMER > OTM\_MAX\_TM -----| | |

(test timed out) |AND -|OR --| OTM\_TST\_RDY := 0

| | | (Bail out)

OTM\_STATE <> 0 -------------| | | OSM\_EO\_ON := 0

(test active) | | OSM\_EO\_OFF := 0

| | OSM\_EDF\_ON := 0

OTM\_TST\_ENA = 0 ------------------| | OSM\_EDF\_OFF := 0

(test not enabled by OBD-II exec) | OSM\_HEDF\_ON := 0

| OSM\_HEDF\_OFF := 0

| (Be sure to turn outputs

| back to normal state)

| run\_otm\_mode := 0

| (done with OTM)

|

| --- ELSE ---

|

| run\_otm\_mode := 1

| (continue in OTM mode)

| (Any subsequent logic in this

| test should execute only if the

| OTM is enabled by OBD-II exec.

| and is able to run)

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ENGINE OFF SELF TEST, OUTPUT TEST MODE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OTM\_STATE <> OUTPUT\_MODE ---------|

(Change in state requested) |

|

OUTPUT\_MODE <= 4 -----------------|AND -| OTM\_TIMER := 0

(4 is the largest valid mode for | | (reset timer to zero if a change

this particular strategy module)| | in state is requested - something

| | is being done to the car.

run\_otm\_mode = 1 -----------------| | Or, keep the timer at zero to

(otm mode is active) | be ready when the test starts)

|

| send(GENERAL\_RESPONSE:

| 7Fh, B1h, 00h, 25h,

| OUTPUT\_MODE, 00h)

| (valid request recieved)

|

| --- ELSE ---

|

| no action

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ENGINE OFF SELF TEST, OUTPUT TEST MODE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

run\_otm\_mode <> 1 ----------------------| OTM\_STATE := 0

(otm mode is not active.) | (test is inactive)

|

| --- ELSE ---

|

OUTPUT\_MODE = 0 ------------------------| OSM\_EO\_ON := 0

(Request inactive state) | OSM\_EO\_OFF := 0

| OSM\_EDF\_ON := 0

| OSM\_EDF\_OFF := 0

| OSM\_HEDF\_ON := 0

| OSM\_HEDF\_OFF := 0

| (no state request)

|

| OTM\_STATE := OUTPUT\_MODE

| (inactive state)

|

| --- ELSE ---

|

OUTPUT\_MODE = 1 ------------------------| OSM\_EO\_ON := 0

(Request off states) | OSM\_EO\_OFF := 1

| OSM\_EDF\_ON := 0

| OSM\_EDF\_OFF := 1

| OSM\_HEDF\_ON := 0

| OSM\_HEDF\_OFF := 1

| (start OSM off tests)

|

| OTM\_STATE := OUTPUT\_MODE

| (off state)

|

| --- ELSE ---

|

OUTPUT\_MODE = 2 ------------------------| OSM\_EO\_ON := 1

(Request on state) | OSM\_EO\_OFF := 0

| OSM\_EDF\_ON := 0

| OSM\_EDF\_OFF := 1

| OSM\_HEDF\_ON := 0

| OSM\_HEDF\_OFF := 1

| (start OSM on tests)

|

| OTM\_STATE := OUTPUT\_MODE

| (on state)

|

| --- ELSE ---

|

OUTPUT\_MODE = 3 ------------------------| OSM\_EO\_ON := 0

(Request EDF on state) | OSM\_EO\_OFF := 1

| OSM\_EDF\_ON := 1

| OSM\_EDF\_OFF := 0

| OSM\_HEDF\_ON := 0

| OSM\_HEDF\_OFF := 1

| (start EDF on test)

|

| OTM\_STATE := OUTPUT\_MODE

| (EDF on state)

|

| --- ELSE ---

(continued on next page)

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ENGINE OFF SELF TEST, OUTPUT TEST MODE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

OUTPUT\_MODE = 4 ------------------------| OSM\_EO\_ON := 0

(Request HEDF on state) | OSM\_EO\_OFF := 1

| OSM\_EDF\_ON := 1

| OSM\_EDF\_OFF := 0

| OSM\_HEDF\_ON := 1

| OSM\_HEDF\_OFF := 0

| (start HEDF on test)

|

| OTM\_STATE := OUTPUT\_MODE

| (HEDF on state

|

| --- ELSE ---

|

| OSM\_EO\_ON := 0

| OSM\_EO\_OFF := 0

| OSM\_EDF\_ON := 0

| OSM\_EDF\_OFF := 0

| OSM\_HEDF\_ON := 0

| OSM\_HEDF\_OFF := 0

| (end requests)

|

| (An invalid value of

| output\_mode was

| recieved)

|

| OUTPUT\_MODE := 0

| OTM\_STATE := 0

| (inactive state)

|

| send(GENERAL\_RESPONSE:

| 7Fh, B1h, 00h, 25h,

| OUTPUT\_MODE, 12h)

| (invalid request)

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23.6.3 ENGINE RUNNING SEQUENCE CONTROLLER (CDAN2)

OVERVIEW

The Key On Engine Running (ER) On-Demand Test sequence is enabled in the same

manner as other OBD-II monitors. When the local conditions (vehicle stopped,

not in gear) are met, the flag ER\_TST\_RDY is set. When requested (via Scan

Tool) the OBD-II executive will set the flag ER\_TST\_ENA to initiate the

Engine Running Sequence.

The control of the test sequence is documented by use of a state pointer

variable called "ER\_STATUS". This parameter is compared to and assigned the

value of non-modifiable calibration constants to control the progress through

the test sequence. This parameter is incremented by both the sequencer and

individual test modules.

A particular test will become active when ER\_STATUS reaches a value of

xxx\_koer\_init, where "xxx" refers to a particular test such as EGR, EGO, etc.

And, when a test is complete, the test will set ER\_STATUS to xxx\_ER\_DONE. At

this point, the sequencer will set ER\_STATUS to yyy\_koer\_init, where yyy is

the next test in the sequence.

Some tests (A/D, look for BOO or PSPS input) will be enabled throughout the

test sequence. These tests will run when CCM\_ER\_ENA = 1 and will not

increment ER\_STATUS.

Since a test starts on xxx\_ER\_INIT and then increments ER\_STATUS to

xxx\_ER\_DONE, each test is independent of the preceding and following tests.

With this strucuture a test can be inserted or deleted through a relatively

small change in the sequencer.

DEFINITIONS

Registers:

- DEMAND\_TIMER = Self Test utility timer.

- ER\_LAM\_DSD1 = LAMBSE1 value requesetd by engine running on-demand test

- ER\_LAM\_DSD2 = LAMBSE2 value requesetd by engine running on-demand test

- ER\_RPM = Register that contains RPM value requested by engine running

on-demand test.

- ER\_SPARK = Required value of SAF during on-demand self test.

- ER\_STATUS = Defines current position in ER sequence. Control of this

psuedo parameter passes between the ER sequencer and individual ER tests.

| - KOER\_TST\_TMR = Amount of time that key on engine running has been

| executing, sec.

- NBAR = Rolling average RPM.

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- VSBAR = Vehicle speed, MPH.

Bit Flags:

- CCM\_ER\_ENA = Flag that signals the Comprehensive Componant Monitors to

run engine running on-demand test.

- CRKFLG = Engine mode flag; 1 -> crank mode, 0 -> underspeed/run mode.

- DEMAND\_ABORT = Flag to indicate that the engine running on-demand test is

in the process of an abort.

- DEMAND\_MODE = Flag set when an On-Demand self test mode is active.

- ER\_ACTIVE = Flag to indicate that the engine running on-demand test is in

progress.

- ER\_CONDTS = Flag indicating whether conditions exits to run engine

running test; 1 -> do not run KOER test.

- ER\_FUL\_REQ = Flag to signal Fuel system to use ER\_LAM\_DSD as the open

loop lambse.

- ER\_ISC\_HLD = Flag to signal the Idle Speed Control system to freeze ISC

duty cycle.

- ER\_ISC\_REQ = Flag to signal Idle Speed Control to use value of ER\_RPM for

desired RPM.

- ER\_MON = Flag indicating the engine running on-demand test is complete

- ER\_SPK\_REQ = Flag to signal Spark control to output a value of ER\_SPK.

- ER\_TST\_ENA = Flag that signals the engine running on-demand test to run.

- ER\_TST\_RDY = Flag to signal OBD-II executive that conditions to run the

engine running on-demand test are met.

- IMFMFLG = Instantaneous MAF sensor failure flag; 1 -> sensor out of

range.

- ISC\_ER\_ENA = Flag that signals the Idle Speed Control system to perform

engine running on-demand test.

- ISC\_HI\_CHECK = Value for state of ER\_STATUS when testing RPM during

engine running high speed ISC test.

- ISC\_HI\_DONE = Value for state of ER\_STATUS when ISC high rpm test is

complete.

- ISC\_HI\_WAIT = Value for state of ER\_STATUS while waiting for engine

running high speed ISC test.

- ISC\_LO\_CHECK = Value for ER\_STATUS when performing ISC low rpm test.

- ISC\_LO\_DONE = Value for ER\_STATUS to indicate that ISC low RPM test is

complete.

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- ISC\_LO\_WAIT = Value for ER\_STATUS when waiting for ISC low rpm test.

- MIS\_ER\_ENA = Flag that signals the Misfire test to perform engine running

on-demand test.

- NDSFLG = Neutral/Drive flag; 1 -> drive.

- OPER\_RSP\_CHK = ER on-demand test for BOO enabled.

- OSM\_EDF\_ON = Request low speed fan during on-demand Self Test; 1 -> fan

on.

- PxxxMALF = Malfunction flag for code Pxxx; 1 -> a malfunction currently

exists for fault Pxxx.

- UNDSP = Run/Underspeed Flag; 1 -> Underspeed (or CRANK), 0 -> Run.

Calibration Constants:

- EGO\_ER\_DONE = Value for state pointer when engine running EGO test is

complete.

- EGO\_ER\_INIT = Value for state of ER\_STATUS to indicate engine running EGO

test is to be run.

- EGR\_ER\_DONE = Value for state of ER\_STATUS to indicate engine running EGR

test is complete.

- EGR\_ER\_INIT = Value for state of ER\_STATUS to request engine running egr

test.

- ER\_CLEANUP = Value of ER\_STATUS when "cleanup" portion of engine running

test is in progress.

- ER\_DONE = Value of ER\_STATUS when engine running test is complete.

- ER\_HI\_RPM = Base value for RPM requeseted during engine running on-demand

test, RPM.

- ER\_INACTIVE = Value for state ER\_STATUS when engine running test is not

active.

- ER\_INIT = Value for state of ER\_STATUS when engine running test first

inits.

- ER\_LAM\_BAS = Base value for LAMBSE requested during engine running

on-demand test, unitless.

- ER\_SPARK\_BAS = Base value for Spark advance during engine running

on-demand test, degrees.

- KOER\_MINMPH = Minimum vehicle speed to conduct KOER self test.

- KOER\_TST\_TM = Maximum ammount of time that KOER can run, sec.

- PURG\_ER\_DONE = Value for state of ER\_STATUS to indicate that the engine

running purge test is complete.

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PURG\_ER\_INIT = Value for state of ER\_STATUS to request the engine running

purge test.

- SAIR\_ER\_DONE = Value for state of ER\_STATUS to indicate that the engine

running secondary air test is complete.

- SAIR\_ER\_INIT = Value for state of ER\_STATUS to request the engine running

secondary air test.

- TRLOAD = Transmission Load;

0 -> Manual Transmission, no clutch or gear switches,

forced neutral state (NDSFLG = 0),

1 -> Manual Transmission, no clutch or gear switch,

2 -> Manual Transmission, one clutch or gear switch,

3 -> Manual Transmission, both clutch and gear switches,

4 -> Auto Transmission, non-electronic, neutral drive switch,

5 -> Auto Transmission, non-electronic, neutral pressure switch

(AXOD),

6 -> Auto Transmission, electronic, PRNDL sensor - park,

reverse, neutral, overdrive, manual 1, manual 2.

- V\_ISC\_HI\_DLY = Time delay to allow RPM to reach minimum value for engine

running on-demand test, seconds.

- V\_ISC\_HI\_MIN = Minimum RPM to pass High RPM portion of engine running

on-demand test.

- V\_ISC\_LO\_DLY = Time delay to allow RPM to return to normal idle before

testing ISC duty cycle, seconds.

- V\_ISC\_LO\_TIM = Time delay to allow ISC to test at low rpm.

OTHER

- P1001 = KOER test did not complete.

- P1131 = Lack of EGO11 switch, EGO indicates lean fault code.

- P1132 = Lack of EGO11 switch, EGO indicates rich fault code.

- P1151 = Lack of EGO21 switch, EGO indicates lean fault filter.

- P1152 = Lack of EGO21 switch, EGO indicates rich fault code.

- P0505 = Inlet air control (Idle speed) system malfunction

- P1501 = Vehicles speed senwor (VSS) out of range during KOER.

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VR\_OBDII\_SEQUENCER\_COM1

This diagram provides for some "bullet proofing" when none of the demand mode

tests are active (engine running, engine off, or output test mode).

DEMAND\_MODE = 0 ------------------------------| OPER\_RSP\_CHK = 0

(None of the on-demand tests are activated | MIS\_ER\_ENA = 0

by the OBD-II exec) | CCM\_ER\_ENA = 0

| ISC\_ER\_ENA = 0

| ER\_ISC\_REQ := 0

| ER\_ISC\_HLD = 0

| ER\_SPK\_REQ := 0

| ER\_FUL\_REQ := 0

| (discontinue all requests

| for engine running on-

| demand parameters.)

Check status of vehicle to be in vehicle running mode.

unconditionally ------------------------| ER\_CONDTS := 0

; reset flag before testing

UNDSP = 1 ------------------------------| ER\_CONDTS := 1

TRLOAD => 3 ----------------------|

|

NDSFLG = 1 -----------------------|AND -| ER\_CONDTS := 1

| | store\_code(ccm,P1705)

ER\_ACTIVE = 1 --------------| | |

|OR --|

ER\_TST\_ENA = 1 -------| |

|AND -|

ER\_ACTIVE = 0 --------|

VSBAR > KOER\_MINMPH --------------|

|AND -| ER\_CONDTS := 1

ER\_ACTIVE = 1 --------------| | | store\_code(ccm,P1501)

|OR --| |

ER\_TST\_ENA = 1 -------| |

|AND -|

ER\_ACTIVE = 0 --------|

IMFMFLG = 1 ----------------------|

|

ER\_ACTIVE = 0 --------------------|AND -| ER\_CONDTS := 1

| | store\_code(ccm,P1101)

ER\_TST\_ENA = 1 -------------------|

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

This diagram detects if an abort has been requested (either by the OBD-II

executive or by this sequencer). If an abort has been initiated, this

diagram will insure that it is completed and then send the appropriate

response on the SCP interface to the diagnostic tools.

DEMAND\_ABORT = 1 -----------------------|

(abort requested) |

|

ER\_STATUS = ER\_DONE --------------------|AND -| DEMAND\_ABORT := 0

(abort complete) | | (Abort complete)

| |

ER\_ACTIVE = 1 --------------------------| | ER\_TST\_RDY = 0

| (Abort of engine run test in progress) | | (Abort done, not running

| | | now)

| P1001MALF = false ----------------------| |

| ER\_ACTIVE = 0

| (No longer running test)

|

| ER\_STATUS = ER\_INACTIVE

|

| --- ELSE ---

DEMAND\_ABORT = 1 -----------------------| |

(Abort requested) | |

| |

ER\_STATUS <> EGR\_ER\_INIT ---------------| |

|AND -| ER\_STATUS := ER\_CLEANUP

ER\_STATUS <> EGO\_ER\_INIT ---------------| | (abort of individual test

(Not in the middle of a test that can't| | complete, turn off any

just be bailed out of) | | flags that may be set

| | via ER\_CLEANUP.)

| ER\_STATUS <> ER\_DONE -------------------| |

| | |

ER\_ACTIVE = 1 --------------------------| |

(Abort of engine run test in progress) |

| --- ELSE ---

|

| no action

| (abort not requested or

| abort requested but not

| yet complete, business as

| usual)

BEGIN: koer\_test\_timer\_logic:

;to be executed once per background loop.

ER\_ACTIVE = 1 --------------------------|

|

ER\_TST\_ENA = 1--------------------------|AND -| store\_code(P1001)

| | DEMAND\_ABORT := 1

| KOER\_TST\_TMR >= KOER\_TST\_TM ------------| | ;test running too long

| ; abort test and store code

|

| --- ELSE ---

ER\_TST\_ENA = 0 -------------------------| |

|OR --| KOER\_TST\_TMR := 0

ER\_ACTIVE = 0 --------------------------|

END: koer\_test\_timer\_logic:

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

This (long) diagram first determines if the engine off on-demand test is able

to and should be running now. And, once activated, the test sequence is

controlled by this diagram.

DEMAND\_ABORT = 1 -----------------------|

(an abort is in progress) |AND -| no action.

| | (some other test is in

ER\_ACTIVE = 0 --------------------------| | the process of aborting,

(engine running is not the test aborting) | just sit tight and wait.)

|

| --- ELSE ---

DEMAND\_ABORT = 0 -----------------------| |

(Abort not in progress yet) | |

|AND -| DEMAND\_ABORT := 1

ER\_ACTIVE = 1 --------------------| | | (Test no longer able to run,

(test in progress) | | | time to bail out...)

|AND -| |

ER\_TST\_ENA = 0 -------------| | | ER\_TST\_RDY := 1

(test not enabled by exec) |OR --| | (abort in progress)

| |

ER\_CONDTS = 1 --------------| | (The test was running and

; conditions not met | either the OBD-II exec

: to be in KOER | cancelled the test or the

| local conditions (engine in

| run mode, vehicle stopped

| were violated)

|

| --- ELSE ---

DEMAND\_ABORT = 0 -----------------------| |

| |

ER\_ACTIVE = 0 --------------------------| |

(test not in progress) |AND -| ER\_TST\_RDY := 0

| | ER\_MON :=1

| | (For some strange reason,

ER\_TST\_ENA = 1 -------------------------| | the test is enabled by

(test enabled by exec) | | the exec but can not now

| | run. Don't start.)

ER\_CONDTS = 1 --------------------------| | (This is not an abort

| because the test was not

| in progress the last

| background loop.)

|

| --- ELSE ---

(continued on next page)

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

DEMAND\_ABORT = 0 -----------------------| |

(Abort not requested) | |

| |

ER\_TST\_ENA = 0 -------------------------| |

(test not enabled by OBD-II exec) |AND -| ER\_STATUS := ER\_INACTIVE

| |

CRKFLG = 0 -----------------------------| | ER\_TST\_RDY := 1

| | (Signal OBD-II exec that

UNDSP = 0 ------------------------------| | ER test could run if

(run mode) | enabled)

|

| ER\_ACTIVE = 0

| (test not active)

|

| (test is not running, but

| could be if enabled)

|

| --- ELSE ---

DEMAND\_ABORT = 0 -----------------------| |

(Abort not requested) |AND -| ER\_STATUS := ER\_INACTIVE

| |

ER\_TST\_ENA = 0 -------------------------| | ER\_TST\_RDY := 0

(test not enabled) | (test is not currently

(note that any subsequent logic in this | enabled by OBD-II and is

chart will execute only if the ER is | not ready to run, exit.)

enabled by OBD-II exec. and is able to |

run, or an abort is in progress.) | ER\_ACTIVE = 0

| (test not active)

|

| --- ELSE ---

(continued on next page)

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

ER\_STATUS = ER\_INACTIVE ----------------------| ER\_STATUS := ER\_INIT

(test not yet started) | (setup to start test)

| ER\_ACTIVE = 1

| (test now active)

|

| ER\_RPM := ER\_HI\_RPM

| ER\_ISC\_REQ := 1

| (ER control of idle speed,

| DSDRPM = ER\_RPM)

|

| ER\_SPARK := ER\_SPARK\_BAS

| ER\_SPK\_REQ := 1

| (Request ER\_SPARK

| from Spark Strategy)

|

| ER\_LAM\_DSD1 := ER\_LAM\_BAS

| ER\_LAM\_DSD2 := ER\_LAM\_BAS

| ER\_FUL\_REQ := 1

| (Request ER\_LAM\_DSD

| from fuel strategy)

|

| OSM\_EDF\_ON = 1

| (request low speed fan to

| avoid overheating but

| remain at a constant load)

|

| DEMAND\_TIMER := 0

| (reset for next user)

|

| KOER\_TST\_TMR := 0

| ; clear test limit timer

|

| | Do: erase\_code(P1001)

| | ; clear test time-out code

| |

| --- ELSE ---

(continued on next page)

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

ER\_STATUS = ER\_INIT --------------------------| ER\_STATUS := ISC\_HI\_WAIT

|

| CCM\_ER\_ENA = 1

| (Enable CCM test)

|

| --- ELSE ---

ER\_STATUS = ISC\_HI\_WAIT ----------------| |

|AND -| ER\_STATUS := ISC\_HI\_CHECK

DEMAND\_TIMER > V\_ISC\_HI\_DLY ------------| |

(enough time has passed for ISC to ramp up) | (Check RPM, if ok, continue

| with test. Else exit.)

|

| --- ELSE ---

|

ER\_STATUS = ISC\_HI\_WAIT ----------------------| ER\_STATUS := ISC\_HI\_WAIT

| (Just sit tight, wait for

| time delay, allow

| DEMAND\_TIMER to run)

|

| --- ELSE ---

ER\_STATUS = ISC\_HI\_CHECK ---------------| |

|AND -| ER\_STATUS := ISC\_HI\_DONE

NBAR > V\_ISC\_HI\_MIN --------------------| | (Continue with ER test.)

|

| --- ELSE ---

|

ER\_STATUS = ISC\_HI\_CHECK ---------------------| ER\_STATUS := ER\_CLEANUP

(RPM did not come up OK) | (Bail out time.)

|

| store\_code(P0505)

| (set code indicating

| inadequate ISC)

|

| --- ELSE ---

|

ER\_STATUS = ISC\_HI\_DONE ----------------------| ER\_STATUS := EGR\_ER\_INIT

|

| DEMAND\_TIMER := 0

| (reset for next user)

|

| --- ELSE ---

(continued on next page)

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

ER\_STATUS = EGR\_ER\_DONE ----------------------| ER\_STATUS := ISC\_HI\_WAIT2

|

| DEMAND\_TIMER := 0

| (reset for next user)

|

| ER\_RPM := ER\_HI\_RPM

| ER\_ISC\_REQ := 1

| (ER control of idle speed,

| DSDRPM = ER\_RPM)

|

| --- ELSE ---

ER\_STATUS = ISC\_HI\_WAIT2 ---------------| |

|AND -| ER\_STATUS := EGO\_ER\_INIT

DEMAND\_TIMER > V\_ISC\_HI\_DL2 ------------| |

(enough time has passed for ISC settle) | (RPM has had a chance to

| settle after EGR test.)

|

| ER\_ISC\_HLD = 1

| (Freeze ISC duty cycle)

|

| ER\_LAM\_DSD1 := ER\_LAM\_BAS

| ER\_LAM\_DSD2 := ER\_LAM\_BAS

|

| DEMAND\_TIMER := 0

| (reset for next user)

|

| --- ELSE ---

ER\_STATUS = EGO\_ER\_DONE ----------------| |

| |

P1131MALF = 0 --------------------------| |

| |

P1132MALF = 0 --------------------------|AND -| ER\_STATUS := SAIR\_ER\_INIT

| | ER\_LAM\_DSD1 := ER\_LAM\_BAS

P1151MALF = 0 --------------------------| | ER\_LAM\_DSD2 := ER\_LAM\_BAS

| | ER\_FUL\_REQ := 1

P1152MALF = 0 --------------------------| | (Request ER\_LAM\_DSD

(no upstream HEGO faults) | from fuel strategy)

| ER\_ISC\_HLD := 0

| DEMAND\_TIMER := 0

| (reset for next user)

|

| MIS\_ER\_ENA = 1

| (Enable misfire test)

|

| --- ELSE ---

|

(continued on next page)

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

ER\_STATUS = EGO\_ER\_DONE ----------------------| ER\_STATUS := PURG\_ER\_DONE

(ego fault detected) | ;skip secondary air and

| ; purge tests in the

| ; event of an EGO

| ; failure)

|

| DEMAND\_TIMER := 0

| (reset for next user)

|

| MIS\_ER\_ENA = 1

| (Enable misfire test)

|

| --- ELSE ---

|

ER\_STATUS = SAIR\_ER\_DONE ---------------------| ER\_STATUS := PURG\_ER\_INIT

|

| ER\_ISC\_REQ := 0

| ER\_FUL\_REQ := 0

|

| DEMAND\_TIMER := 0

| (set up for time delay)

|

| --- ELSE ---

|

ER\_STATUS = PURG\_ER\_DONE ---------------------| ER\_STATUS := ISC\_LO\_WAIT

|

| DEMAND\_TIMER := 0

| (set up for time delay)

| ER\_ISC\_HLD := 0

| ER\_ISC\_REQ := 0

| ER\_SPK\_REQ := 0

| ER\_FUL\_REQ := 0

| (normal ISC control)

|

| --- ELSE ---

(continued on next page)

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

ER\_STATUS = ISC\_LO\_WAIT ----------------| |

|AND -| ER\_STATUS := ISC\_LO\_CHECK

DEMAND\_TIMER > V\_ISC\_LO\_DLY ------------| |

(enough time has passed for ISC to | DEMAND\_TIMER := 0

ramp down) | (reset for next user)

|

| --- ELSE ---

|

ER\_STATUS = ISC\_LO\_WAIT ----------------------| ER\_STATUS := ISC\_LO\_WAIT

| (Just sit tight, wait for

| time delay, allow

| DEMAND\_TIMER to run)

|

| --- ELSE ---

ER\_STATUS = ISC\_LO\_CHECK --------------| |

|AND -| ER\_STATUS := ISC\_LO\_DONE

DEMAND\_TIMER > V\_ISC\_LO\_TIM ------------| | (Continue with ER test.)

(enough time has passed for ISC to |

test) | ISC\_ER\_ENA := 0

| (done testing ISC duty

| cycle)

|

| --- ELSE ---

|

ER\_STATUS = ISC\_LO\_CHECK ---------------------| ER\_STATUS := ISC\_LO\_CHECK

| (wait for test to run)

| ISC\_ER\_ENA := 1

| (test ISC duty cycle)

|

| --- ELSE ---

|

ER\_STATUS = ISC\_LO\_DONE ----------------------| ER\_STATUS := ER\_CLEANUP

|

| ISC\_ER\_ENA = 0

| (End ISC test)

|

| OPER\_RSP\_CHK = 1

| (Check BOO, PSPS, etc.

| on/off flags)

|

| --- ELSE ---

(continued on next page)

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ENGINE RUNNING SELF TEST, ENGINE RUNNING SEQUENCE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

ER\_STATUS = ER\_CLEANUP -----------------------| ER\_STATUS := ER\_DONE

|

| OPER\_RSP\_CHK = 0

| (End check of BOO, etc.

| on/off flags)

|

| MIS\_ER\_ENA = 0

| (End misfire test)

|

| CCM\_ER\_ENA = 0

| (End CCM test)

|

| ISC\_ER\_ENA = 0

| (End ISC test)

|

| ER\_ISC\_REQ := 0

| (end control of idle speed)

|

| ER\_ISC\_HLD = 0

| (Unfreeze ISC duty cycle)

|

| ER\_SPK\_REQ := 0

| (End request for ER\_SPARK

| from Spark Strategy)

|

| ER\_FUL\_REQ := 0

| (End request for

| ER\_LAM\_DSD from fuel

| strategy)

|

| OSM\_EDF\_ON = 0

| (End request for

| low speed fan)

|

| --- ELSE ---

|

ER\_STATUS = ER\_DONE --------------------------| ER\_STATUS = ER\_INACTIVE

| (done with test)

|

| ER\_MON = 1

| (signal exec, monitor

| complete)

|

| | DEMAND\_ABORT := 0

| | ; make sure DEMAND\_ABORT

| | ; is reset if KOER timer

| | ; causes abort.

| |

| ER\_ACTIVE = 0

| (No longer running test)

|

| --- ELSE ----

|

| (no action, ER\_STATUS

| under control of a test)

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CHAPTER 24

AIR CHARGE CALCULATION

24-1

AIR CHARGE CALCULATION

24.1 FEATURE: AIR CHARGE - V3.1\_AIR\_CHARGE\_97\_IMRC (CDAM0)

24.1.1 AIRMETER OVERVIEW (CDAM0)

OVERVIEW

Shown below is the relationship between modules used in calculating

aircharge.

The Air Charge Background Calculation module, executed in the background,

calculates variables which do not change rapidly such as those based on RPM,

ECT, ACT, etc. The Air Meter Background FMEM module is also executed in the

background to set relevant flags in case of faulty air meter. (In the OBDII

strategy, self tests are also carried out in this module.)

In the foreground, the SAMPLE AIR METER and the Air Meter Foreground FMEM

modules are executed. Depending on the setting of the switch AIR\_DOWN\_CAL,

the SAMPLE AIRMETER module will trigger the rest of the aircharge

calculations on either the up or down edge of PIP. This includes the

manifold filling, anticipation, and final aircharge modules. The final value

used by the rest of the strategy is CYL\_AIR\_CHG. AIR\_CHG\_ST is calculated

separately for use by self test. The MFMFLG flag is also exported for use in

other modules.

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AIR CHARGE CALCULATION, AIRMETER OVERVIEW - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: AIR\_OVERVIEW\_COM2

Foreground Background

|----------------------------| |---------------------------------|

+---------------+ IMFMCTR +---------------+

| AIRMETER FMEM |---IMFMFLG----->| AIRMETER FMEM |-->MFMFLG

| Foreground |-----+----------| Background |

+---------------+ | +---------------+

IMFMFLG |

|---------------| V\_MAF\_ER\_FLG

| |

V V

+----------------+ +---------------+

| SAMPLE | | AIRCHARGE |

AIR\_CHG\_ST<---| AIRMETER |<--- AIR\_CHG\_LEAK -----| BACKGROUND |

| CALCULATION | CYLARC\_BG | CALCULATIONS |

+----------------+ +---------------+

| | | |

+- AIR\_CHG\_PRV | | |

| +--------- AIR\_CHG\_CUR | |

| | V | |

| | +----------------+ AIR\_CHG\_WOT | |

| | | MANIFOLD | AIR\_B3\_N | |

| | | FILLING |<--- AIR\_NUM\_MULT ------+ |

| | | | MAP\_AIR\_0 |

| | +----------------+ ARCHFLG |

| | | AIR\_BG\_FIL |

+----|---|-------- AIR\_CHG AIR\_BF\_FLG |

| | | AIR\_K\_OLD |

| | | V |

| | | +----------------+ |

| | +--->| ANTICIPATION | |

| +------->| | |

| | +----------------+ |

| | | |

| | air\_ant |

| | V |

| | +----------------+ |

+----|------->| FINAL | |

| | AIRCHARGE |<--- AIR\_WOT\_ANT -----------------+

+------->| | AIR\_CHG\_WOT

+----------------+

|

CYL\_AIR\_CHG

|

V

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AIR CHARGE CALCULATION, SAMPLE AIRMETER CALCULATION - CDAN2

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24.1.2 SAMPLE AIRMETER CALCULATION (CDAG0)

OVERVIEW

This module samples the signal produced by the mass air flow meter and

converts the flow rate data to air mass. The air meter signal is sampled at

each PIP edge, to obtain data when the engine is running, and once per

background loop, to obtain data when the engine is not running. Sampling

once per background loop does not interfere with the PIP interrupt sampling.

DEFINITIONS

INPUTS

Registers:

- AIR\_CHG\_COMP = Un-metered air charge past the throttle, lbm/intake

stroke.

- AIR\_CHG\_CUR = Air meter air charge, lbm/intake stroke.

- AIR\_CHG\_ST = Air charge measured at the air meter, including leaking

compensation, lbm/intake stroke.

- AIR\_PIP\_CNT = Counter incremented every PIP edge to determine if the MAF

integration is valid, PIP edges.

- AM\_INT\_CUR\_X = Integrated air mass computed at the current PIP edge, lbm.

- AM\_INT\_PRV\_X = Integrated air mass computed at the previous PIP edge,

lbm.

- CYLARC\_BG = Background-calculated cylinder air charge, lbm/intake stroke.

- DATA\_TIME = Time of current PIP edge, clock ticks.

- IMAF = Sampled air mass flow rate, counts.

- INTM = Time interval between the current air mass integration and the

previous air mass integration, ticks.

- MAF = Sampled air mass flow rate, lbm/tick.

- MAF\_TIME = Time of current air meter sample, clock ticks.

- TSLPIP = Amount of time which has passed since the last PIP interrupt,

msec.

Bit Flags:

- BGACFLG = Flag indicating cylinder air charge is background-derived; 1 ->

background-derived, unitless.

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AIR CHARGE CALCULATION, SAMPLE AIRMETER CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PIP\_HIGH = State of PIP transition; 1 -> low-to-high transition,

unitless.

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AIR CHARGE CALCULATION, SAMPLE AIRMETER CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- AIR\_DOWN\_CAL = Switch indicating when to perform the cylinder air charge

calculation; 0 -> calculate on PIP up edges, 1 -> calculate on PIP down

edges, unitless.

- FN036I(IMAF) = Air meter transfer function (A/D counts to lbm/tick),

lbm/tick.

OUTPUTS

Registers:

- AIR\_CHG\_CUR = See above.

- AIR\_CHG\_PRV = Air meter air charge last PIP period, lbm/intake stroke.

- AIR\_CHG\_ST = See above.

- AIR\_PIP\_CNT = See above.

- AM\_INT\_CUR\_X = See above.

- AM\_INT\_PRV\_X = See above.

- IMAF = See above.

- INTM = See above.

- MAF = see above.

- MAF\_TIME = See above.

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AIR CHARGE CALCULATION, SAMPLE AIRMETER CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: AIR\_SAMPLE\_METER\_COM5

BEGIN: air\_sample\_main

;This process is called at each PIP edge interrupt (both low-to-high and

;high-to-low transitions).

Perform an A-to-D conversion on the air meter signal.

unconditionally --------------------| IMAF := A-to-D measurement of air mass

| flow

|

| MAF := FN036I(IMAF)

Integrate, using the sampled value of air flow rate, to determine the air

mass which passed through the air meter during the current half PIP period.

unconditionally --------------------| INTM := DATA\_TIME - MAF\_TIME(old)

| MAF\_TIME := DATA\_TIME

|

| AM\_INT\_PRV\_X := AM\_INT\_CUR\_X(old)

| ;previous integrated air mass value

|

| AM\_INT\_CUR\_X := MAF \* INTM

| ;current integrated air mass value

Increment the PIP edge counter.

unconditionally --------------------| AIR\_PIP\_CNT := AIR\_PIP\_CNT + 1

| ;clip at 255

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AIR CHARGE CALCULATION, SAMPLE AIRMETER CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Sum the current and previous integrated air mass values to determine the air

mass which passed through the air meter during the current full PIP period.

This summation may be performed on either PIP up edges or down edges.

AIR\_PIP\_CNT >= 3 -------------|

;integration ok |

|

AIR\_DOWN\_CAL = 0 -------------|AND -| Do: air\_charge\_calculation

;calculate on up edges | | ;up edge timing

| |

PIP\_HIGH = 1 -----------------| |

| --- ELSE ---

AIR\_PIP\_CNT >= 3 -------------| |

;integration ok | |

| |

AIR\_DOWN\_CAL = 1 -------------|AND -| Do: air\_charge\_calculation

;calculate on down edges | | ;down edge timing

| |

PIP\_HIGH = 0 -----------------| |

| --- ELSE ---

|

| NO ACTION

END: air\_sample\_main

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AIR CHARGE CALCULATION, SAMPLE AIRMETER CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: air\_charge\_calculation

;This process is executed only when explicitly called.

Sum the previous half PIP period air mass, the current half PIP period air

mass, and the estimated unmetered air mass.

unconditionally --------------------| AIR\_CHG\_ST := AM\_INT\_PRV\_X +

| AM\_INT\_CUR\_X +

| AIR\_CHG\_COMP

BGACFLG = 1 ------------------------| AIR\_CHG\_PRV := CYLARC\_BG

;use background air charge | AIR\_CHG\_CUR := CYLARC\_BG

|

| --- ELSE ---

|

| AIR\_CHG\_PRV := AIR\_CHG\_CUR(old)

| AIR\_CHG\_CUR := AIR\_CHG\_ST

END: air\_charge\_calculation

BEGIN: air\_sample\_bg

;This process is executed once per background loop.

The mass air flow sensor signal is sampled here to ensure that accurate air

flow data is available in the absence of PIP interrupts (e.g. when the

engine is not running). This is especially important for diagnostic and

service related functions.

Perform an A-to-D conversion on the air meter signal.

TSLPIP > 1000 ----------------------| IMAF := A-to-D measurement of air mass

;more than 1 sec since | flow

;last PIP interrupt |

| MAF := FN036I(IMAF)

END: air\_sample\_bg

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AIR CHARGE CALCULATION, MAF FMEM - FOREGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

24.1.3 MAF SENSOR FMEM - FOREGROUND (CDAM0)

OVERVIEW

During the analog to digital conversion of the air meter signal (at each PIP

interrupt), a quick check is made to determine if the air meter signal is

within acceptable limits. If the digital value is outside the acceptable

range, the foreground FMEM flag, IMFMFLG, is set. Although this flag is set

in foreground, it is cleared only in the background, when a counter, IMFMCTR,

is decremented from MFMHYS to zero.

DEFINITIONS

INPUTS

Registers:

- IMAF = Raw A/D value read at the MAF sensor, counts.

- N = Engine speed, rpm.

Bit Flags:

- MFMFLG = Flag indicating that MAF sensor has failed, set in background.

Calibration Constants:

- MAF\_HI\_ER = Maximum MAF sensor reading, counts.

- MAF\_LO\_ER = Minimum MAF sensor reading, counts.

- MAF\_RPM\_MAX = Maximum RPM for checking MAF sensor high limit.

- MFMHYS = Calibration for IMFMFLG background loop hysteresis, counts.

OUTPUTS

Registers:

- IMFMCTR = Provides hysteresis for IMFMFLG, background loop counter,

counts.

- IMAF = See above.

Bit Flags:

- IMFMFLG = Instantaneous mass air flow sensor FMEM flag, set in

foreground.

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AIR CHARGE CALCULATION, MAF FMEM - FOREGROUND - CDAN2

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PROCESS

STRATEGY MODULE: AIR\_FMEM\_OBDII\_FG\_COM1

This logic is performed during the MAF sensor engineering units conversion

(PIP interrupt) and checks if the sensor reading is within limits.

MFMFLG = 1 ------------------------|

(Failure set in background) |

|

IMAF < MAF\_LO\_ER ------------------|

(Output below minimum voltage) |OR --| IMFMFLG = 1

| | (Set foreground MAF failure flag)

N < MAF\_RPM\_MAX -------------| | | IMFMCTR = MFMHYS

(RPM not to high for max | | | (Start countdown counter for

voltage check (MAF\_HI\_ER)) |AND -| | FMEM exit delay)

| |

IMAF > MAF\_HI\_ER ------------| |

(Above maximum sensor voltage) |

| --- ELSE ---

|

| (MAF Sensor output

| within limits, no action.

| Note: IMFMFLG is cleared in

| logic below when IMFMCTR

| decrements to zero.)

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AIR CHARGE, MANIFOLD FILLING MODEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

24.1.4 MANIFOLD FILLING MODEL (CDAM0)

OVERVIEW

Air flow into the engine is measured at a location upstream of the intake

manifold. At a given instant in time, an air charge calculated from this

measurement may differ considerably from the air charge actually being

inducted into the cylinder. The differences are caused by intake manifold

dynamics. This logic filters the measured air charge to account for these

dynamics. The air charge value produced represents the air mass inducted

into the cylinder.

A filter coefficient is calculated in the foreground based on engine

displacement volume, intake manifold volume, and engine volumetric

efficiency. Adjustments for the effects of changes in ACT, ECT, BP, and N

are made once per background loop.

Filter coefficients calculated in the background are used, or can be used, at

idle, during cranking, or when the air meter signal is not reliable to

improve stability. Use of a large filter coefficient enhances stability by

richening the mixture slightly when the engine speed decreases.

DEFINITIONS

Registers:

- AIR\_BG\_FIL = Background-derived filter coefficient, unitless.

- AIR\_B3\_N = Slope of MAP vs. air charge, inches Hg/(lbm/intake stroke).

- AIR\_CHG = Air charge after the manifold filling model (i.e. filtered air

charge), lbm/intake stroke.

- AIR\_CHG\_CUR = Air charge measured at the air meter, lbm/intake stroke.

- AIR\_CHG\_WOT = Maximum acceptable value of cylinder air charge, lbm/intake

stroke.

- AIR\_FK = Filter coefficient for the manifold filling model, unitless.

- AIR\_FK\_LAST = Previous value of the filter coefficient, unitless.

- AIR\_K\_OLD = Previous value of the foreground-derived filter coefficient,

unitless.

- AIR\_NUM\_MULT = ECT, ACT, and manifold volume factor for manifold filling,

inches Hg/(lbm/intake stroke).

- MAP\_AIR\_0 = MAP at 0 air charge, including BP correction, inches Hg.

Bit Flags:

- AIR\_BF\_FLG = Flag indicating operation in the air meter backflow region;

1 -> in backflow region, unitless.

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AIR CHARGE, MANIFOLD FILLING MODEL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- ARCHFLG = Flag indicating the background-derived filter coefficient

should be used; 0 -> use background-derived coefficient, unitless.

Calibration Constants:

- AIR\_DEC\_MUL = Filter coefficient multiplier for use during decelerations,

unitless.

- FILFRC = Ratio of unfiltered air charge to filtered air charge below

which the deceleration multiplier AIR\_DEC\_MUL is applied, unitless.

- FILFRC\_IN = Ratio of unfiltered air charge to filtered air charge above

which a throttle tip-in is assumed to have occurred, unitless.

Other

- air\_chg = Temporary, unclipped value of filtered air charge, lbm/intake

stroke.

- air\_k\_base = Temporary, foreground-derived filter coefficient, unitless.

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AIR CHARGE, MANIFOLD FILLING MODEL - CDAN2

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PROCESS

STRATEGY MODULE: AIR\_MANIFOLD\_FILL\_COM3

Determine the foreground-calculated filter coefficient:

unconditionally -----------| air\_k\_base := AIR\_NUM\_MULT /

| [AIR\_B3\_N + (MAP\_AIR\_0/AIR\_CHG(old))]

Select the appropriate filter coefficient.

If a large increase in air charge at the flow meter is detected, switch

immediately from the special idle filter coefficient to the

foreground-calculated coefficient. Waiting for the background loop to

recognize the change may produce large overshoots in air charge due to the

light filtering in idle mode.

A significant decrease in the air charge at the flow meter indicates a

throttle tip-out. When this occurs, apply a tip-out multiplier to reduce the

filtering effect.

ARCHFLG = 0 --------------------------|

;background loop request for |

;background-calculated filter |AND --| ;idle mode or no filter

;coefficient | |

| | AIR\_FK := AIR\_BG\_FIL

(AIR\_CHG\_CUR/AIR\_CHG) < FILFRC\_IN ----| | AIR\_FK\_LAST := AIR\_BG\_FIL

;no large air charge increase |

;indicative of throttle tip-in |

| --- ELSE ---

|

(AIR\_CHG\_CUR/AIR\_CHG) <= FILFRC -------------| ;throttle tip-out mode

;significant air charge decrease |

;indicative of throttle tip-out | AIR\_FK := air\_k\_base \*

| AIR\_DEC\_MUL

| AIR\_FK\_LAST := AIR\_K\_OLD \*

| AIR\_DEC\_MUL

|

| --- ELSE ---

|

| ;normal mode

|

| AIR\_FK := air\_k\_base

| AIR\_FK\_LAST := AIR\_K\_OLD

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AIR CHARGE, MANIFOLD FILLING MODEL - CDAN2

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Calculate the filtered air charge:

AIR\_FK <> 0 ----------------------|

|AND -| air\_chg = ((AIR\_FK/AIR\_FK\_LAST)

AIR\_FK\_LAST <> 0 -----------------| | \* (1 - AIR\_FK)

;avoid dividing by zero | \* AIR\_CHG(old))

| + (AIR\_FK \* AIR\_CHG\_CUR)

|

| --- ELSE ---

|

| air\_chg = AIR\_CHG(old)

Store the value of the foreground-calculated filter coefficient for use in

the next pass so that the volumetric efficiency differences from one pass to

the next can be compensated for:

unconditionally -------------------------| AIR\_K\_OLD := air\_k\_base

Clip over-estimates of air charge caused by backflow past the air meter:

air\_chg > AIR\_CHG\_WOT -------------|

;greater than maximum |

;possible charge |AND -| AIR\_CHG := AIR\_CHG\_WOT

| |

AIR\_BF\_FLG = 1 --------------------| |

;in backflow region |

| --- ELSE ---

|

| AIR\_CHG := air\_chg

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AIR CHARGE CALCULATION, AIR CHARGE ANTICIPATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

24.1.5 AIR CHARGE ANTICIPATION (CDAM0)

OVERVIEW

To make up for fuel scheduling delays, aircharge anticipation is used to

predict what the aircharge will be two events in the future.

Assumptions and description of anticipation equation:

- Assumption #1

Straight line increase in AIR\_CHG\_CUR for next event, i+1, then stays at

that level for the i+2 event.

throttle | |

aircharge| | \* \*

| \*

| \* |

+---+-----+-----+-----+-------

time i-1 i i+1 i+2

AIR\_CHG\_CUR(i+1) = AIR\_CHG\_CUR(i) + AIR\_CHG\_CUR(i) - AIR\_CHG\_CUR(i-1)

AIR\_CHG\_CUR(i+2) = AIR\_CHG\_CUR(i+1)

- Assumption #2

Filling coefficient remains the same for the next two events.

AIR\_FK(i+1) = AIR\_FK(i)

AIR\_FK(i+2) = AIR\_FK(i)

Using the manifold filling model, the equations for the current intake event

and next two events can be written as follows:

AIR\_CHG(i) = AIR\_FK \* AIR\_CHG\_CUR(i)

+ [(AIR\_FK(i)/AIR\_FK(i-1) \* (1-AIR\_FK(i)) AIR\_CHG(i-1)]

AIR\_CHG(i+1) = AIR\_FK(i+1) \* AIR\_CHG\_CUR(i+1)

+ [(AIR\_FK(i+1)/AIR\_FK(i) \* (1-AIR\_FK(i+1)) AIR\_CHG(i)]

AIR\_CHG(i+2) = AIR\_FK(i+2) \* AIR\_CHG\_CUR(i+2)

+ [(AIR\_FK(i+2)/AIR\_FK(i+1) \* (1-AIR\_FK(i+2)) AIR\_CHG(i+1)]

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AIR CHARGE CALCULATION, AIR CHARGE ANTICIPATION - CDAN2

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The preceding equations are then simplified to reach the final form of the

equation shown in the strategy process. The solution is shown below.

EEC notation:

air\_thr\_bod = AIR\_CHG\_CUR(i+1) = AIR\_CHG\_CUR(i+2) = AIR\_CHG\_CUR(i)

+ AIR\_CHG\_CUR(i)

- AIR\_CHG\_CUR(i-1)

AIR\_FK = AIR\_FK(i)= AIR\_FK(i+1) = AIR\_FK(i+2)

nxt\_arch\_2x = AIR\_CHG(i+2)

Solve the equations to obtain the aircharge two events in the future.

The filling model output is AIR\_CHG(i)

|

+--------------------+

|substitute

AIR\_CHG(i+1) = AIR\_FK \* air\_thr\_bod v

| + [(AIR\_FK/AIR\_FK \* (1-AIR\_FK) \* AIR\_CHG(i)]

|

+-----------------------------------------------+

|substitute

nxt\_arch\_2x = AIR\_FK \* air\_thr\_bod V

+ [(AIR\_FK/AIR\_FK \* (1-AIR\_FK) \* AIR\_CHG(i+1)]

Simplify to final form:

nxt\_arch\_2x = [(2 - AIR\_FK) \* AIR\_FK \* air\_thr\_bod]

+ [(1 - AIR\_FK) \* (1- AIR\_FK) \* AIR\_CHG(new)]

When AIR\_K\_OLD is used in the anticipation model it contains the latest value

for air\_k\_base. AIR\_FK may contain the idle or no filter.

nxt\_arch\_2x = [(2 - AIR\_K\_OLD) \* AIR\_K\_OLD \* air\_thr\_bod]

+ [(1 - AIR\_K\_OLD) \* (1- AIR\_K\_OLD) \* AIR\_CHG(new)]

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AIR CHARGE CALCULATION, AIR CHARGE ANTICIPATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- AIR\_CHG\_PRV = previous value of AIR\_CHG\_CUR

- AIR\_CHG\_CUR = Aircharge from air meter calculation, lbm.

- AIR\_CHG = Aircharge value after the filling model, lbm.

- AIR\_FK = Manifold filling filter constant.

- AIR\_K\_OLD = Manifold filling base coefficient derived in manifold filling

module.

Calibration Constants:

- ANTICIPATION = Calibration switch to use predicted ARCHG; 0 -> do not use

predicted value, 1 -> use predicted value.

OUTPUTS

Registers:

- air\_ant = Anticipated aircharge, lbm.

PROCESS

STRATEGY MODULE: AIR\_ANTICIPATION\_COM2

air\_thr\_bod = AIR\_CHG\_CUR + AIR\_CHG\_CUR - AIR\_CHG\_PRV

nxt\_arch\_2x = [(2 - AIR\_K\_OLD) \* AIR\_K\_OLD \* air\_thr\_bod] +

[(1 - AIR\_K\_OLD) \* (1- AIR\_K\_OLD) \* AIR\_CHG(new)]

ANTICIPATION = 0 ------------------------| air\_ant = AIR\_CHG

|

| --- ELSE ---

|

| air\_ant = nxt\_arch\_2x

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AIR CHARGE CALCULATION, FINAL CYLINDER AIRCHARGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

24.1.6 FINAL CYLINDER AIRCHARGE (CDAM0)

OVERVIEW

Several intermediate values of air charge are calculated by EEC air charge

strategy before a final result is achieved. This strategy module defines the

final value of air charge to be used by the entire strategy. This value

represents the mass of air in the cylinder and is called CYL\_AIR\_CHG.

An anticipated value of cylinder air charge is often used to compensate for

fueling delays. Under certain conditions however, use of the anticipated

values is inappropriate. Large manifold filling overshoots can produce

excessive anticipation, both positive and negative (i.e. an anticipated

cylinder air charge greater than the maximum possible charge or a large,

rapid drop in cylinder air charge). Under these conditions, alternative

values of air charge, instead of the anticipated value, are assigned to

CYL\_AIR\_CHG. Also, as air charge approachs the maximum possible charge,

anticipation of rapidly changing conditions is no longer required.

DEFINITIONS

INPUTS

Registers:

- AIR\_CHG = Air charge result from manifold filling model, lbm/intake

stroke.

- AIR\_CHG\_PRV = Previous value of air charge at the air meter, lbm/intake

stroke.

- AIR\_CHG\_WOT = Maximum acceptable cylinder air charge, lbm/intake stroke.

- AIR\_WOT\_ANT = Maximum acceptable value for anticipated air charge,

lbm/intake stroke.

- CYL\_AIR\_CHG = Current cylinder air charge, lbm/intake stroke.

OUTPUTS

Registers:

- CYL\_AIR\_CHG = See above.

OTHER

- air\_ant = Anticipated future value of cylinder air charge, lbm/intake

stroke.

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AIR CHARGE CALCULATION, FINAL CYLINDER AIRCHARGE - CDAN2

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PROCESS

STRATEGY MODULE: AIR\_FINAL\_AIRCHARGE\_COM1

AIR\_CHG > AIR\_WOT\_ANT -----------|

;charge is near the maximum |

;possible charge |

|AND -| CYL\_AIR\_CHG := AIR\_CHG

AIR\_CHG\_PRV > AIR\_CHG\_WOT -------| | ;Do not anticipate excessively.

;manifold filling overshoot | | ;Use result from manifold

| | ;filling model.

air\_ant < CYL\_AIR\_CHG[old] ------| |

;anticipating a decrease in |

;cylinder air charge |

| --- ELSE ---

AIR\_CHG\_PRV > AIR\_CHG\_WOT -------| |

;manifold filling overshoot |AND -| CYL\_AIR\_CHG := CYL\_AIR\_CHG[old]

| | ;Do not anticipate excessively.

air\_ant < CYL\_AIR\_CHG[old] ------| | ;Hold current value.

;anticipating a decrease in |

;cylinder air charge |

| --- ELSE ---

|

AIR\_CHG > AIR\_WOT\_ANT -----------------| CYL\_AIR\_CHG := AIR\_CHG

;charge is near the maximum | ;Don't use anticipation value when

;possible charge | ;close to WOT air charge. Use

| ;manifold filling result.

|

| --- ELSE ---

|

air\_ant > AIR\_WOT\_ANT -----------------| CYL\_AIR\_CHG := AIR\_WOT\_ANT

;charge is near the maximum | ;Limit anticipation.

;possible charge |

| --- ELSE ---

|

| CYL\_AIR\_CHG := air\_ant

| ;Use anticipated value

unconditionally -----------------------| Do: FOREGROUND FUEL CALCULATION

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AIR CHARGE CALCULATION, AIR CHARGE BACKGROUND CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

24.1.7 AIR CHARGE BACKGROUND CALCULATIONS (CDAM0)

OVERVIEW

The background portion of the air charge calculations handles calculations

for manifold filling, background filtering values, anticipation and failure

modes. Each is described where it is calculated.

DEFINITIONS

Registers:

- ACT = Air charge temperature, deg F.

- AIR\_BG\_FIL = Background-derived filling coefficient, unitless.

- AIR\_B3\_N = Slope of MAP vs. air charge, inches Hg/(lbm/intake stroke).

- AIR\_CHG = Air charge value after the manifold filling model, lbm/intake

stroke.

- AIR\_CHG\_WOT = Maximum acceptable cylinder air charge, lbm/intake stroke.

- AIR\_NUM\_MULT = ECT, ACT, and manifold volume factor for manifold filling,

inches Hg/(lbm/intake stroke).

- AIR\_WOT\_ANT = Maximum acceptable anticipated air charge, lbm/intake

stroke.

- ATMR1 = Time since engine start, sec.

- BP = Barometric pressure, inches Hg.

- CYL\_AIR\_CHG = Foreground-calculated cylinder air charge, lbm/intake

stroke.

- CYLARC\_BG = Background-calculated cylinder air charge, lbm/intake stroke.

- ECT = Engine coolant temperature, deg F.

- EGRACT = Actual EGR flow rate, percent.

- INF\_MAP = Inferred MAP, inches Hg.

- INF\_MVAC = Inferred manifold vacuum, inches Hg.

- ISCFLG = Idle Speed Control mode register; -1 -> dashpot mode, 0 ->

dashpot preposition, 1 -> closed-loop RPM mode, 2 -> closed-loop lockout

mode, unitless.

- MAP\_AIR\_0 = MAP at 0 air charge, including BP correction, inches Hg.

- N = Engine speed, rpm.

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AIR CHARGE CALCULATION, AIR CHARGE BACKGROUND CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TOTLDST = Total throttle-based load (normalized air charge), unitless.

- TP\_REL = Relative throttle position, counts.

- VBAT = Battery voltage, volts.

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AIR CHARGE CALCULATION, AIR CHARGE BACKGROUND CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- AIR\_BF\_FLG = Flag indicating operation in the air meter backflow region;

1 -> in backflow region, unitless.

- AIR\_CRK\_INT = Flag indicating when to initialize the air registers with a

load-based air charge calculation; 0 -> initialize air registers, 1 ->

registers have already been initialized, unitless.

- ARCHFLG = Flag indicating background-derived filling coefficient; 0 ->

background-derived, unitless.

- ARCHGQ1\_FLG = Flag indicating unacceptable battery voltage; 1 ->

unacceptable voltage, unitless.

- BGACFLG = Flag indicating cylinder air charge is background-derived; 1 ->

background-derived, unitless.

- CRKFLG = Crank mode flag; 1 -> in crank mode, unitless.

- IMFMFLG = Mass Air Flow sensor failure flag; 1 -> failed sensor,

unitless.

- IMRC\_POSN = Flag indicating actual position of Intake Manifold Runner

Control valves; 1 -> valves open, 0 -> valves closed, unitless.

- MAF\_INTP\_FLG = Flag indicating an unreliable MAF signal; 1 -> unreliable

MAF signal, unitless.

- TFMFLG = Throttle position failure mode flag; 1 -> failed TP sensor,

unitless.

- UNDSP = Run/underspeed mode flag; 0 -> run mode, 1 -> underspeed or crank

mode, unitless.

Calibration Constants:

- AIR\_MAN\_VOL = Intake manifold volume for use in manifold filling model,

liters.

- AIR\_STRT = Minimum time since engine start to use special idle filter

coefficient, sec.

- ARCANTCOR = Correction factor for maximum anticipated air charge (must be

less than ARCWOTCOR), unitless.

- ARCHIDLE\_SW = Switch to enable special idle filter; 1 -> use special idle

filter.

- ARCHSW = Manifold filling model select switch; 1 -> use filling model.

- ARCWOTCOR = Correction factor for maximum cylinder air charge (must be

greater than ARCANTCOR), unitless.

- FKARCIDLE = Special idle mode filter coefficient, unitless.

- FN022V(ACT or ECT) = Normalized temperature (ACT and ECT) for use in

FN1052, unitless.

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AIR CHARGE CALCULATION, AIR CHARGE BACKGROUND CALCULATIONS - CDAN2

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- FN040A(N) = Cylinder air charge as a function of engine speed (for MAF

and TP failure management), lbm/intake stroke.

- FN044(TP\_REL) = Normalized relative throttle position, unitless.

- FN052BF(N) = Throttle position above which air meter backflow occurs,

counts.

- FN052BP(BP) = Correction for y-intercept of MAP vs. air charge curve,

unitless.

- FN052C(ECT) = Normalized air charge values for initial cylinder air

charge, unitless.

- FN052M(N) = MAP at 0 air charge, inches Hg.

- FN052N(N) = Slope of MAP vs air charge, inches Hg/(lbm/intake stroke).

- FN059(ACT) = Volumetric efficiency correction factor,

SQRT((ACT+460)/560), unitless.

- FN059T(ACT) = Density correction factor for cylinder air charge,

unitless.

- FN070E(N) = Normalized engine speed, unitless.

- FN1036A(N,TP\_REL) = Normalized engine air charge at sea level, with no

EGR, and IMRC valves closed, unitless.

X = FN070E(N)

Y = FN044(TP\_REL)

- FN1036B(N,TP\_REL) = Normalized engine air charge at sea level, with no

EGR, and IMRC valves open, unitless.

X = FN070E(N)

Y = FN044(TP\_REL)

- FN1052(ACT,ECT) = Volumetric efficiency correction for the manifold

filling model, unitless.

X = FN022V(ACT)

Y = FN022V(ECT)

- MAPPEREGR = Inferred MAP correction factor for ACT sensor location;

MAPPEREGR = 1.00 for ACT measured in the intake manifold,

MAPPEREGR = 1.25 for ACT measured in the air cleaner.

- SARCHG = Standard Air Charge, lbm/intake stroke.

= 4.4256 \* 10e-5 \* (engine size in cubic inches) /

(number of cylinders)

- TPBKFLOWH = Throttle position hysteresis for air meter backflow region,

counts.

- VBMAFMIN = Minimum acceptable battery voltage for reliable air meter

readings, volts.

- VBMAF\_CL = Acceptable battery voltage at which to re-enable use of air

meter readings, volts.

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AIR CHARGE CALCULATION, AIR CHARGE BACKGROUND CALCULATIONS - CDAN2

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OTHER

- adj\_fact = Adjustment factor to account for variations in ACT, ECT, and

BP, unitless.

- air\_wot = Maximum cylinder air charge, lbm/intake stroke.

- throttle\_load = Normalized engine air charge, unitless.

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AIR CHARGE CALCULATION, AIR CHARGE BACKGROUND CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: AIR\_AIRMETER\_BG\_COM3

BEGIN: air\_background\_main

;This process is executed once per background loop.

These are the values required in the foreground portion of the manifold

filling, anticipation, air meter air charge, and final cylinder air charge

modules.

Choose the appropriate throttle-based load.

IMRC\_POSN = 1 -----| throttle\_load = FN1036B(N,top row)

|

| --- ELSE ---

|

| throttle\_load = FN1036A(N,top row)

unconditionally ---| adj\_fact = FN1052(ACT,ECT) \* (BP/29.875) \*

| FN059T(ACT)

|

| air\_wot = throttle\_load \* SARCHG \* adj\_fact

|

| AIR\_WOT\_ANT = air\_wot \* ARCANTCOR

| AIR\_CHG\_WOT = air\_wot \* ARCWOTCOR

| AIR\_NUM\_MULT = (11781.34/AIR\_MAN\_VOL) \*

| FN1052(ACT,ECT)

| AIR\_B3\_N = FN052N(N)

| MAP\_AIR\_0 = FN052M(N) \* FN052BP(BP)

| INF\_MAP = MAP\_AIR\_0 + AIR\_B3\_N \* AIR\_CHG

| \* (1 + MAPPEREGR \* EGRACT/100) /

| FN059(ACT)

| INF\_MVAC = BP - INF\_MAP

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AIR CHARGE CALCULATION, AIR CHARGE BACKGROUND CALCULATIONS - CDAN2

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During low speed operation on some four cylinder applications, the air meter

will over-estimate the engine air flow due to backflow at the air meter.

Under these conditions, the air charge will be estimated based on the total

inferred air charge.

TP\_REL >= FN052BF(N)-----------------| AIR\_BF\_FLG = 1

|

| --- ELSE ---

|

TP\_REL < (FN052BF(N) - TPBKFLOWH) ---| AIR\_BF\_FLG = 0

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AIR CHARGE CALCULATION, AIR CHARGE BACKGROUND CALCULATIONS - CDAN2

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At low system voltages, the air meter looses accuracy. Under these

conditions, it is preferable to use a failure mode value for air charge. The

meter can however be used to some degree even at low system voltages to

measure low air mass flow rates (e.g. during cranking).

VBAT < VBMAFMIN ---------------|

(low battery voltage) |

|AND -|S Q -| ARCHGQ1\_FLG = 1

| |

UNDSP = 0 ---------------------| |

(not in crank or underspeed mode) |

|

VBAT > VBMAF\_CL ---------------------|C

IMFMFLG = 1 -------------------------|

(air meter failed) |

|

ARCHGQ1\_FLG = 1 ---------------------|OR --| MAF\_INTP\_FLG = 1

(low battery voltage) | | (MAF signal unreliable)

| |

AIR\_BF\_FLG = 1 ----------------------| | --- ELSE ---

(in backflow region) |

|

| MAF\_INTP\_FLG = 0

| (MAF signal OK)

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AIR CHARGE CALCULATION, AIR CHARGE BACKGROUND CALCULATIONS - CDAN2

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If the air meter signal is not reliable, the value of cylinder air charge is

based on the total inferred air charge (primarily a function of engine speed

and throttle position). If signals from both the TP and MAF sensors are

unreliable, air charge is estimated as a function of engine speed only.

Calculated manifold filling coefficients are used only if the air meter

signal is good. When the background-derived value of the air charge is used,

the ARCHFLG flag disables manifold filling by setting the filling coefficient

to 1.

Initialization of air charge at start-up is of special interest. A

calibratable load, FN052C(ECT), is converted to air charge. This value is

used until crank mode is exited. After AIR\_STRT seconds the idle filter is

used to enhance stability.

CRKFLG = 1 --------------------------|

|AND -| CYLARC\_BG = FN052C(ECT) \*

AIR\_CRK\_INT = 0 ---------------------| | SARCHG \* (BP/29.875)

| AIR\_CHG = CYLARC\_BG

| CYL\_AIR\_CHG = CYLARC\_BG

| BGACFLG = 1

| AIR\_CRK\_INT = 1

|

| (crank mode initializer)

|

| --- ELSE ---

|

MAF\_INTP\_FLG = 0 --------------------------| CYLARC\_BG = CYL\_AIR\_CHG

(airmeter OK) | BGACFLG = 0

|

| --- ELSE ---

|

TFMFLG = 0 --------------------------------| CYLARC\_BG = TOTLDST \* SARCHG

(TP sensor okay) | \* adj\_fact

| BGACFLG = 1

|

| --- ELSE ---

|

| CYLARC\_BG = FN040A(N)

| \* adj\_fact

| BGACFLG = 1

24-29

AIR CHARGE CALCULATION, AIR CHARGE BACKGROUND CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

When the flag BGACFLG is set, the manifold filling model is essentially

disabled. Filtering coefficients are then assigned so that air charge is

effectively derived directly from the measurement made at the air meter. The

calibration parameter ARCHSW provides the ability to disable the model for

testing purposes.

CRKFLG = 1 --------------------------------| AIR\_BG\_FIL = 0

| ARCHFLG = 0

| (use special crank filter)

|

| --- ELSE ---

ARCHSW = 0 --------------------------| |

|OR --| AIR\_BG\_FIL = 1

BGACFLG = 1 -------------------------| | ARCHFLG = 0

(no filter) | (use BG filter)

|

| --- ELSE ---

ISCFLG >= 1 -------------------------| |

| | AIR\_BG\_FIL = FKARCIDLE

ARCHIDLE\_SW = 1 ---------------------|AND -| ARCHFLG = 0

| | (use special idle filter)

ATMR1 > AIR\_STRT --------------------| |

| --- ELSE ---

|

| AIR\_BG\_FIL = NO CHANGE

| ARCHFLG = 1

unconditionally ---------------------------| Do: AIR LEAKAGE CALCULATION

|

| Do: air\_mafs\_diag\_select

| ;check for sensor failures

| ;

| ;this calls a process external

| ;to this module

END: air\_background\_main

24-30

AIR CHARGE CALCULATION, AIR LEAKAGE CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

24.1.8 AIR LEAKAGE CALCULATION (CDAM0)

OVERVIEW

This module calculates an air charge offset, AIR\_CHG\_COMP, due to unmetered

air flow. The calibration constant ARCHLK is intended to account for flows

due to PCV, CANP, EVR solenoid, etc. The term AIR\_BRK is intended to account

for air flow which occurs when vacuum-assisted brakes are applied or

released. FN123A and FN123E compensate for air meter drifts which correlate

with changes in ambient and engine coolant temperatures, respectively.

DEFINITIONS

Registers:

- ACT = Air charge temperature, deg F.

- AIR\_BRK = Air flow rate from brake booster to intake manifold, lbm/min.

- AIR\_CHG\_COMP = Total unmetered air charge, lbm.

- AIR\_CHG\_CUR = Air charge measured at MAF sensor, lbm.

- ECT = Engine coolant temperature, deg F.

- N = Engine Speed, rpm.

- PG\_AIR = Air flow from canister purge system, lbm/min.

- PG\_DC = Canister purge duty cycle, unitless.

Bit Flags:

- PGM\_RUNNING = Flag indicating that the purge monitor test is running; 1

-> test running.

Calibration Constants:

- ARCHLK = Air flow leakage, lbm/min.

- ENGCYL = Number of intake strokes per engine revolution.

- FN123A(ACT) = Air meter correction for air charge temperature, unitless.

- FN123E(ECT) = Air meter correction for engine coolant temperature,

unitless.

- PG\_DC\_OF = Canister purge duty cycle offset, unitless.

- PG\_LK\_ML = Canister purge valve leakage multiplier, lbm/min.

OTHER

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AIR CHARGE CALCULATION, AIR LEAKAGE CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- pg\_dc = Purge duty cycle, unitless.

- temp\_air = Unclipped, temporary value of air flow rate from brake booster

to intake manifold, lbm/min.

- temp\_chg = Air charge measured by the MAF sensor, lbm.

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AIR CHARGE CALCULATION, AIR LEAKAGE CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: AIR\_AIRLEAK\_COM4

Determine the air flow rate from the brake booster to the intake manifold

when the brakes are applied or released.

unconditionally -----------| Do: air\_compensation\_brake

| ;this calls a process external

| ;to this module

Estimate the flow of air from the canister purge system.

PGM\_RUNNING = 1 -----------| PG\_AIR := 0

;purge monitor is |

;running | --- ELSE ---

|

| pg\_dc := max(0, (PG\_DC - PG\_DC\_OF))

| PG\_AIR := pg\_dc \* PG\_LK\_ML

| ;flow from canister purge

Determine the air charge compensation necessary to account for all

unmetered air flows.

always --------------------| temp\_chg := AIR\_CHG\_CUR - AIR\_CHG\_COMP

| ;estimate of MAF sensor-measured charge

|

| AIR\_CHG\_COMP := (ARCHLK + AIR\_BRK + PG\_AIR)/

| (N \* ENGCYL) +

| (FN123A(ACT) + FN123E(ECT))\*

| temp\_chg

| ;total unmetered air charge

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AIR CHARGE CALCULATION, BRAKE COMPENSATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

24.1.9 BRAKE COMPENSATION (CDAM0)

OVERVIEW

+-----------------------------+

|AIR\_COMP\_BRAKE |

+-----------------------------+

|PUBLIC PROCEDURES: |

|. air\_compensation\_brake |

+-----------------------------+

|PRIVATE PROCEDURES: |

|. NONE |

+-----------------------------+

This module estimates the air flow rate from the power brake booster to the

intake manifold. Vacuum-assisted power brakes make use of intake manifold

vacuum to increase braking force, but because the connections between the

brake booster and the manifold are downstream of the engine's air flow

sensor, the flow into the manifold is never measured.

To compensate for this disturbance in engine air flow, an open-loop,

feedforward estimate of the flow from the brake booster is computed and

included along with the measured air flow. AIR\_BRK (in lbm/min) is this

estimate.

Each time the brake is applied or released, air flows from the brake booster

to the manifold. The logic below provides the flexibility to specify the

initial air flow, the linear rate at which the flow decreases over time, and

the maximum duration of the flow. The flow can be calibrated to decay to

zero before the maximum duration period.

| initial

| flow \_\_\_\_

| | |\_\_\_\_ decay rate

| | |\_\_\_\_

flow | | |\_\_\_\_

rate | | |\_\_\_\_

| | |\_\_\_\_

| | |

| | |

0| \_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_

+--------------------------------------------------------- time

max.

|<--------- duration -------->|

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AIR CHARGE CALCULATION, BRAKE COMPENSATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Assumptions:

(no data available)

Flow rate

Minimum: 0 lbm/min

Maximum: 0.1 lbm/min

Resolution: 0.0001 lbm/min

Decay rate

Minimum: 0 lbm/min/sec

Maximum: 1.0 lbm/min/sec

Resolution: 0.001 lbm/min/sec

Duration

Minimum: 0 sec

Maximum: 5 sec

Resolution: 0.001 sec

DEFINITIONS

Registers:

- AIR\_BRK = Air flow rate from brake booster to intake manifold, lbm/min.

- AIR\_BRK\_ET = Elapsed time of brake event, sec.

- AIR\_TM\_OLD = Time at which previous compensation calculation was made,

sec.

Bit Flags:

- AIR\_BIFLGLST = Flag indicating state of BIFLG on the previous pass

through this routine, unitless.

- AIR\_BRK\_INIT = Flag indicating that brake compensation variables have

been initialized; 0 -> not initialized, 1 -> initialized, unitless.

- BIFLG = Flag indicating state of brake; 0 -> released, 1 -> applied,

unitless.

- CRKFLG = Engine operating mode flag; 0 -> not in Crank mode, 1 -> in

Crank mode, unitless.

Calibration Constants:

- AIR\_BRK\_0 = Initial air flow rate from brake booster to intake manifold,

lbm/min.

- AIR\_BRK\_DCY = Desired decay rate of brake booster air flow, lbm/min/sec.

- AIR\_BRK\_DUR = Desired duration of brake booster compensation event, sec.

- AIR\_BRK\_SW = Switch which enables brake booster air charge compensation;

0 -> no compensation desired, 1 -> compensation desired, unitless.

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AIR CHARGE CALCULATION, BRAKE COMPENSATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- BIHP = Switch indicating presence of brake switch hardware; 1 -> present,

unitless.

Other

- air\_brk\_tmp = Unclipped, temporary value of air flow rate from brake

booster to intake manifold, lbm/min.

- air\_time = Time at which current compensation calculation is made, sec.

- ticks\_to\_sec = Clock ticks to seconds conversion factor, seconds/clock

tick.

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AIR CHARGE CALCULATION, BRAKE COMPENSATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: AIR\_COMP\_BRAKE\_COM1

BEGIN: air\_compensation\_brake

;This process is executed only when explicitly called.

Estimate the air flow rate from the power brake booster to the intake

manifold when the brakes are applied or released.

unconditionally -------------------| air\_time := clock \* ticks\_to\_sec

| ;timestamp, in seconds, for use later

AIR\_BRK\_SW = 0 --------------|

;compensation not desired |

|

BIHP <> 1 -------------------|OR --| air\_brk\_tmp := 0.0

;brake switch not present | | ;either can't determine flow or

| | ;don't need to, so estimate of air

CRKFLG = 1 ------------------| | ;flow rate is zero

;engine not at stable speed, | AIR\_BRK\_ET := 0.0

;don't complicate air | ;reset elapsed time

;charge calculation | AIR\_BRK\_INIT := 0

| ;indicate that variables need to

| ;be initialized

|

| --- ELSE ---

|

BIFLG <> AIR\_BIFLGLST -------------| ;brake just applied or released,

;state of brake changed | ;initialize variables

;since last pass |

| air\_brk\_tmp := AIR\_BRK\_0

| ;initial flow rate

| AIR\_BRK\_ET := 0.0

| ;reset elapsed time

| AIR\_TM\_OLD := air\_time

| ;time at which estimate was

| ;calculated

| AIR\_BRK\_INIT := 1

| ;indicate that variables have been

| ;initialized

|

| --- ELSE ---

|

(continued on next page)

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AIR CHARGE CALCULATION, BRAKE COMPENSATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

AIR\_BRK\_INIT = 1 ------------| |

;flow terms have been | |

;initialized |AND -| ;air already flowing, estimate

| | ;flow rate

AIR\_BRK\_ET < AIR\_BRK\_DUR ----| |

;elapsed time less than | AIR\_BRK\_ET := AIR\_BRK\_ET +

;desired timeout period | (air\_time - AIR\_TM\_OLD)

| ;update elapsed time of event

| air\_brk\_tmp := AIR\_BRK\_0 -

| AIR\_BRK\_DCY\*AIR\_BRK\_ET

| ;flow rate is decaying

| AIR\_TM\_OLD := air\_time

| ;time at which estimate was

| ;calculated

|

| --- ELSE ---

|

| air\_brk\_tmp := 0.0

| ;no flow from brake booster,

| ;event has finished

| AIR\_BRK\_INIT := 0

| ;indicate that variables need to

| ;be initialized

unconditionally -------------------| AIR\_BRK := max(0,air\_brk\_tmp)

| ;clip estimate of flow rate

| ;to a minimum of zero

|

| AIR\_BIFLGLST := BIFLG

| ;state of the brake switch

| ;for use next pass

END: air\_compensation\_brake

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AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TEST SELECTION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

24.1.10 MAF SENSOR DIAGNOSTIC TEST SELECTION (CDAM0)

OVERVIEW

+--------------------------------+

|AIR\_MAFS\_DIAG\_SELECT |

+--------------------------------+

|PUBLIC PROCEDURES: |

|. air\_mafs\_diag\_select |

+--------------------------------+

|PRIVATE PROCEDURES: |

|. NONE |

+--------------------------------+

Mass air flow sensor readings are tested to ensure that the sensor is

functioning properly. Under appropriate operating conditions, the raw

digital value read from the air meter is used to identify "open", "short",

and "out-of-range" failures.

DEFINITIONS

Bit Flags:

- CCM\_EO\_ENA = Flag indicating the Engine-Off On-Demand test is enabled,

unitless.

- CCM\_ER\_ENA = Flag indicating the Engine-Running On-Demand test is

enabled, unitless.

- CCM\_TST\_ENA = Flag indicating that Continuous Comprehensive Component

monitoring is enabled, unitless.

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AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TEST SELECTION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: AIR\_MAFS\_DIAG\_SELECT\_COM1

BEGIN: air\_mafs\_diag\_select

;This process is executed only when explicitly called.

Only indicate a failure to the OBD-II executive if diagnostic testing is

requested by the executive routine. Otherwise, do not call OBDII executive

routines.

CCM\_ER\_ENA = 1 -------------------------| ;perform Engine-Running On-Demand

;Engine-Running On-Demand | ;tests

;test enabled |

|

| Do: air\_over\_voltage\_entry

| Do: air\_under\_voltage\_er\_entry

| Do: air\_self\_test\_er\_entry

| Do: air\_update\_fault\_codes

| ;these call processes external to

| ;this module

|

| --- ELSE ---

|

CCM\_EO\_ENA = 1 -------------------------| ;perform Engine-Off On-Demand tests

;Engine-Off On-Demand test |

;test enabled | Do: air\_over\_voltage\_entry

| Do: air\_self\_test\_eo\_entry

| Do: air\_update\_fault\_codes

| ;these call processes external to

| ;this module

|

| ;note: tests for under-voltage

| ;failure are not performed unless

| ;the engine is running since the

| ;sensor output is expected to be

| ;very low

|

| --- ELSE ---

|

CCM\_TST\_ENA = 1 ------------------------| ;perform Continuous tests

;Continuous test enabled |

| Do: air\_over\_voltage\_entry

| Do: air\_under\_voltage\_cont\_entry

| Do: air\_update\_fault\_codes

| ;these call processes external to

| ;this module

24-40

AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TEST SELECTION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

If any failures are detected, malfunction flags are set to indicate to the

rest of the strategy that the mass air flow sensor is not functioning

properly.

unconditionally ------------------------| Do: air\_update\_failure\_flags

| ;update failure flags used by the

| ;rest of the strategy

| ;

| ;this calls a process external to

| ;this module

END: air\_mafs\_diag\_select

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AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

24.1.11 MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND (CDAM0)

OVERVIEW

+--------------------------------+

|AIR\_MAFS\_DIAG\_BG |

+--------------------------------+

|PUBLIC PROCEDURES: |

|. air\_over\_voltage\_entry |

|. air\_under\_voltage\_cont\_entry |

|. air\_under\_voltage\_er\_entry |

|. air\_self\_test\_er\_entry |

|. air\_self\_test\_eo\_entry |

|. air\_over\_voltage\_test |

|. air\_under\_voltage\_test |

|. air\_self\_test\_er |

|. air\_self\_test\_eo |

|. air\_update\_fault\_codes |

|. air\_update\_failure\_flags |

+--------------------------------+

|PRIVATE PROCEDURES: |

|. NONE |

+--------------------------------+

This module contains the processes which perform Continuous and On-Demand

testing of the mass air flow sensor circuit. Processes are also included to

update fault codes and malfunction flags.

Fault filtering for the air meter uses the rolling average filter routine and

will filter towards 1 with a fault present and 0 without a fault present. If

the fault threshold (Pxxxx\_LVL) is set to 0.632, the fault code will be set

when a failure has been present for approximately Pxxxx\_TC seconds. If the

entry criteria for a particular test are not met, the test cannot be

performed, and the fault filter holds its value. If any fault code is set,

the overall air meter malfunction flag, MFMFLG, is set to indicate to the

rest of the strategy that the mass air flow sensor is not functioning

properly.

Different test modes may have different failure thresholds, but the failure

types are generally as follows:

out out

under of of over

voltage | range | in range, OK | range | voltage

------------|-----------|-------------------|-----------|------------>

increasing

voltage

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AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- DSDRPM = Desired idle speed, rpm.

- IMAF = Raw mass air flow sensor output, A-to-D counts.

- IMFMCTR = Hysteresis term for foreground air meter failure indication,

background loop counts.

- N = Engine speed, rpm.

- P0102\_FIL = Fault filter for fault P0102 (mass air flow circuit low),

unitless.

- P0103\_FIL = Fault filter for fault P0103 (mass air flow circuit high),

unitless.

- TP\_REL = Relative throttle position, A-to-D counts.

- TSLPIP = Amount of time which has passed since the last, msec.

Bit Flags:

- CRKFLG = Crank mode flag; 1 -> in crank mode, unitless.

- FFG\_MAF = OBD-II system FMEM flag for MAF; 1 -> MAF sensor not currently

reliable, unitless.

- IMFMFLG = Flag indicating an instantaneous mass air flow sensor fault,

unitless.

- MFMFLG = Flag indicating a mass air flow sensor failure; 1 -> failed

sensor, unitless.

- P0102\_INST = Flag indicating an instantaneous under-voltage condition; 1

-> condition exists, unitless.

- P0103\_INST = Flag indicating an instantaneous over-voltage condition; 1

-> condition exists, unitless.

- PxxxxMALF = OBD-II malfunction flag for fault xxxx; 1 -> a malfunction

currently exists for fault xxxx.

- UNDSP = Run/underspeed mode flag; 0 -> in run mode, 1 -> in underspeed or

crank mode, unitless.

Calibration Constants:

- FIL\_HYST = Hysteresis term to prevent spurious clearing of fault codes,

unitless.

- MAF\_HI\_ER = MAFS test upper limit, A-to-D counts.

- MAF\_HI\_KOEO = Engine-Off On-Demand MAFS test upper limit, A-to-D counts.

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AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- MAF\_HI\_KOER = Engine-Running On-Demand MAFS test upper limit, A-to-D

counts.

- MAF\_LO\_ER = MAFS test lower limit, A-to-D counts.

- MAF\_LO\_KOER = Engine-Running On-Demand MAFS test lower limit, A-to-D

counts.

- MAF\_RPM\_MAX = Engine speed below which air flow is low enough to

distinguish normal air flow signal from over-voltage condition, rpm.

- P0102\_LVL = Fault threshold for under-voltage fault, unitless.

- P0103\_LVL = Fault threshold for over-voltage fault, unitless.

- P0102\_TC = Fault filter time constant for under-voltage fault, seconds.

- P0103\_TC = Fault filter time constant for over-voltage fault, seconds.

- TP\_VMAF = TP above which the MAF sensor Continuous test is executed.

- VMAFPIPLMT = Amount of time since last PIP which indicates engine has

stalled, msec.

OTHER

- clear\_malf(Pxxxx) = Logic process imported from the MIL control module

which clears the MIL fault code specified by Pxxxx.

- malfunction(ccm,Pxxxx) = Logic process imported from the MIL control

module which stores the MIL fault code specified by Pxxxx.

- maf\_codes = SET OF {P0102, P0103}

- maf\_other\_codes = SET OF {P1101}

- P0102 = Fault code (MIL) - mass air flow circuit low.

- P0103 = Fault code (MIL) - mass air flow circuit high.

- P1101 = Fault code (non-MIL) - mass air flow sensor outside self test

range.

- store\_code(Pxxxx) = Logic process which stores the non-MIL fault code

specified by Pxxxx.

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AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: AIR\_MAFS\_DIAG\_BG\_COM1

BEGIN: air\_over\_voltage\_entry

;This process is executed only when explicitly called.

This logic controls entry to the over-voltage test. Because so much of the

range of the sensor is normally used to sense air flow, the sensor's output

at high flow is indistinguishable from an over-voltage failure. An

over-voltage failure can therefore only be detected at low or moderate flows.

N < MAF\_RPM\_MAX ------------------------| Do: air\_over\_voltage\_test

;air flow and sensor output | ;check for over-voltage

;should not be high | ;condition

|

| --- ELSE ---

|

| NO ACTION

| ;air flow and sensor output

| ;should be high, can't detect

| ;an over-voltage condition,

| ;do not execute test

END: air\_over\_voltage\_entry

24-45

AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: air\_under\_voltage\_cont\_entry

;This process is executed only when explicitly called.

This logic controls entry to the Continuous (as opposed to the On-Demand)

under-voltage test. Because so much of the range of the sensor is normally

used to sense air flow, the sensor's output at low flow is indistinguishable

from an under-voltage failure. An under-voltage failure can therefore only

be detected at moderate or high flows.

TSLPIP <= VMAFPIPLMT -------------|

;engine has not stalled |

|

UNDSP = 0 ------------------------|

;in run mode |AND -| Do: air\_under\_voltage\_test

| | ;check for under-voltage

TP\_REL > TP\_VMAF -----------------| | ;condition

;air flow and sensor output | |

;should not be low | |

| |

P0103\_INST = 0 -------------------| |

;no over-voltage condition |

;detected, |

;if there had been, no point |

;in checking for under-voltage |

| --- ELSE ---

|

| NO ACTION

| ;air flow and sensor output

| ;should be low, can't detect

| ;an under-voltage condition,

| ;do not execute test

END: air\_under\_voltage\_cont\_entry

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AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: air\_under\_voltage\_er\_entry

;This process is executed only when explicitly called.

This logic controls entry to the Engine-Running On-Demand under-voltage test.

Because so much of the range of the sensor is normally used to sense air

flow, the sensor's output at low flow is indistinguishable from an

under-voltage failure. An under-voltage failure can therefore only be

detected at moderate or high flows.

TSLPIP <= VMAFPIPLMT -------------|

;engine has not stalled |

|

UNDSP = 0 ------------------------|AND -| Do: air\_under\_voltage\_test

;in run mode | | ;check for under-voltage

| | ;condition

P0103\_INST = 0 -------------------| |

;no over-voltage condition |

;detected, |

;if there had been, no point |

;in checking for under-voltage |

| --- ELSE ---

|

| NO ACTION

| ;air flow and sensor output

| ;should be low, can't detect

| ;an under-voltage condition,

| ;do not execute test

END: air\_under\_voltage\_er\_entry

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AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: air\_self\_test\_er\_entry

;This process is executed only when explicitly called.

This logic controls entry to the Engine-Running On-Demand in-range test. To

ensure sufficient air flow for the test, execution of the test is restricted

to the high engine speed portion of the Engine-Running On-Demand test

(typically this is about 1600 rpm).

Also, it is undesirable to indicate an "out of self test range" condition if

the circuit is clearly over- or under-voltage (indicating specifically over-

or under-voltage provides more detail than just out-of-range). Consequently,

if an over- or under-voltage condition has been detected, the in-range test

is not performed.

N > 1000 -------------------------|

;engine must be generating |

;sufficient flow |

|

DSDRPM > 1000 --------------------|

;engine must be generating |

;sufficient flow |AND -| Do: air\_self\_test\_er

| | ;check for out-of-range

P0103\_INST = 0 -------------------| | ;condition

;no over-voltage condition | |

;detected | |

| |

P0102\_INST = 0 -------------------| |

;no under-voltage condition |

;detected |

| --- ELSE ---

|

| NO ACTION

| ;can't do test or higher

| ;priority code imminent

END: air\_self\_test\_er\_entry

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AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: air\_self\_test\_eo\_entry

;This process is executed only when explicitly called.

This logic controls entry to the Engine-Off On-Demand in-range test. It is

undesirable to indicate an "out of self test range" condition if the circuit

is clearly over- or under-voltage (indicating specifically over- or

under-voltage provides more detail than just out-of-range). Consequently, if

an over- or under-voltage condition has been detected, the in-range test is

not performed.

P0103\_INST = 0 -------------------|

;no over-voltage condition |

;detected |AND -| Do: air\_self\_test\_eo

| | ;check for out-of-range

P0102\_INST = 0 -------------------| | ;condition

;no under-voltage condition |

;detected |

| --- ELSE ---

|

| NO ACTION

| ;higher priority code imminent

END: air\_self\_test\_eo\_entry

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AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: air\_over\_voltage\_test

;This process is executed only when explicitly called.

This logic defines the over-voltage test. It is assumed that if this process

is called, engine operating conditions are appropriate for detecting this

type of failure.

IMAF > MAF\_HI\_ER -----------------------| ;over-voltage condition

;sensor output higher than expected |

| P0103\_FIL := ROLAV(1,P0103\_TC)

| ;increment over-voltage fault

| ;filter

|

| P0102\_FIL := ROLAV(0,P0102\_TC)

| ;decrement under-voltage fault

| ;filter,

| ;can't be under-voltage if

| ;over-voltage fault exists

|

| P0103\_INST := 1

| ;instantaneous over-voltage

| ;condition exists

|

| --- ELSE ---

|

| P0103\_FIL := ROLAV(0,P0103\_TC)

| ;decrement over-voltage fault

| ;filter

|

| P0103\_INST := 0

| ;instantaneous over-voltage

| ;condition does not exist

END: air\_over\_voltage\_test

24-50

AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: air\_under\_voltage\_test

;This process is executed only when explicitly called.

This logic defines the under-voltage test. It is assumed that if this

process is called, engine operating conditions are appropriate for detecting

this type of failure.

IMAF < MAF\_LO\_ER -----------------------| ;under-voltage condition

;sensor output lower than expected |

| P0102\_FIL := ROLAV(1,P0102\_TC)

| ;increment under-voltage fault

| ;filter

|

| P0103\_FIL := ROLAV(0,P0103\_TC)

| ;decrement over-voltage fault

| ;filter,

| ;can't be over-voltage if

| ;under-voltage fault exists

|

| P0102\_INST := 1

| ;instantaneous under-voltage

| ;condition exists

|

| --- ELSE ---

|

| P0102\_FIL := ROLAV(0,P0102\_TC)

| ;decrement under-voltage fault

| ;filter

|

| P0102\_INST := 0

| ;instantaneous under-voltage

| ;condition does not exist

END: air\_under\_voltage\_test

24-51

AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: air\_self\_test\_er

;This process is executed only when explicitly called.

This logic defines the Engine-Running On-Demand in-range test. It is assumed

that if this process is called, engine operating conditions are appropriate

for detecting this type of failure.

IMAF < MAF\_LO\_KOER --------------|

;sensor output lower |

;than expected |OR --| ;outside Engine-Running

| | ;On-Demand range

IMAF > MAF\_HI\_KOER ---------------| |

;sensor output higher | store\_code(P1101)

;than expected | ;filter not used so that

| ;intermittent faults can

| ;be detected

|

| --- ELSE ---

|

| NO ACTION

END: air\_self\_test\_er

24-52

AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: air\_self\_test\_eo

;This process is executed only when explicitly called.

This logic defines the Engine-Off On-Demand in-range test. It is assumed

that if this process is called, engine operating conditions are appropriate

for detecting this type of failure.

IMAF > MAF\_HI\_KOEO ---------------------| ;outside Engine-Off

;sensor output higher than expected | ;On-Demand range

|

| store\_code(P1101)

| ;filter not used so that

| ;intermittent faults can

| ;be detected

|

| --- ELSE ---

|

| NO ACTION

END: air\_self\_test\_eo

24-53

AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: air\_update\_fault\_codes

;This process is executed only when explicitly called.

When a fault filter exceeds the fault level, the malfunction flag is set for

that code. FIL\_HYST provides hysteresis before clearing the malfunction

flag.

P0102\_FIL > P0102\_LVL ------------------| malfunction(ccm,P0102)

;persistent under-voltage condition | ;alert diagnostic executive that

| ;an under-voltage fault exists

|

| --- ELSE ---

|

P0102\_FIL < P0102\_LVL - FIL\_HYST -------| clear\_malf(P0102)

;no under-voltage condition | ;alert diagnostic executive that

| ;an under-voltage fault does not

| ;exists

P0103\_FIL > P0103\_LVL ------------------| malfunction(ccm,P0103)

;persistent over-voltage condition | ;alert diagnostic executive that

| ;an over-voltage fault exists

|

| --- ELSE ---

|

P0103\_FIL < P0103\_LVL - FIL\_HYST -------| clear\_malf(P0103)

;no over-voltage condition | ;alert diagnostic executive that

| ;an over-voltage fault does not

| ;exists

END: air\_update\_fault\_codes

24-54

AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: air\_update\_failure\_flags

;This process is executed only when explicitly called.

The flag MFMFLG is used to indicate the status of the MAF sensor to the rest

of the strategy. The flags P0102MALF and P0103MALF are maintained by the

diagnostic executive routine.

P0102MALF = 1 --------------------|

;MAF circuit failed low |OR --| MFMFLG := 1

| | ;circuit malfunction detected,

P0103MALF = 1 --------------------| | ;set flag to alert rest of

;MAF circuit failed high | ;strategy

|

| --- ELSE ---

|

| MFMFLG := 0

| ;no circuit malfunction detected,

| ;clear flag to alert rest of

| ;strategy

This logic provides a calibratable delay after the sensor returns in range,

equal to MFMHYS - 1 background loops, before clearing the foreground failure

flag.

CRKFLG = 1 -----------------------------| IMFMFLG := 0

;in crank mode | IMFMCTR := 0

| ;sensor test disabled in

| ;crank mode

|

| --- ELSE ---

|

IMFMCTR = 0 ----------------------------| IMFMFLG := 0

;FMEM exit delay complete | ;clear foreground FMEM flag

;or FMEM has not been active |

| --- ELSE ---

|

| IMFMCTR := max((IMFMCTR - 1),0)

| ;clip to a minimum of zero

24-55

AIR CHARGE CALCULATION, MAF SENSOR DIAGNOSTIC TESTS - BACKGROUND - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The FFG\_MAF flag is used to immediately signal the OBD-II executive that MAF

is currently unreliable and that a malfunction may exist. The FFG\_MAF flag

bypasses the delays caused by fault filters used for malfunction codes to

ensure that other OBD-II tests which rely on the MAF sensor are promptly

advised that a malfunction may exist.

IMFMFLG = 1 ----------------------------| FFG\_MAF := 1

;instantaneous failure | ;MAF failure

|

| --- ELSE ---

|

| FFG\_MAF := 0

| ;no MAF failure

END: air\_update\_failure\_flags

24-56

AIR CHARGE CALCULATION, LOAD CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OVERVIEW

24.1.12 LOAD CALCULATION (CDAM0)

LOAD is a unitless value showing the ratio of the Cylinder Air Charge

(CYLARC\_BG) to the theoretical air charge at EEC Standard Temperature and

Pressure (SARCHG). Using LOAD makes all engine sizes more directly

comparable, and allows a similar scaling for all table look-ups.

AIR MASS DETERMINATION

Air mass is computed for use in background in units of lbs/min.

PERLOAD CALCULATION

PERLOAD is a variable used to control air/fuel ratio and upstream air. The

air/fuel ratio control includes: 1) stabilized open loop enrichment, 2) MPG

mode cruise enable and desired air/fuel, 3) cold start enrichment. Its

original definition was corrupted when the option was included to set PERLOAD

= LOAD. Thus a true percent load (PCT\_LOAD) had to be introduced to predict

flow across orifices like the air bypass valve.

DEFINITIONS

Registers:

- AM = Average air mass flow rate, lbm/min.

- BP = Barometric pressure, inches Hg abs.

- CYLARC\_BG = Air mass inducted per intake stroke, lbm/intake.

- LOAD = Normalized cylinder air charge, unitless.

- N = Engine speed, rpm.

- PCT\_LOAD = Percent inferred LOAD, unitless.

- PERLOAD = Percent load, unitless.

Calibration constants:

- ENGCYL = Number of intake strokes per engine revolution.

- FN035(N) = Peak load at sea level as a function of engine speed,

unitless.

24-57

AIR CHARGE CALCULATION, LOAD CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PRLDSW = Switch to control calculation of PERLOAD, unitless.

24-58

AIR CHARGE CALCULATION, LOAD CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SARCHG = Standard air charge for a single cylinder, lbm/intake.

= 2.701E-09 \* pi \* [(B/2)\*\*2] \* S lbm/intake

where B = bore in millimeters

S = stroke in millimeters

(2.701E-09 = denisty of air in lbm per cubic millimeter)

PROCESS

STRATEGY MODULE: AIR\_LOAD\_COM1

unconditionally ------------------------| LOAD := CYLARC\_BG / SARCHG

|

| AM := N \* ENGCYL \* CYLARC\_BG

PRLDSW = 0 -----------------------------| PERLOAD = [LOAD \* 29.9] /

| [FN035(N) \* BP]

|

| --- ELSE ---

|

PRLDSW = 1 -----------------------------| PERLOAD = LOAD

|

| --- ELSE ---

|

PRLDSW = 2 -----------------------------| PERLOAD = PCT\_LOAD

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AIR CHARGE CALCULATION, INFERRED LOAD - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

24.1.13 INFERRED LOAD (CDAM0)

OVERVIEW

There is a need in EEC strategy for air flow calculations made independently

of the air meter and BP sensor. Engine speed, throttle position, and percent

EGR provide sufficient information to infer the volumetric flow of air

through the throttle body. Given an air density, this volumetric flow rate

can be converted to a mass flow rate. The air bypass valve's duty cycle and

pressure ratio across the orifice approximately define the flow across a

forced balanced air bypass valve. (The lack of force balancing at high

manifold vacuums is not yet modeled so errors in prediction exist).

From these inputs the following variables are calculated for use elsewhere in

the strategy:

1) TOTLDST is an estimate of what LOAD would be under the current engine

operating condition (speed, throttle position, and EGR rate) and at ECC

Standard Temperature and Pressure (ESTP). It includes components from

throttle body flow and air bypass flow.

2) BYMAST is an estimate of what the mass flow rate of air through the air

bypass valve would be at the current engine operating condition (speed,

throttle position, and EGR rate) and at ESTP.

3) DELTOTLD is the magnitude of the change in inferred LOAD between

successive calculations. It can be used to detect rapid transients.

4) PCT\_LOAD is calculated for use in the air bypass model and for an optional

PERLOAD calculation. It has the characteristic of going to 1.0 at any

altitude and any engine speed when the maximum air flow for that altitude and

engine speed is reached, thus indicating that the driver is demanding maximum

torque. PCT\_LOAD does not use BP in its calculation and is therefore immune

to any inaccuracy in BP.

NOTE: EEC Standard Temperature and Pressure (ESTP) is defined to be 100 deg

F inlet air (ACT), 29.92 in Hg barometric pressure, and 200 deg F engine

coolant temperature (ECT).

DEFINITIONS

Registers:

- BYLDST = Estimate of component of LOAD due to bypass air mass, unitless.

- BYLDST\_INST = Instantaneous load due to air flow through bypass valve,

unitless.

- BYMAST = Estimate of flow rate of air through the air bypass valve at

ESTP, lbm/min.

- DELTOTLD = Magnitude of change in inferred LOAD between two successive

calculations, unitless.

24-60

AIR CHARGE CALCULATION, INFERRED LOAD - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- EGRACT = Actual percent EGR, unitless.

- ISCDTY = Air bypass valve commanded duty cycle, unitless.

- N = Engine speed, rpm.

- PCT\_LOAD = Percent inferred LOAD based on mapped engine behavior at ESTP,

unitless.

- TOTLDST = Total inferred LOAD, unitless.

- TP\_REL = Throttle position, A/D counts.

- TPLDST = Estimate of LOAD due to mass of air that flows through the

throttle at ESTP during a single cylinder induction event, unitless.

Calibration constants:

- ENGCYL = Number of intake strokes per engine revolution.

- FN044(TP\_REL) = Normalized throttle position, unitless.

- FN070E(N) = Normalized engine speed, unitless.

- FN077(PCT\_LOAD) = Normalized percent load, unitless.

- FN078(ISCDTY) = Normalized air bypass valve duty cycle, unitless.

- FN1036A = Normalized cyinder air charge at sea level with no EGR and port

throttles closed, unitless.

X = FN070E(N)

Y = FN044(TP\_REL)

- FN1036B = Normalized cyinder air charge at sea level with no EGR and port

throttles open, unitless.

X = FN070E(N)

Y = FN044(TP\_REL)

- FN1037 = TPLDST subtractor as a function of N and TP\_REL at ESTP for 10%

EGR, unitless.

X = FN070E(N)

Y = FN044(TP\_REL)

- FN1039 = Flow rate of air through air bypass valve at ESTP, lbm/min.

X = FN078(ISCDTY)

Y = FN077(PCT\_LOAD)

- SARCHG = Standard air charge for a single cylinder, lbm/intake stroke.

- TCBYLD = Time constant of filter for flow through air bypass valve, sec.

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AIR CHARGE CALCULATION, INFERRED LOAD - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: AIR\_LOAD\_INFERRED\_COM2

BEGIN: air\_load\_inferred

;This process is executed once per background loop.

IMRC\_POSN = 1 -----| ; port throttles open

;port throttles |

;are open | load\_table = FN1036B(N,TP\_REL)

| ;normalized air charge

|

| load\_wot = FN1036B(N,top row)

| ;normalized air charge at

| ;wide open throttle

|

| --- ELSE ---

|

| ; port throttles closed

|

| load\_table = FN1036A(N,TP\_REL)

| ;normalized air charge

|

| load\_wot = FN1036A(N,top row)

| ;normalized air charge at

| ;wide open throttle

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AIR CHARGE CALCULATION, INFERRED LOAD - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

unconditionally ---| TPLDST := load\_table -

| EGRACT/10. \* FN1037(N,TP\_REL)

| ;estimate of LOAD due to mass of air

| ;that flows through the throttle at

| ;ESTP during a single cylinder

| ;induction event

|

| BYMAST := FN1039(ISCDTY,PCT\_LOAD)

| ;estimate of mass flow rate of air

| ;through the air bypass valve

| ;at ESTP

|

| BYLDST\_INST := BYMAST/(N \* ENGCYL \* SARCHG)

| ;air bypass valve flow rate converted

| ;to air mass and normalized to load units

|

| BYLDST := ROLAV(BYLDST\_INST,TCBYLD)

| ;filtered estimate of LOAD due to bypass

| ;air mass

|

| totldst\_old := TOTLDST

| ;save old value for use in calculating

| ;change in inferred load

|

| TOTLDST := clip((BYLDST + TPLDST),

| 0,load\_wot)

| ;total inferred load,

| ;includes components from throttle body

| ;and air bypass valve

|

| DELTOTLD := abs(TOTLDST - totldst\_old)

| ;magnitude of change in inferred load

| ;since previous calculation

|

| PCT\_LOAD := TOTLDST / load\_wot

| ;normalized inferred LOAD

END: air\_load\_inferred

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AIR CHARGE CALCULATION, j1979 PARAMETER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

24.1.14 J1979\_01\_10, MASS AIR FLOW, CALCULATION (CDAM0)

OVERVIEW

SAE standard j1979 requires that a parameter (j1979\_01\_10 in grams per

second) be available for the scan tool. This value must reflect the current

value of the sensor input and not a value substituted via a FMEM action.

This parameter is derived from MAF (lbm/tick) which is calculated at each PIP

edge. Note that it is necessary to convert from ticks to seconds as well as

from pounds mass to grams.

j1979\_01\_10 gm/sec = MAF lbm/tick \* STCF tic/sec \* 453.6 gm/lbm

DEFINITIONS

INPUTS

Registers:

- MAF = The air flow that is computed at each PIP edge, lbm/tick.

Non-Calibratable Constants:

- STCF = Seconds to clock ticks conversion factor.

OUTPUTS

Registers:

- j1979\_01\_10 = Current Mass air flow in grams per second for SCP

interface.

PROCESS

STRATEGY MODULE: AIR\_J1979\_COM1

BEGIN: pid\_definitions

unconditionally --------| pid\_def(j1979\_01\_10, (MAF \* STCF \* 453.6))

| (Calculate mass air flow in gm/sec)

END: pid\_definitions

24-64

AIR CHARGE CALCULATION, SAE J1979 LOAD PARAMETER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

24.1.15 CALCULATION OF SAE J1979 LOAD PARAMETER (CDAM0)

OVERVIEW

SAE standard J1979 requires that a parameter for current engine load be

available for the scan tool, expressed as a percent where 00h corresponds to

zero percent and FFh corresponds to 100 percent of maximum load of the

engine. This load is used primarly for engine diagnostics and duplication of

engine operating conditions.

DEFINITIONS

INPUTS

Registers:

- N = Engine speed, rpm.

Calibration Constants:

- NSTALL = Engine speed below which the engine is considered to have

stalled, rpm.

OUTPUTS

Registers:

- j1979\_01\_04 = Engine load PID available via the scan tool, unitless.

- LOAD\_SAE = Engine load as required by SEA standard J1979, unitless.

- PCT\_LOAD = Inferred percent load (based on mapped engine behavior),

unitless.

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AIR CHARGE CALCULATION, SAE J1979 LOAD PARAMETER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: AIR\_J1979\_LOAD\_COM1

BEGIN: air\_pid\_definition\_load

;This process is executed once per background loop.

When the engine is not turning or turning very slowly (e.g. during

engine-off testing, during cranking, following an engine stall, etc.), the

load value is set to zero. A service technician expecting a load of zero

under these conditions may misdiagnosis or replace a good MAF sensor if a

non-zero value is transmitted to diagnostic tools via SCP.

N < NSTALL -----------------| LOAD\_SAE := 0

;engine speed below | ;engine turning too slowly,

;stall speed | ;set engine load for SAE J1979

| ;to zero

|

| --- ELSE ---

|

| LOAD\_SAE := PCT\_LOAD

| ;calculate engine load for SAE J1979

| ;from mapped engine behavior

unconditionally ------------| pid\_def( j1979\_01\_04, (LOAD\_SAE \* 255) )

| ;PID definition for value of engine load

| ;transmitted via SCP

END: air\_pid\_definition\_load

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CHAPTER 25

TRANSMISSION INPUT CONVERSIONS

25-1

TRANSMISSION INPUT CONVERSIONS, PERFORMANCE WEIGHTING DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.1 PERFORMANCE WEIGHTING DETERMINATION (CDAI0)

OVERVIEW

This module will continuously determine the performance weighting factor.

This will be a function of TP\_REL and TPRATE\_PWF. It will be used to adjust

the shift points in the shift schedules toward a performance value or a

economy value. This allows the shift points to be biased toward the economy

schedule at low values of TPRATE\_PWF. It also allows biasing the shift

points toward the performance schedule for high rates of throttle movement.

DEFINITIONS

INPUTS

Registers:

- BG\_TMR = Background loop timer.

- PNWF = Performance and Normal Weighting Factor.

- pnwf = Instantaneous PNWF.

- PWF\_AT\_DNSFT = The value of PNWF at the moment a downshift is commanded.

- TM\_PWF\_DEC = Time to hold PNWF after an upshift, seconds.

- TPRATE\_PWF = Filtered throttle position rate for PNWF determination,

counts.

- TP\_RATE = Throttle position rate.

- TP\_REL = Relative throttle position, counts.

Bit Flags:

- FLG\_FRST\_CM = First time a shift is commanded flag; 1 -> shift commanded

this background pass, 0 -> no shift commanded this background pass.

- FLG\_SFT\_DN = Downshift flag. 1 -> last shift was an downshift. 0 ->

last shift was a upshift.

- FLG\_SFT\_UP = Upshift flag; 1 -> last shift was an upshift, 0 -> last

shift was a downshift.

Calibration Constants:

- FNPWFE = Performance weighting factor lookup table for economy mode.

X = FNPWFX(TP\_REL)

Y = FNPWFY(TP\_RATE)

- FNPWFX(TP\_REL) = Normalizing function for TP\_REL for input to FNPWFE or

FNPWFP.

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TRANSMISSION INPUT CONVERSIONS, PERFORMANCE WEIGHTING DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FNPWFY(TP\_RATE) = Normalizing function for TP\_RATE for input to FNPWFE or

FNPWFP.

- PWF\_DEC\_E = Decrement PNWF by this amount every second (after a

downshift, or when TM\_PWF\_DEC expires), in economy mode.

- TMHOLDPWF = Time to hold PNWF after an upshift, seconds.

OUTPUTS

Registers:

- PNWF = See above.

- pnwf = See above.

- PWF\_AT\_DNSFT = See above.

- TM\_PWF\_DEC = See above.

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TRANSMISSION INPUT CONVERSIONS, PERFORMANCE WEIGHTING DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_PWF\_DET\_COM3

always -------------------------| pnwf = FNPWFE(TP\_REL,TPRATE\_PWF)

pnwf >= PNWF -------------------| PNWF = pnwf

(increasing PNWF) | (pass pnwf through to PNWF)

|

| --- ELSE ---

|

| PNWF = MAX[PWF\_AT\_DNSFT,pnwf,PNWF -

| PWF\_DEC\_E \* BG\_TMR]

| (let PWF decay to pnwf with minimum

clip of PWF\_AT\_DNSFT)

FLG\_SFT\_DN = 1 -----------|

|AND -| PWF\_AT\_DNSFT = PNWF

FLG\_FRST\_CM = 1 ----------| | (set minimum clip to PNWF at the

(a downshift is commanded | time of the downshift)

this B.G. pass) |

| TM\_PWF\_DEC = TMHOLDPWF

| (set PNWF hold timer)

|

| --- ELSE ---

FLG\_SFT\_UP = 1 -----| |

|AND -| |

FLG\_FRST\_CM = 1 ----| | |

(an upshift is | |

comanded this |OR --| PWF\_AT\_DNSFT = 0

B.G. pass) | | (set minimum clip to allow

| | PNWF to decay to pwf)

TM\_PWF\_DEC = 0 ----------|

(timer expired)

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TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL INDICATOR LIGHT - CDAN2

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25.2 TRANSMISSION CONTROL INDICATOR LIGHT (CDAM0)

OVERVIEW

The Transmission Control Indicator Light (TCIL), located in the instrument

panel, visually indicates the status of "Transmission Control" to the driver,

or alerts the driver to certain transmission faults. If not indicating a

fault, the light is on when overdrive is canceled; off when overdrive is

enabled. A flashing light indicates a transmission fault. The transmission

control switch will continue to operate normally in the flashing mode, but

there is no visual indication of cancel mode.

To disable flashing for any fault, set TCIL\_TM\_DLY = 31.875.

To enable flashing for specific faults, set TCIL\_TM\_DLY < 31.875, and set the

calibration switch for that fault = 1. For example, to flash the TCIL for

converter clutch errors and shift errors, set CC\_ERR\_SW = 1 and SFT\_ERR\_SW =

1, and all remaining switches = 0.

DEFINITIONS

Registers:

- TCILTMR = Time since transmission fault occurred, sec.

- TCIL\_FLASH\_TMR = Time since TCIL changed states in flashing mode, sec.

Bit Flags:

- CRKFLG = Flag indicating engine mode status; 0 -> not in CRANK mode, 1 ->

in CRANK mode.

- FLG\_DIS\_CSM = Disable Continuous Slip Mode Flag; 1 -> -converter clutch

system is stability detected, disable softlock.

- FLG\_TCS = Transmission Control flag; 0 -> overdrive enable, 1 ->

overdrive lockout mode.

- OTEMP\_FM\_FLG = Transmission overtemperature FMEM flag; 1 -> Transmission

is overtemperature, 0 -> Transmission temperature okay.

- PDL\_ERROR = Transmission Range Sensor error flag; 1 -> TRS error

detected.

- PxxxMALF = OBD-II malfunction flag for fault xxx; 1 -> Malfunction xxx

currently exits.

- SFT\_FM\_FLG = Flag indicating whether 1-2 or 2-3 or 3-4 shifts are failing

to occur properly; 0 -> shifts OK, 1 -> Shifts not OK.

- TCIL\_STATE = Flag indicating state of TCIL; 0 -> TCIL off, 1 -> TCIL on.

- TOT\_FM\_FLG = TOT failure mode flag; 1 -> TOT fmem in progress.

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TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL INDICATOR LIGHT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- CC\_ERR\_SW = Calibration selection switch to enable/disable flashing TCIL

for converter clutch error; 0 -> disable, 1 -> enable.

- CNET\_ERR\_SW = Calibration switch to enable/disable flashing the TCIL for

Catchnet (converter clutch system instability) errors; 1 -> enable.

- EPC\_ERR\_SW = Calibration selection switch to enable/disable flashing TCIL

for EPC open circuit error; 0 -> disable, 1 -> enable.

- EPC\_SHORT\_SW = Calibration switch to enable/disable flashing the TCIL for

EPC short circuit error; 1 -> enable.

- OSS\_ERR\_SW = Calibration switch to enable/disable flashing the TCIL for

OSS malfunctions; 1 -> enable.

- OS\_NOISE\_SW = Calibration switch to enable/disable flashing the TCIL for

a noisy OSS malfunction; 1 -> eanble.

- OTEMP\_ERR\_SW = Calibration selection switch to enable/disable flashing

TCIL for Transmission overtemperature condition; 0 -> disable, 1 ->

enable.

- SFT\_ERR\_SW = Calibration selection switch to enable/disable flashing TCIL

for Shift Errors; 0 -> disable, 1 -> enable.

- SOL\_CKT\_SW = Calibration switch to enable/disable flashing TCIL for shift

solenoid circuit malfunctions; 1 -> enable.

- SW\_0741\_TCIL = Calibration selection switch to enable/disable flashing

TCIL for converter system stuck off error; 0 -> disable.

- SW\_1743\_TCIL = Calibration selection switch to enable/disable flashing

TCIL for PWM "on" error; 0 -> disable.

- TCC\_CKT\_SW = Calibraiton switch to enable/disable flashing the TCIL for

TCC solenoid circuit malfunctions; 1 -> enable.

- TCILTM1 = Flashing TCIL "ON"/"OFF" time period, sec.

- TCIL\_TM\_DLY = Time after fault has occurred before the TCIL begins to

flash, sec. Set to 31.875 to disable flashing.

- TOT\_ERR\_SW = Calibration selection switch to enable/disable flashing the

TCIL for TOT failures; 0 -> disable, 1 -> enable.

- TRS\_ERR\_SW = Calibration switch to enable/disable flashing the TCIL for

Transmission Range Sensor malfunctions; 1 -> enable.

- VSS\_ERR\_SW = Calibration switch to enable/disable flashing the TCIL for

VSS malfunctions; 1 -> enable.

- VS\_NOISE\_SW = Calibration switch to enable/disable flashing the TCIL for

a noisy VSS malfunction; 1 -> eanble.

25-6

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL INDICATOR LIGHT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OTHER

- P0500 = Fault code for vss failure.

- P0503 = Noisy VSS malfunction.

- P0720 = OBD-II fault code - Output Speed Sensor Malfucntion.

- P0721 = OBD-II fault code, noisy OSS.

- P0741 = Torque converter clutch system performance or stuck off.

- P0743 = Torque converter clutch system electrical.

- P0750 = OBD-II fault code for SSA circuit malfunction.

- P0755 = OBD-II fault code for SSB circuit malfunction.

- P1743 = Fault code, PWM mechanically "on" failure (NON MIL code).

- P1746 = Fault code; EPC VFS open circuit.

- P1747 = Fault code; EPC VFS short to ground.

25-7

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL INDICATOR LIGHT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_TCIL\_STATE\_COM5

FLG\_TCS = 0 ----------------|

(overdrive enable) |AND -|

| |

TCILTMR <= TCIL\_TM\_DLY -----| |

(flashing mode entry delay) |OR --| (turn TCIL off)

| | TCIL\_STATE = 0

TCIL\_FLASH\_TMR >= TCILTM1 --| | | TCIL\_FLASH\_TMR = 0

(flashing period expired) |AND -| |

| |

TCIL\_STATE = 1 -------------| |

(TCIL currently on) |

| --- ELSE ---

FLG\_TCS = 1 ----------------| |

(overdrive lockout mode) |AND -| |

| | |

TCILTMR <= TCIL\_TM\_DLY -----| |OR --| (turn TCIL on)

| | TCIL\_STATE = 1

TCIL\_FLASH\_TMR >= TCILTM1 --| | | TCIL\_FLASH\_TMR = 0

|AND -| |

TCIL\_STATE = 0 -------------| |

(TCIL currently off) |

| --- ELSE ---

|

| Do not change TCIL\_STATE

| Increment TCIL\_FLASH\_TMR

P0750MALF = 0 --|

|AND -|

P0755MALF = 0 --| |

|OR --|

SOL\_CKT\_SW = 0 -------| |

|

P0743MALF = 0 --------| |

|OR --|

TCC\_CKT\_SW = 0 -------| |AND -| tr\_out\_flash = 0

| | ;No transmission output

P1746MALF = 0 --------| | | ;faults (for which flashing

|OR --| | ;the TCIL is cal'ed in)

EPC\_ERR\_SW = 0 -------| | | ;have been detected

| |

P1747MALF = 0 --------| | |

|OR --| |

EPC\_SHORT\_SW = 0 -----| |

| --- ELSE ---

|

| tr\_out\_flash = 1

| ;Flash TCIL for detected trans

| ;output malfunction

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TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL INDICATOR LIGHT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SFT\_ERR\_SW = 0 -------|

|OR --|

SFT\_FM\_FLG = 0 -------| |

|

P1743MALF = 0 --------| |

|OR --|

SW\_1743\_TCIL = 0 -----| |

|

P0741MALF = 0 --------| |

|OR --|AND -| tr\_fn\_flash = 0

SW\_0741\_TCIL = 0 -----| | | ;no transmission functional

| | ;faults (for which flashing

FLG\_DIS\_CSM = 0 ------| | | ;the TCIL is cal'ed in) have

|OR --| | ;been detected

CNET\_ERR\_SW = 0 ------| | |

| |

OTEMP\_FM\_FLG = 0 -----| | |

|OR --| |

OTEMP\_ERR\_SW = 0 -----| |

| --- ELSE ---

|

| tr\_fn\_flash = 1

| ;Flash TCIL for detected trans

| ;functional malfunction

TOT\_ERR\_SW = 0 -------|

|OR --|

TOT\_FM\_FLG = 0 -------| |

|

PDL\_ERROR = 0 --------| |

|OR --|

TRS\_ERR\_SW = 0 -------| |

|

P0503MALF = 0 --------| |

|OR --|

VS\_NOISE\_SW = 0 ------| |

|AND -| tr\_in\_flash = 0

P0500MALF = 0 --------| | | ;no transmission input

|OR --| | ;faults (for which flashing

VSS\_ERR\_SW = 0 -------| | | ;the TCIL is cal'ed in)

| | ;have been detected

P0720MALF = 0 --------| | |

|OR --| |

OSS\_ERR\_SW = 0 -------| | |

| |

P0721MALF = 0 --------| | |

|OR --| |

OS\_NOISE\_SW = 0 ------| |

| --- ELSE ---

|

| tr\_in\_flash = 1

| ;Flash TCIL for detected trans

| ;input malfunction

25-9

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL INDICATOR LIGHT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TCILTMR LOGIC

CRKFLG = 1 -----------------------|

|

tr\_in\_flash = 0 ------------| |OR --| TCILTMR = 0

| | | ;Conditions to flash

tr\_out\_flash = 0 -----------|AND -| | ;the TCIL not met, zero

| | ;flashing mode entry delay

tr\_fn\_flash = 0 ------------| | ;timer

unconditionally ------------------------| output(TCIL\_STATE)

|

| (Turn TCIL on/off based

| on TCIL\_STATE)

25-10

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL SWITCH - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.3 TRANSMISSION CONTROL SWITCH (CDAM0)

OVERVIEW

The momentary contact Transmission Control Switch allows the driver to 1)

select an alternate shift pattern or 2) lockout overdrive (fourth gear). The

function of the Transmission Control Switch is dependent on the application.

On each power-up, the state of the Transmission Control Switch is 1)

alternate shift pattern disabled or 2) overdrive lockout disabled.

In addition to the TCS input processing logic, this module contains TCS self

test. During engine running self test the operator is required to depress

the Transmission Control Switch. The TCS circuit test monitors the ITCS

register for the states corresponding respectively to the open and the closed

states of the switch. If, during the course of the KOER test sequence, both

states are not recognized, code 1780 will be output diring the KOER code

output.

DEFINITIONS

INPUTS

Registers:

- ER\_STATUS = Defines current position in ER sequence. Control of this

psuedo parameter passes between the ER sequencer and the individual ER

tests.

- TM\_TCS\_RES = Transmission Control switch input residence timer, sec.

- TSTRAT = Transmission strategy switch; The TSTRAT software switch

controls which transmission control strategy is executed:

0 -> No transmission control (Manual trans., AOD, ATX, C6, C3, etc.)

1 -> SIL (Shift indicator light)

2 -> A4LD with 3-4 shift control and converter clutch control

3 -> AXOD

4 -> C64E (E4OD)

5 -> A4LDE

6 -> FAX-4

7 -> AOD-E (AOD-I)

8 -> 4EAT

9 -> CD4E

- VSBART\_RT = Filtered vehicle speed compensated for N/V.

Bit Flags:

- CCM\_ER\_ENA = Engine Running CCM test enable flag; 1 -> Engine Running CCM

test enabled.

- FLG\_FRST\_TCS = Flag used to prevent multiple toggles of FLG\_TCS during a

single activation of TCS button; 0 -> FLG\_TCS has not been toggled, 1 ->

FLG\_TCS has been toggled.

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TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL SWITCH - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- ITCS = Transmission Control switch input state; 0 -> TCS depressed, 1 ->

TCS not depressed.

- OPER\_RSP\_CHK = Operator response check flag; 1 -> Engine running response

check over, output code if operator response was not observed during

KOER.

- TCS\_OPEN = 1 -> the LOW voltage state of the TCS input pin on the LSI has

been recognized during the KOER TCS test.

- TCS\_SHORT = 1 -> the HIGH voltage state of the TCS input pin on the LSI

has been recognized during the KOER TCS test.

Calibration Constants:

- ER\_INIT = Value for state of ER\_STATUS when engine running test first

inits.

- TMTCS = Transmission Control switch residence time, sec.

- TCS\_TST\_ENA = TCS circuit test enable switch; 1 -> enable.

- VS\_OD\_CAN = Vehicle speed above which O/D cancel will not be allowed.

OUTPUTS

Registers:

- TM\_TCS\_RES = See above.

Bit Flags:

- FLG\_FRST\_TCS = See above.

- FLG\_TCS = Transmission control switch flag.

- TCS\_OPEN = See above.

- TCS\_SHORT = See above.

OTHER

- clear\_malf(Pxxx) = Logic process, clear malfunction flag indicated by

Pxxx.

- tcs\_codes = Set of Transmission Control Switch fault codes {P1780}.

- store\_code(Pxxx) = Stores the fault code specified by Pxxx.

- P1780 = Fault code; TCS did not change states during engine running

on-demand self test.

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TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL SWITCH - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_TCS\_OBDII\_COM1

At power-up initialize the following parameter:

initially -------------------------------| FLG\_TCS = 0

Once per background the following logic is executed:

TSTRAT <= 3 ------------------------------| Exit module

(Manual/non-electric transmission) |

| --- ELSE ---

|

ITCS = 1 ---------------------------------| Allow TM\_TCS\_RES to count up

(TCS button depressed, 12 volts) |

| --- ELSE ---

|

ITCS = 0 ---------------------------------| TM\_TCS\_RES = 0

(normal state, 0 volts) | (zero residence timer)

| FLG\_FRST\_TCS = 0

| (clear first pass flag)

VSBART\_RT > VS\_OD\_CAN --------------------| FLG\_TCS = 0

|

| --- ELSE ---

|

TM\_TCS\_RES >= TMTCS ----------------| |

(button depressed long enough) |AND -| Toggle FLG\_TCS

| | (change TCS state)

FLG\_FRST\_TCS = 0 -------------------| | FLG\_FRST\_TCS = 1

(1st time to toggle TCS) | (set first pass flag)

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TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL SWITCH - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The on-demand TCS test requires the self test operator to toggle the TCS

during engine running self test. The logic works as follows - during engine

running initialization the TCS open/short flags are cleared. Code P1780 will

be set if both states are not observed during the operator response check

portion of engine running self test.

ER\_STATUS = ER\_INIT ----------------------| TCS\_SHORT = 0

(During KOER initialization) | TCS\_OPEN = 0

| (Initialize TCS

| test parameters)

|

| --- ELSE ---

CCM\_ER\_ENA = 0 ---------------| |

(Engine Runing CCM disabled) |AND -| |

| | |

OPER\_RSP\_CHK = 0 -------------| | |

(Operator response check code |OR --| Exit module

output disabled) | | (Engine running CCM

| | not in progress, or TCS

TCS\_TST\_ENA = 0 --------------------| | test disabled)

(TCS test cal'ed out) |

| --- ELSE ---

|

ITCS = 1 ---------------------------------| TCS\_SHORT = 1

(TCS button depressed, 12 volts) | (TCS closed state has

| been monitored during

| engine running self test)

|

| --- ELSE ---

|

| TCS\_OPEN = 1

| (TCS open state has

| been monitored during

| engine running self test)

OPER\_RSP\_CHK = 1 -------------------|

(Operator response check code |

output enable) |

|AND -| store\_code(P1780)

TCS\_SHORT = 0 ----------------| | |

(TCS closed state has not | | | (Operator response check

been observed) |OR --| | is over and both TCS states

| | have not been observed, set

TCS\_OPEN = 0 -----------------| | code 1780)

(TCS open state has not |

been observed) |

| --- ELSE ---

|

| clear\_malf(P1780)

25-14

TRANSMISSION INPUT CONVERSIONS, TORQUE NET CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.4 TORQUE NET CALCULATION (CDAN0)

OVERVIEW

This module calculates the brake torque available at the engine output. It

is based on a base torque value, modified for spark deviation from MBT, for

fuel deviation from stoichiometry, for engine friction, for accessory loads

and for A/C. It also calculates the torque at the input to the transmission.

If that torque TQ\_INP\_NET exceeds the limit TQ\_LIMIT, then a torque reduction

ratio is calculated. This value is used by spark to clip spark.

DEFINITIONS

Registers:

- ECT = Engine coolant temperature, deg F.

- GR\_CM = Commanded gear for shift solenoids.

- INJ\_TR = Torque ratio obtained from turning off a number of injectors.

- LOAD = Universal load as ratio of air charge over standard.

- N = RPM.

- SAFTOT = The SAF spark value after modification by foreground strategy,

deg.

- SPD\_RATIO = Speed Ratio Across Torque Converter (Output / Input).

- SPK\_LAMBSE = Value of LAMBSE to be used in spark calculations, unitless.

- SBK\_M\_B\_T = Spark advance required to achieve maximum brake torque.

- TQ\_BAR = Filtered TQ\_NET.

- TQ\_BAR\_LST = Last pass value of TQ\_BAR

- TQ\_INP\_NET = Transmission input shaft torque.

- TQ\_LIMIT = Gear specific transmission input torque limit.

- TQ\_MBT = Maximum gross torque that could be produced by engine.

- TQ\_NET = Net torque into torque converter.

- TQ\_NET\_LST = Last pass value of TQ\_NET.

- TQ\_NET\_S = Torque net from engine (signed).

- TR\_SPK\_DELTA = Current torque ratio as determined from spark advance,

which is being output by engine.

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TRANSMISSION INPUT CONVERSIONS, TORQUE NET CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TR\_TQ\_LIMIT = Torque ratio required to achieve TQ\_LIMIT.

Bit flags:

- ACCFLG = A/C engaged flag; 1 -> A/C engaged, 0 -> A/C disengaged.

- FLG\_TQ\_TRUN = Apply Torque limit when set.

- REVFLG = AXOD reverse flag; 1 -> reverse.

Calibration Constants:

- FN617 = Torque converter torque ratio.

- FN618A = Engine accessory torque without A/C.

- FN619A = A/C accessory torque.

- FN623 = Fuel multiplier used in torque calculation.

- FN766 = Transfer function which calculates the torque ratio at which an

engine is operating from the spark delta from MBT.

- FN1615A = Indicated engine torque for TQ\_NET calculation

- FN1616 = Engine friction torque for TQ\_NET calculation; X = normalized

engine speed in rpm.

- FNFRIC\_TQ(N,ECT) = Cold multiplier to the torque loss calculations.

X = FN070C(N) = Normalizing function for engine speed.

Y = FN014(ECT) = Normalizing function for ECT.

- FNTQ\_MAX = Gear specific transmission input torque limit.

- TCTQ\_BAR = Time constanty for TQ\_BAR.

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TRANSMISSION INPUT CONVERSIONS, TORQUE NET CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_TRANS\_TQ\_NET\_CALC\_COM12

ACCFLG = 1 ------------| ac\_torque = FN619A(N)

(A/C on) |

| --- ELSE ---

|

| ac\_torque = 0

always ----------------| TR\_SPK\_DELTA = FN766(SPK\_M\_B\_T - SAFTOT)

always ----------------| tq\_mbt = FN1615A(N,LOAD) \* FN623(SPK\_LAMBSE) \*

| INJ\_TR

| tq\_loss = FN1616(N,LOAD) + FN618A(N)

| + ac\_torque + FNFRIC\_TQ(N,ECT)

| TQ\_MBT = tq\_mbt - tq\_loss

| tq\_inp\_mbt = max(TQ\_MBT \* FN617(SPD\_RATIO), 0.0)

| TQ\_NET\_S = tq\_mbt \* TR\_SPK\_DELTA - tq\_loss

| TQ\_NET\_LST = TQ\_NET

| TQ\_NET = max(TQ\_NET\_S, 0)

| TQ\_INP\_NET = TQ\_NET \* FN617(SPD\_RATIO)

| TQ\_BAR\_LST = TQ\_BAR

| TQ\_BAR = ROLAV(TQ\_NET,TCTQ\_BAR)

REVFLG = 1 ------------| fn\_index = 0

|

| --- ELSE ---

|

| fn\_index = GR\_CM

always ----------------| TQ\_LIMIT = FNTQ\_MAX[fn\_index]

TQ\_LIMIT < tq\_inp\_mbt -| tq\_eng = TQ\_LIMIT / FN617(SPD\_RATIO) + tq\_loss

| TR\_TQ\_LIMIT = min(tq\_eng / tq\_mbt, 1.0)

| FLG\_TQ\_TRUN = 1

|

| --- ELSE ---

|

| TR\_TQ\_LIMIT = 1.0

| FLG\_TQ\_TRUN = 0

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TRANSMISSION INPUT CONVERSIONS, VS\_RATE CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.5 VS\_RATE CALCULATIONS (CDAF0)

OVERVIEW

Vehicle acceleration rate VS\_RATE is calculated by differentiating VSBART

with respect to time. This is to be used in calibrating the prevent

powertrain hunting strategy.

The calculation is performed as follows: Every time VSBARTL is updated, the

time at which this occurs is stored in VS\_SMPL\_TM. Every background loop the

acceleration is computed using the current and previous values of VSBARTL and

VS\_SMPL\_TM (backwards difference approximation). The result is then

converted to MPH/seconds, filtered and the current values of VSBARTL and

VS\_SMPL\_TM become the previous values in preperation for the next

calculation.

DEFINITIONS

INPUTS

Registers:

- VSBARTL = Word value of vehicle speed for transmission use, MPH.

- VSBARTL\_PREV = Previous value of VSBARTL.

- VS\_SMPL\_TM = Value in the MS\_CLOCK at the time VSBART is calculated.

Calibration Constants:

- TCVSR = Time constant for vehicle acceleration.

- TCVSRPH = Time constant for vehicle acceleration.

- TCVSRSS = Time constant for vehicle acceleration used for shift schedule

compensation.

- VSRATE\_MAX = Maximum allowable vehicle acceleration to be used in shift

schedule compensation.

- VSRATE\_MIN = Minimum allowable vehicle acceleration to be used in shift

schedule compensation.

OUTPUTS

Registers:

- VSBARTL\_PREV = See above.

- VS\_RATE = Filtered vehicle acceleration rate.

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TRANSMISSION INPUT CONVERSIONS, VS\_RATE CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- VS\_RATEPH = Filtered vehicle acceleration rate.

- VS\_RATE\_SS = Filtered vehicle acceleration rate used for shift schedule

compensaton.

- VSSMPLTM\_PREV = See above.

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TRANSMISSION INPUT CONVERSIONS, VS\_RATE CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_CALC\_VS\_RATE\_COM1

unconditionally -----| vs\_smpl\_prd = (VS\_SMPL\_TM - VSSMPLTM\_PREV) / 1024

| (time since last calculation in seconds)

| vsr = [(VSBARTL - VSBARTL\_PREV) / vs\_smpl\_prd]

| (instantaneous vehicle acceleration in MPH/sec)

| VS\_RATE = ROLAV(vsr,TCVSR,vs\_smpl\_prd)

| VS\_RATEPH = ROLAV(vsr,TCVSRPH,vs\_smpl\_prd)

| vs\_rate\_ss = ROLAV(vsr,TCVSRSS,vs\_smpl\_prd)

| VS\_RATE\_SS = min(VSRATE\_MAX,

| (max(vs\_rate\_ss,VSRATE\_MIN))

| VSSMPLTM\_PREV = VS\_SMPL\_TM

| VSBARTL\_PREV = VSBARTL

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TRANSMISSION INPUT CONVERSIONS, SHIFT SCHEDULE COMPENSATION CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.6 PREDICTIVE SHIFT SCHEDULE COMPENSATION CALCULATIONS (CDAN0)

OVERVIEW

This module calculates the predictive vehicle used to compensate the shift

schedules for system delays (e.g. solenoid delay times between command and

start of a shift).

Both the upshift and downshift predicted vehicle speeds are calculated. The

predicted values are calculated using the associated delay times based from

the current gear.

Predictive engine speed is also calculated here for engine based upshifts.

The predicted values are calculated using background loop, hardware delays,

verify time, and engine acceleration. It can be calibrated out with a switch

if desired.

The base hardware delay times should be calibrated when the transmission has

reached normal operating temperature. A scalar multplier as a function of

TOT is provided to compensate the hardware delay times.

DEFINITIONS

Registers:

- BG\_TMR = Background loop time.

- DNDT\_PSS = Engine acceleration for predictive shift scheduling.

- GR\_CM = Commanded gear.

- GR\_DS = Desired transmission gear.

- GR\_DS\_LST = Desired gear in last background pass.

- NEBART = Engine speed.

- NEBART\_PU = Predicted engine speed for an upshift from current gear.

- RT\_NOVS = Ratio of actual N/V to base N/V stored.

- TM\_12\_AKD = Timer register to track time in 1st gear after a 3-1/4-1

kickdown.

- TOT = Transmission oil temperature (degrees F).

- TP\_REL = Relative TP (TP - RATCH).

- VSBART = Filtered vehicle speed for transmission in MPH.

- VSBART\_RT = VSBART / RT\_NOVS (MPH).

- VSBART\_RT\_PD = Predicted vehicle speed for a downshift from current gear.

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TRANSMISSION INPUT CONVERSIONS, SHIFT SCHEDULE COMPENSATION CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- VSBART\_RT\_PU = Predicted vehicle speed for an upshift from current gear.

- VS\_RATE\_SS = Filtered Vehicle acceleration rate used for shfit schedule

compensation.

Bit FLags:

- FLG\_TIP\_OUT = Flag which indicates a tip-out upshift in progress; 0 -> no

tip-out upshift in progress, 1 -> a tip-out upshift in progress.

- FLG\_W12\_AKD = Flag indicating that a WOT 1-2 after a kickdown is

possible; 1 -> WOT 1-2 after a kickdown possible.

Calibration Constants:

- FNTOTDLY = Transmission temperature compensation for hardware delay

times, scalar multiplier.

- MAXNEPU = Maximum predictive engine speed. Clip to this value - engine

cannot accelerate more than this.

- NEPUMIN = Minimum engine speed to allow predictive engine speed based

upshifts to insure reliable engine acceleration rate calculation.

- NEPU\_SW = Switch to allow predictive engine speed based upshifts.

- TMDN2DLY = Shift hardware delay time associated with a downshift from

2nd.

- TMDN3DLY = Shift hardware delay time associated with a downshift from

3rd.

- TMDN4DLY = Shift hardware delay time associated with a downshift from

4th.

- TMUP1DLY = Shift hardware delay time associated with an upshift from 1st.

- TMUP2DLY = Shift hardware delay time associated with an upshift from 2nd.

- TMUP3DLY = Shift hardware delay time associated with an upshift from 3rd.

- TMVEDN = Time to delay desired automatic downshift, i.e. hold original

desired gear for this time, sec.

- TMVETOUP = Time to delay desired automatic tip-out upshift, i.e. hold

original desired gear for this time, sec.

- TMVEUP = Time to delay desired automatic upshift, i.e. hold original

desired gear for this time. units: secon.

- TMW12DLY = Shift hardware delay time associated with a WOT 1-2 shift

after a kickdown.

- TM12AKD = Time threshold in 1st gear to disable compensation for WOT 1-2

after a 3-1/4-1 kickdown, secs.

- TPNEPUMIN = Minimum throttle position to allow predictive engine speed

based upshifts to insure reliable engine acceleration rate calculation.

25-22

TRANSMISSION INPUT CONVERSIONS, SHIFT SCHEDULE COMPENSATION CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TP12AKD = Threshold to determine high throttle condition, counts.

- TP12HYS = Hysteresis value to determine a low throttle condition, counts.

- VS31MIN = Minimum vehicle speed to trigger the WOT 1-2 after a 3-1

kickdown, mph.

PROCESS

STRATEGY MODULE: INTRN\_SHFT\_SCHLD\_COMP\_CALC\_COM4

FLG\_TIP\_OUT = 1 ---------------------| tmversftss = TMVETOUP

|

| --- ELSE ---

|

| tmversftss = TMVEUP

Update the high throttle 1-2 after a 3-1/4-1 kickdown possible flag:

TP\_REL > TP12AKD --------------|

(high throttle) |

|

GR\_DS = 1 ---------------------|AND -| FLG\_W12\_AKD = 1

| | TM\_12\_AKD = TM12AKD

GR\_DS\_LST >= 3 ----------------| | (update flag/1st gear timer for

| | a high TP 1-2 after a 3-1/4-1

VSBART\_RT > VS31MIN -----------| | kickdown)

|

| --- ELSE ---

TP\_REL < TP12AKD - TP12HYS ----| |

|OR --| FLG\_W12\_AKD = 0

TM\_12\_AKD = 0 -----------------| |

| --- ELSE ---

|

| no action

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TRANSMISSION INPUT CONVERSIONS, SHIFT SCHEDULE COMPENSATION CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_W12\_AKD = 1 ---------------|

|AND -| hrdupdly = TMW12DLY \* FNTOTDLY(TOT)

GR\_CM = 1 ---------------------| |

| VSBART\_RT\_PU = VSBART\_RT + [RT\_NOVS

| \* ((VS\_RATE\_SS \* (tmversftss

| + hrdupdly + BG\_TMR)))]

|

| ne\_rate = min(MAXNEPU,DNDT\_PSS)

|

| --- ELSE ---

|

GR\_CM < 4 ---------------------------| hrdupdly = TMUP[GR\_CM]DLY \*

| FNTOTDLY(TOT)

|

| VSBART\_RT\_PU = VSBART\_RT + [RT\_NOVS

| \* ((VS\_RATE\_SS \* (tmversftss

| + hrdupdly + BG\_TMR)))]

|

| ne\_rate = min(MAXNEPU,DNDT\_PSS)

GR\_CM > 1 ---------------------------| hrddndly = TMDN[GR\_CM]DLY \*

| FNTOTDLY(TOT)

| VSBART\_RT\_PD = VSBART\_RT + [RT\_NOVS \*

| ((VS\_RATE\_SS \* (TMVEDN + hrddndly

| + BG\_TMR)))]

GR\_CM < 4 ---------------------|

|

NEBART > NEPUMIN --------------|

(engine speed high enough |

for a reliable rate) |

|AND -| NEBART\_PU = NEBART + (ne\_rate \*

TP\_REL > TPNEPUMIN ------------| | (tmversftss + hrdupdly + BG\_TMR))

(TP high enough for a | |

reliable rate) | |

| |

NEPU\_SW = 1 -------------------| |

(predictive cal'ed in for |

engine based shifts) |

| --- ELSE ---

|

| NEBART\_PU = NEBART

25-24

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION SELF TEST ENABLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.7 TRANSMISSION SELF TEST ENABLE (CDAM0)

OVERVIEW

As transmission operating temperature decreases, shift times and engagement

times increase (due to changes in fluid viscosity). Certain portions of the

transmission control and self test strategy (learned N/V, inferred vehicle

motion, gear ratio validity) are disabled when shifts and/or engagements are

in progress based on timers. Theses timers are not valid at low (sub-zero)

TOT.

A transmission self test enable flag (TST\_ENA\_FLG) will be set when it is ok

to execute the above mentioned transmission control strategy. This flag will

be set based on transmission operating temperature (TOT >= TST\_TOT\_MIN) if

TOT is not failed (FFG\_TOT = 0), or a minimum time since the engine has been

running (RUN\_TMR >= TST\_ENA\_TM) and engine coolant temperature (ECT >=

TST\_ECT\_MIN).

NOTE: the RUN\_TMR/ECT condition also protects for in range (low) TOT

failures, which is why the TOT failure mode flag is not checked for this

condition.

DEFINITIONS

INPUTS

Registers:

- ECT = Engine Coolant Temperature, deg F.

- TOT = Transmission Oil Temperature, deg F.

- RUN\_TMR = Time since entering "RUN" mode.

Bit Flags:

- FFG\_TOT = OBD-II system FMEM flag for TOT; 1 -> TOT is currently not

reliable.

Calibration Constants:

- TST\_DIS\_TIM = Maximum time transmission self test will be disable based

on TOT.

- TST\_ECT\_MIN = Minimum ECT to allow transmission self test entry if TOT

fails.

- TST\_TOT\_MIN = Minimum TOT to allow transmission self test entry.

25-25

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION SELF TEST ENABLE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Bit Flags:

- TST\_ENA\_FLG = Transmission self test enable flag; 1 -> TOT dependent

trans logic enabled.

PROCESS

STRATEGY MODULE: INTRN\_TST\_ENA\_COM1

FFG\_TOT = 0 ----------------|

(TOT is reliable) |AND -|

| |

TOT >= TST\_TOT\_MIN ---------| |

(TOT high enough to enable |

trans self test) |OR --| TST\_ENA\_FLG = 1

| | (Enable TOT dependent

ECT >= TST\_ECT\_MIN ---------| | | transmission logic)

(ECT high enough to enable | | |

trans self test) |AND -| |

| |

RUN\_TMR >= TST\_DIS\_TIM -----| |

(Max. time to disable trans self |

test based on TOT has passed) |

| --- ELSE ---

|

| TST\_ENA\_FLG = 0

| (Conditions not met to

| enable TOT dependent

| transmission logic)

25-26

TRANSMISSION INPUT CONVERSIONS, RT\_NOVS\_KAM CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.8 RT\_NOVS\_KAM CALCULATION (CDAJ0)

OVERVIEW

This module calculates RT\_NOVS\_KAM, based on filtered output shaft speed and

vehicle speed. The calculation occurs once after each power up and KAM

initialization. The calculation occurs when vehicle speed is in a reliable

area, and no related sensors have failed. The N / V ratio is calculated

NOVCNT times and as long as the samples calculated are approximately the

same, the average is taken and stored in KAM.

NOTE: The calibration constant NVBASE\_X\_NVC = Base N / V \* NVCNT. Choosing

the constant this way prevents the processor from having to perform the

multiplication during execution.

DEFINITIONS

INPUTS

Registers:

- N = Engine speed, RPM.

- NOBART = Filtered Output Shaft Speed in RPM.

- NOV\_ACT = Actual computed N / V.

- NOV\_ACT\_LST = Last pass value of NOV\_ACT.

- NOVCTR = Number of N / V calculations counter.

- NOVSUM = Running total of valid N / V samples.

- RT\_NOVS\_KAM = Ratio of actual N / V to base N / V.

- TM\_NOV\_CALC = Time since last NOV\_ACT calculation.

- VSBARV = Filtered Vehicle Speed, MPH.

- VSCTR = Count of MPH sensor errors.

Bit Flags:

- FLG\_4X4L = 4x4 low flag.

- FLG\_FRST\_NOV = 0 -> A new RT\_NOVS KAM value is needed for KAM.

- FLG\_NEW\_NOV = New NOV\_ACT calculation flag.

- OSFMFLG = Output shaft speed sensor FMEM flag.

- VSFMFLG = Vehicle speed sensor FMEM flag.

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TRANSMISSION INPUT CONVERSIONS, RT\_NOVS\_KAM CALCULATION - CDAN2

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Calibration Constants:

- NOVCNT = Minimum number of consecutive, good N / V samples required to

update KAM.

- NOVDIF = Maximum difference between N / V samples, RPM / MPH.

- NVBASE\_X\_NVC = Base N / V \* NOVCNT.

- RT4X4L = 4 x 4 low transfer case ratio units.

- RTNVMN = Minimum valid RT\_NOVS\_KAM value.

- RTNVMX = Maximum valid RT\_NOVS\_KAM value.

- TMRTVSCAL = Time between consecutive NOV calculations.

- VSRTVSMN = Minimum vehicle speed to calculate N / V.

OUTPUTS

Registers:

- NOV\_ACT = See above.

- NOV\_ACT\_LST = See above.

- NOVCTR = See above.

- NOVSUM = See above.

- RT\_NOVS = Ratio of actual N / V to base N / V stored.

- RT\_NOVS\_KAM = See above.

- TM\_NOV\_CALC = See above.

Bit Flags:

- FLG\_FRST\_NOV = See above.

- FLG\_NEW\_NOV = See above.

- FLG\_NOV\_KAM = Flag indicating at least one update of RT\_NOVS\_KAM has

occurred since KAM initialization.

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TRANSMISSION INPUT CONVERSIONS, RT\_NOVS\_KAM CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_RT\_NOVS\_KAM\_CALC\_COM2

FLG\_FRST\_NOV = 0 ----------------------|

(need to calculate N / V) |

|

VSBARV >= VSRTVSMN --------------------|

(vehicle speed signal is reliable) |

|

TM\_NOV\_CALC >= TMRTVSCAL --------------|AND -| NOV\_ACT\_LST = NOV\_ACT

(enough time since last calculation) | | (update last pass NOV

| | calculation)

VSFMFLG = 0 ---------------------------| | NOV\_ACT = NOBART / VSBARV

| | (compute actual NOV)

OSFMFLG = 0 ---------------------------| | TM\_NOV\_CALC = 0

| | (reset interval pacer)

VSCTR = 0 -----------------------------| | NOVCTR = NOVCTR + 1

| (increment sample counter)

| FLG\_NEW\_NOV = 1

| (New NOV\_ACT occurred)

|

| --- ELSE ---

|

| FLG\_NEW\_NOV = 0

| (No new NOV\_ACT)

FLG\_NEW\_NOV = 1 -----------------------|

(new N / V actual this pass) |AND -| NOVCTR = 0

| | (reset sample counter)

ABS(NOV\_ACT\_LST - NOV\_ACT) > NOVDIF ---| | NOVSUM = 0

(too much variation in NOV calculations) | (reset running total)

|

| --- ELSE ---

|

FLG\_NEW\_NOV = 1 -----------------------------| NOVSUM = NOVSUM + NOV\_ACT

NOVCTR = NOVCNT -----------------------|

(enough consecutive matches) |

|

FLG\_FRST\_NOV = 0 ----------------------|AND -| RT\_NOVS\_KAM = NOVSUM /

(new value for KAM) | | NVBASE\_X\_NVC

| | (store new NOV ratio in KAM)

RTNVMN <= (NOVSUM/(NVBASE\_X\_NVC)) | | RT\_NOVS = RT\_NOVS\_KAM

<= RTNVMX -----------| | FLG\_FRST\_NOV = 1

(reasonable value for N / V has been | (do not store another)

calculated) | FLG\_NOV\_KAM = 1

| (indicate a new update since

| KAM initialization)

25-29

TRANSMISSION INPUT CONVERSIONS, RT\_NOVS\_KAM CALCULATION - CDAN2

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FLG\_4X4L = 1 --------------------------------| RT\_NOVS = RT\_NOVS\_KAM \*

| RT4X4L

| (modify shift schedule by

| transfer case ratio)

|

| --- ELSE ---

|

| RT\_NOVS = RT\_NOVS\_KAM

25-30

INPUT CONVERSIONS AND FILTERS, AODE TRANSMISSION CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.9 AODE TRANSMISSION CALCULATIONS (CDAL0)

OVERVIEW

These System Equations are used in the AODE Transmission Calculation Process.

DEFINITIONS

INPUTS

Registers:

- AM = Air Mass flow through the throttle body, lb/min.

- BP = Barometric pressure as defined in the Inferred BP Section.

- ENGCYL = Number of injections per engine revolution = 2, 3, 4 for 4, 6,

and 8-cylinder engines respectively.

- N = Engine RPM.

- NEBART = Filtered engine RPM for transmission.

- NOBART = Filtered transmission output shaft speed.

- NTBART = Filtered transmission turbine speed, rpm.

- RATCH = Closed throttle position, counts.

- RT\_GR\_CUR = Current transmission gear ratio.

- TP = Throttle Position, counts.

- TPBART = Filtered throttle position for transmission.

- TP\_REL = Relative TP, (TP - RATCH).

Calibration Constants:

- SARCHG = Standard Aircharge = 4.4256E-05 \* CID/# of cylinders.

- TCNE = Time constant for filtered RPM.

- TCTPREL = Time constant for filtered TP\_REL, sec.

- TCTPTE = Time constant for filtered TP.

- TCTPTV = Time constant for filtered TP for TV pressure.

25-31

INPUT CONVERSIONS AND FILTERS, AODE TRANSMISSION CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- ARCHG = See above.

- BP\_INTR = BP interpolation factor = FN615(BP).

- LOAD = Nondimensional, generic engine load.

- NEBART = See above.

- NTBART = See above.

- SLIP\_ABS = Absolute value of SLIP = NEBART - NTBART, rpm.

- SPD\_RATIO = Speed ratio across torque converter.

- TPBART\_PWF = Filtered throttle position for performance and normal.

- TP\_RATE = Throttle rate.

- TPRATE\_PWF = Throttle position rate for performanc and normal.

- TP\_REL = See above.

- TP\_REL\_BAR = Filtered TP\_REL (TP - RATCH).

- TPBART = See above.

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INPUT CONVERSIONS AND FILTERS, AODE TRANSMISSION CALCULATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_AODE\_INPUT\_EQNS\_COM1

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* FILTERED ENGINE SPEED FOR TRANSMISSIONS USE \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

NEBART = ROLAV(N,TCNE)

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* FILTERED THROTTLE POSITION FOR TRANSMISSION USE \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

TPBART = ROLAV(TP,TCTPTE)

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* THROTTLE POSITION RATE \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

TP\_RATE = TP - TPBART (TP\_RATE is clipped to +/- 512 counts)

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* FILTERED THROTTLE POSITION FOR PNN \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

TPBART\_PWF = ROLAV(TP,TCTPPWF)

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* THROTTLE POSITION RATE FOR PNN \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

TPRATE\_PWF = TP - TPBART\_PWF (TPRATE\_PWF is clipped to +/- 512 counts)

25-33

INPUT CONVERSIONS AND FILTERS, AODE TRANSMISSION CALCULATIONS - CDAN2

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\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* FILTERED TRANSMISSION TURBINE SPEED \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

NTBART = NOBART \* RT\_GR\_CUR

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* BP INTERPOLATION FACTOR \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

BP\_INTR = FN615(BP)

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* SPEED RATIO ACROSS TORQUE CONVERTER \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

NTBART

SPD\_RATIO = ------

NEBART

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* FILTERED THROTTLE POSITION FOR TV PRESSURE \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

TPBARTV = ROLAV(TP,TCTPTV)

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* FILTERED THROTTLE POSITION FOR TORQUE INTERPOLATION STRATEGY \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

TP\_REL\_BAR = ROLAV(TP\_REL,TCTPREL)

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* ABSOLUTE VALUE OF SLIP \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

SLIP\_ABS = |NEBART - NTBART|

25-34

INPUT CONVERSIONS AND FILTERS, COLD SHIFT MULTIPLIER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.10 COLD SHIFT MULTIPLIER (CDAF0)

OVERVIEW

During cold weather starts/drives, the initial shifts of the transmission

seem delayed. This impression results from the decrease in engine torque

during the early part of the cold start. Therefore, strategy which computes

shift schedules as a function of the initial Transmission Oil Temperature,

TOT, (temperature at the time of the start), to the current TOT is required.

The cold weather strategy output CS\_SFT\_MULT, is also used in the

unconditional converter clutch unlock strategy. When CS\_SFT\_MULT is not

equal to one, the converter clutch is unconditionally unlocked; i.e., when

cold transmission conditions exist, the converter clutch is kept unlocked.

Once CS\_SFT\_MULT gets set to 1.0 (transmission is warm), the check on TOT

will be disabled.

A time limit is placed upon the time allowed for the actual TOT to rise above

the initial TOT.

FLG\_TQM\_ENA is set based on a function of Initial TOT or ECT. FLG\_TQM\_ENA is

used to limit the spark retard due to toarue modulation when the powertrain

is cold.

DEFINITIONS

INPUTS

Registers:

- ECT = Engine coolant temperature, degrees F.

- INIT\_TOT = TOT at start-up; arithmetic average of the first 8 TOT

reading.

- TOT = Transmission Oil Temperature, degrees F.

- RUN\_TMR = Time since entering RUN mode, sec.

Bit Flags:

- FLG\_TOT\_WRM = Flag to signal transmission is sufficiently warm to

lock-up.

- FLG\_TQM\_ENA = Flag to signal transmission is sufficiently warm to permit

full spark retard due to torque modulation.

Calibration Constants:

- CS\_MAX\_TIME = Maximum time allowed in cold start shift schedules.

- CS\_MULT = Cold Start Multiplier for all shifts.

- ECT\_TQM = Engine coolant temperature required to permit toruqe

modulation.

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INPUT CONVERSIONS AND FILTERS, COLD SHIFT MULTIPLIER - CDAN2

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- FN690(INIT\_TOT) = Temperature required to leave cold start shift

schedules.

- FN690TQM(INIT\_TOT) = Transmission oil temperature required to permit

torque modulation.

OUTPUTS

Registers:

- CS\_SFT\_MULT = Cold Start Shift Multiplier.

Bit Flags:

- FLG\_TQM\_ENA = See above.

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INPUT CONVERSIONS AND FILTERS, COLD SHIFT MULTIPLIER - CDAN2

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PROCESS

STRATEGY MODULE: INTRN\_CSM\_COM3

TOT < FN690(INIT\_TOT) ------------|

|

RUN\_TMR < CS\_MAX\_TIME ------------|AND -| CS\_SFT\_MULT = CS\_MULT

| |

FLG\_TOT\_WRM = 0 ------------------| |

(once TOT reaches temperature, |

do not check again) |

| --- ELSE ---

|

| CS\_SFT\_MULT = 1.0

| FLG\_TOT\_WRM = 1

TOT < FN690TQM(INIT\_TOT) ---|

|OR --|

ECT < ECT\_TQM --------------| |

(Clip spark retard due to |

torque modulation until the |AND -| FLG\_TQM\_ENA = 0

powertrain warms up) | |

| |

FLG\_TQM\_ENA = 0 ------------------| |

| --- ELSE ---

|

| FLG\_TQM\_ENA = 1

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TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - CDAN2

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25.11 MLPS CONVERSION (CDAN0)

OVERVIEW

This strategy is a fully calibratable control strategy to allow the use of a

six position Manual Lever Position Sensor (MLPS) combined with the

Transmission Control Switch (TCS-if present). As defined by TAPME, all

transmissions have three forward positions, neutral, reverse and park. The

three forward positions are overdrive, second (if TCS present) or drive (if

no TCS present) and first. The second to last PRNDL position is calibratable

to second or drive using the MLPS\_2 parameter discussed later.

The analog MLPS input is decoded into IPDL to give one of six positions. In

this decoding, deadbands can be calibrated between each position range. The

calibration constants PARKHI, PARKLO, REVHI, REVLO, NEUHI, NEULO, ODHI, ODLO,

MLPS\_2HI, MLPS\_2LO, MAN1HI, and MAN1LO are the parameters for each

corresponding PRNDL position band. Anytime a MLPS fault is detected IPDL

will be set to zero.

A residence timer exists to delay passing the MLPS signal through to the

control. Anytime a change in IPDL occurs the residence timer is reset to

PDL\_TIM. PDL may only change states after the residence timer has timed out.

If the residence timer reaches zero with a valid region present, IPDL will be

passed into PDL. If the residence timer reaches zero in a failed condition

FMMMLP will be passed into PDL.

MLPS diagnostic testing distinguishes four separate failure modes: in range

failure, (P0705), MLPS short to ground, (P0707), MLPS open circuit, (P0708),

and high vehicle speed observed in park, (P1706). When any of the MLPS codes

are set, PDL\_ERROR will be set, which tells the control to enter FMEM.

NOTE: During EPC VFS short circuit FMEM (OFMFLG = 1), OD will be cancelled

to prevent failure of the direct clutch . The direct clutch carries a

greater percentage of input torque in 4th (compared to 3rd), and half fuel is

not enough to prevent the direct clutch from slipping in 4th gear.

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TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - CDAN2

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Below is a diagram showing how the MLPS test parameters are related.

The logic starts by checking for the presence of three of the fault

conditions, high vehicle speed in park, the MLPS open circuit and finally

MLPS short to ground. If any of these faults are present it is flagged, IPDL

set to zero and this logic exited.

Next the logic compares the current MLPS output (INDS) to the Park range, if

INDS is between PARKHI and PARKLO, IPDL is set to PARK. If INDS is not

within the PARK range, the strategy compares INDS to the REVERSE range (then

NEUTRAL, OD,...,MAN1). As soon as a valid range is found, IPDL is set to

that position and this logic is exited. If a valid range is not found, IPDL

is set to zero.

If calibrating out one of the error bands is desired, the parameters on

either side of the band should be set equal. Example - to calibrate out the

band between Park and Reverse, PARKLO = 826 = REVHI would work

PRNDL POSITION CALIBRATION PARAMETER APPROXIMATE VALUE

OUT OF RANGE HI

\_\_\_\_\_\_\_\_\_ ------------ PARKHI 968

| |

| PARK |

|\_\_\_\_\_\_\_\_\_|

------------ PARKLO 879

ERROR BAND

\_\_\_\_\_\_\_\_\_ ------------ REVHI 773

| |

| REVERSE |

|\_\_\_\_\_\_\_\_\_|

------------ REVLO 701

ERROR BAND

\_\_\_\_\_\_\_\_\_ ------------ NEUHI 621

| |

| NEUTRAL |

|\_\_\_\_\_\_\_\_\_|

------------ NEULO 537

ERROR BAND

\_\_\_\_\_\_\_\_\_ ------------ ODHI 468

| |

| OD |

|\_\_\_\_\_\_\_\_\_|

------------ ODLO 385

ERROR BAND

\_\_\_\_\_\_\_\_\_ ------------ MLPS\_2HI 314

| |

| MLPS\_2 |

|\_\_\_\_\_\_\_\_\_|

------------ MLPS\_2LO 245

ERROR BAND

\_\_\_\_\_\_\_\_\_ ------------ MAN1HI 160

| |

| MANUAL1 |

|\_\_\_\_\_\_\_\_\_|

------------ MAN1LO 60

OUT OF RANGE LO

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TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - CDAN2

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DEFINITIONS

Registers:

- CCM\_TST\_ENA = OBDII Comprehensive Component test enable flag; 1 -> test

enabled.

- INDS = Input from manual lever position sensor (MLPS) in counts.

- INDS\_LST = Previous input from MLPS.

- IPDL = Unverified PRNDL position.

- IPDL\_LST = Last unverified PRNDL position.

- NDSFLG = Neutral/Drive Flag; 1 -> Drive.

- PDL = Verified PRNDL position.

- PDL\_ERR\_TMR = PRNDL malfunction test error timer.

- PDL\_LST = Last verified PRNDL value.

- PDL\_MON\_TMR = MLPS monitor timer.

- P0707FIL = MLPS short to ground fault filter.

- P0708FIL = MLPS open circuit fault filter.

- TM\_PDL\_RES = Input residence timer.

- VS = Vehicle Speed.

Bit Flags:

- CCM\_EO\_ENA = Key on engine off CCM test enabled; 1 -> enabled.

- FLG\_TCS = Transmission control switch flag.

- OFMFLG = EPC VFS short circuit failure mode flag; 1 -> EPC VFS short

circuti failure detected.

- PARK\_ERR = High vehicle speed in park error flag; 1 -> High vehicle speed

in park band error, 0 -> Vehicle speed in park range.

- PDL\_ERROR = PRNDL FMEM flag; 1 -> Enter FMEM for PRNDL, 0 -> Don't enter

FMEM for PRNDL.

- PDL\_GND = MLPS short to ground present.

- PDL\_MON = MLPS monitored flag; 1 -> MLPS monitored, 0 -> MLPS not

monitored.

- PxxxMALF = Malfunction flag for code Pxxx; 1 -> a malfunction currently

exists for fault Pxxx.

- PDL\_HGH = MLPS open circuit present.

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TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - CDAN2

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Calibration Constants:

- DLT\_INDS = Minimum change in MLPS voltage which guarantees a shift has

taken place.

- FMMMLP = IPDL value when PDL\_ERROR is present.

- MLPS\_KOEO\_EN = MLPS KOEO test enable calibration switch; 1 -> test called

in.

- MAN1HI = MLPS manual 1 position band high limit.

- MAN1LO = MLPS manual 1 position band low limit.

- MLPS\_2 = IPDL value when MLPS is in the second to last position; 2 ->

Manual 2 has been selected (TCS present), 3 -> Drive mode/Overdrive

cancel has been selected (no TCS present).

- MLPS\_2HI = MLPS second to last position band high limit.

- MLPS\_2LO = MLPS second to last position band low limit.

- NEUHI = MLPS neutral position band high limit.

- NEUHI\_EO = MLPS neutral position band high limit for engine off self

test.

- NEULO = MLPS neutral position band low limit.

- NEULO\_EO = MLPS neutral position band low limit for engine off self test.

- ODHI = MLPS overdrive position band high limit.

- ODLO = MLPS overdrive position band low limit.

- PARK\_ERR\_TM = Park validity test error time, minimum time error must be

present to set code, sec.

- PARKHI = MLPS park position band high limit.

- PARKHI\_EO = MLPS park position band high limit for engine off self test.

- PARKLO = MLPS park position band low limit.

- PARKLO\_EO = MLPS park position band low limit for engine off self test.

- PDL\_ERR\_TM = PRNDL malfunction test error time, minimum time error must

be present to set code.

- PDL\_MON\_TM = Minimum amount of time MLPS sensor must be observed to set

the monitor flag.

- PDLTIM = PRNDL load residence time.

- PDL\_LVL = Fault filter failure level.

- PDL\_UP = Fault filter up count value.

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TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - CDAN2

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- REVHI = MLPS reverse postion band high limit.

- REVLO = MLPS reverse position band low limit.

- TSTRAT = Transmission Strategy Switch; The TSTRAT software switch selects

which transmission control strategy to be executed:

0 -> No transmission control (Manual trans., AOD,ATX,C6,C3, etc)

1 -> SIL (Shift Indicator Light)

2 -> A4LD with 3-4 shift control and converter clutch control.

3 -> AXOD

4 -> C64E(E40D)

5 -> A4lDE

6 -> FAX-4

7 -> AOD-E (AOD-I)

8 -> 4EAT

9 -> CD4E

- VSPMIN = Indicate PRNDL error if PRNDL = park and vehicle speed is GE,

this value (MPH).

OTHER

- MLP\_CODES = Set of (P0705, P0707, P0708, P1705, P1706) MLPS OBDII fault

codes.

- NDS\_CODES = Set of (P1709) fault codes.

- P1709 = Fault code for vehicle not in park or neutral.

- P0705 = Fault code for out of range.

- P0707 = Fault code for MLPS short to ground.

- P0708 = Fault code for MLPS open circuit.

- P1705 = Fault code for MLPS indicating incorrect position during KOEO.

- P1706 = Fault code for high vehicle speed observed in park.

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TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - CDAN2

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PROCESS

STRATEGY MODULE: INTRN\_MLPS\_CONV\_COM9

As the PRNDL switch moves from position to position, the next contact is made

before the current contact is broken. This prevents sensing an open circuit

condition during PRNDL transitions.

At power-up initialize the following parameter:

initially ------------------------------| PDL = 7

| PDL\_LST = 4

| IPDL = 5

Once per Background the following logic is executed:

always ---------------------------------| PDL\_LST = PDL

| IPDL\_LST = IPDL

TSTRAT >= 4 ----------------------------| Do: mlps\_range\_check

(Electronic Automatic Transmission | Do: mlps\_prndl\_verification

present)

CCM\_EO\_ENA = 1 -------------------------| Do: mlps\_eo\_test

(Engine Off CCM test enabled |

| --- ELSE ---

CCM\_TST\_ENA = 1 ------------------| |

(Continuous CCM test enabled) |AND -| Do: mlps\_prndl\_malfunction

| |

TSTRAT >= 4 ----------------------| |

(Electronic Automatic Transmission |

present) |

| --- ELSE ---

|

| Exit Module

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TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: mlps\_eo\_test

MLPS\_KOEO\_EN = 1 -----------------|

|

INDS < PARKLO\_EO -----------| |

|OR --|

INDS > PARKHI\_EO -----------| |AND -| store\_code(P1705)

(INDS not indicating park) | |

| | (MLPS not indicating required

INDS < NEULO\_EO ------------| | | position during KOEO)

|OR --| |

INDS > NEUHI\_EO ------------| |

(INDS not indicating neutral) |

| --- ELSE ---

TSTRAT < 4 -----------------------| |

(manual or non\_electronic | |

automatic trans,) |AND -| store\_code(P1709)

| |

NDSFLG = 1 -----------------------| | (Park/Neutral Position switch

| not indicating Neutral during

| KOEO)

|

| --- ELSE ---

|

| clear\_malf(P1705)

| clear\_malf(P1709)

| (MLPS/PNP reading correctly

| during KOEO)

END: mlps\_koeo\_test

BEGIN: mlps\_range\_check

To verify the INDS signal is in an allowable range and convert the counts

into a PRNDL position.

always ---------------------------------| PARK\_ERR = 0

| PDL\_HGH = 0

| PDL\_GND = 0

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TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PARKLO <= INDS < PARKHI ----------|

|AND -| IPDL = 0

VS > VSPMIN ----------------------| | PARK\_ERR = 1

|

| --- ELSE ---

|

INDS >= PARKHI -------------------------| IPDL = 0

| PDL\_HGH = 1

|

| --- ELSE ---

|

INDS < MAN1LO --------------------------| IPDL = 0

| PDL\_GND = 1

|

| --- ELSE ---

|

PARKLO <= INDS < PARKHI ----------------| (PARK position)

| IPDL = 7

|

| --- ELSE ---

|

REVLO <= INDS < REVHI ------------------| (REVERSE position)

| IPDL = 6

|

| --- ELSE ---

|

NEULO <= INDS < NEUHI ------------------| (NEUTRAL position)

| IPDL = 5

|

| --- ELSE ---

|

ODLO <= INDS < ODHI --------------------| (OVERDRIVE position)

| IPDL = 4

|

| --- ELSE ---

|

MLPS\_2LO <= INDS < MLPS\_2HI ------------| (MLPS\_2 postion)

| IPDL = MLPS\_2

|

| --- ELSE ---

|

MAN1LO <= INDS < MAN1HI ----------------| (MANUAL 1 postion)

| IPDL = 1

|

| --- ELSE ---

|

| (in range fault detected)

| IPDL = 0

END: mlps\_range\_check

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TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: mlps\_prndl\_verification

IPDL <> IPDL\_LST -----------------|

|OR --| TM\_PDL\_RES = PDLTIM

IPDL = 0 -------------------| | | (load residence timer)

|AND -|

|INDS - INDS\_LST| > |

DLT\_INDS --|

always ---------------------------------| INDS\_LST = INDS

Set PDL based on IPDL, TCS (if present), and fault flags:

IPDL = 0 -------------------|

|AND -|

TM\_PDL\_RES = 0 -------------| |

|

P0707MALF = 1 --------------------|OR --| Do: PDL FMEM Logic

(MLPS short circuit present) | |

| |

P0708MALF = 1 --------------------| |

(MLPS open circuit present) |

| --- ELSE ---

|

TM\_PDL\_RES > 0 -------------------------| No Action Taken

|

| --- ELSE ---

IPDL = 4 -------------------------| |

(overdrive position) | |

| |

FLG\_TCS = 1 ----------| |AND -| PDL = 3

(overdrive cancel) |AND -| | | (Overdrive cancel/Drive

| | | | position selected)

MLPS\_2 = 2 -----------| |OR --| |

(TCS input present) | |

| |

OFMFLG = 1 -----------------| |

(EPC VFS short circuit |

fault present) |

| --- ELSE ---

|

| PDL = IPDL

| (let input pass through)

END: mlps\_prndl\_verification

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TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - CDAN2

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Begin: PDL FMEM Logic

FMMMLP = 4 -----------------------|

(overdrive is PDL FMEM value) |

|

FLG\_TCS = 1 ----------| |AND -| PDL = 3

(overdrive cancel) |AND -| | |

| | | |

MLPS\_2 = 2 -----------| |OR --| |

(TCS input present) | |

| |

OFMFLG = 1 -----------------| |

(EPC VFS short circuit |

fault present) |

| --- ELSE ---

|

| PDL = FMMMLP

END: PDL FMEM logic

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TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: mlps\_prndl\_malfunction

To perform PRNDL malfunction check:

IPDL = 0 -------------------------------| PDL\_MON\_TMR = 0

(mlps is suspect) |

| --- ELSE ---

|

| PDL\_ERR\_TMR = 0

| clear\_malf(P0705)

| clear\_malf(P1706)

| (mlps is valid,

| zero error timer

| and malfunction flags

| set based on the timer)

PDL\_GND = 1 ----------------------------| P0707FIL = P0707FIL + PDL\_UP

(MLPS out of range low) | Do: mlps\_short\_check

|

| --- ELSE ---

|

PDL\_HGH = 1 ----------------------------| P0708FIL = P0708FIL + PDL\_UP

(MLPS out of range low) | Do: mlps\_open\_check

|

| --- ELSE ---

PARK\_ERR = 1 ---------------------| |

(high vs in park error) |AND -| store\_code(P1706)

| |

PDL\_ERR\_TMR > PARK\_ERR\_TM --------| |

| --- ELSE ---

PARK\_ERR = 0 ---------------------| |

(in range fault) |AND -| malfunction(ccm,P0705)

| |

PDL\_ERR\_TMR > PDL\_ERR\_TM ---------| |

| --- ELSE ---

|

| P0707FIL = P0707FIL - 1

| P0708FIL = P0708FIL - 1

| Do: mlps\_open\_check

| Do: mlps\_short\_check

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TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - CDAN2

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P0705MALF = 1 --------------------|

|

P0707MALF = 1 --------------------|

|OR --| PDL\_ERROR = 1

P0708MALF = 1 --------------------| | (mlps fault present,

| | enter fmem)

P1706MALF = 1 --------------------| |

| --- ELSE ---

|

| PDL\_ERROR = 0

| (no mlps fault present)

PDL\_ERROR = 1 --------------------|

(mlps fault present) |OR --| PDL\_MON = 1

| | (mlps has been monitored

PDL\_MON\_TMR > PDL\_MON\_TM ---------| | this power-up)

END: mlps\_prndl\_malfunction

BEGIN: mlps\_short\_check

P0707FIL > PDL\_LVL ---------------------| malfunction(ccm,P0707)

|

| --- ELSE ---

|

| clear\_malf(P0707)

END: mlps\_short\_check

BEGIN: mlps\_open\_check

P0708FIL > PDL\_LVL ---------------------| malfunction(ccm,P0708)

|

| --- ELSE ---

|

| clear\_malf(P0708)

END: mlps\_open\_check

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TRANSMISSION INPUT CONVERSIONS, TORQUE INTERPOLATION CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.12 TORQUE INTERPOLATION CALCULATION (CDAN0)

OVERVIEW

Shift schedules and converter lock schedules need to be adjusted based on

torque losses. This module calculates the percent torque loss by comparing

TQ\_NET to the expected torque output at that speed and TP\_REL point.

The expected torque output table, FN1619A(NEBART, TP\_REL\_BAR), is calibrated

at the time the base shift schedule is developed.

To prevent rapid swings in TQ\_NORM, several conditions are placed on the

uupdate of the parameter. TQ\_NET values must be steady, otherwise a delay

timer is started and the update occurs once the trasnient settles. Because

low TQ\_NET values may be inaccurate or not repeatable, a minimum required

value is placed on TQ\_NET for an update of TQ\_NORM to occur. Because of

rapid changes in engine speed during a shiftand the effects of Torque

Modulation during that time, TQ\_NORM may not update unless there is no shift

in progress. The amount that TQ\_NORM is allowed to change from background

loop to background loop is also limited. Finally, a low pass filter is

placed on TQ\_NORM to smooth out the signal and prevent step changes

DEFINITIONS

Registers:

- BTR\_BASE = Output of FN1619A, expected torque output at the current

engine speed and TP\_REL point, ft-lbs.

- FLG\_SFT\_IN = 1 -> shift is in progress.

- NEBART = Filtered engine RPM for transmission.

- TP\_REL\_BAR = Filtered value of TP\_REL (TP - RATCH).

- TQ\_INTRP = Torque interpolation factor.

- TQ\_NET = Net torque into torque converter, ft-lbs.

- TQ\_NET\_LST = Last background pass value of TQ\_NET, ft-lbs.

- TQ\_NORM = Ratio of actual to expected torque output.

- TQ\_NORM\_CUR = Current unfiltered value of the ratio of TQ\_NET and

BTR\_BASE.

- TQ\_NORM\_LST = Last background pass value of TQ\_NORM\_NEW.

- TQ\_NORM\_NEW = Unfiltered value of TQ\_NORM.

- UPDATE\_TMR = Timer which delays the update of TQ\_NORM due to large

changes in TQ\_NET, seconds.

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TRANSMISSION INPUT CONVERSIONS, TORQUE INTERPOLATION CALCULATION - CDAN2

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Calibration Constants:

- FN1619A = Expected torque output at the current engine speed and TP\_REL

point, normalized.

x = FN070P(NEBART) = Normalized engine speed.

y = FN067D(TP\_REL\_BAR) = Normalized TP\_REL\_BAR.

- FN615TQ = Normalized torque vs. interpolation factor.

- FN067D = Normalizing function for TP\_REL\_BAR.

- FN070P = Normalizing function for NEBART

- TCTQ\_NORM = Time constant for TQ\_NORM, seconds.

- TQ\_MAX\_DELT = Maximum allowed change in TQ\_NET to allow TQ\_NORM to

update, ft-lbs.

- TQ\_MAX\_TM = Time to wait before TQ\_NORM is allowed to update due to a

large change in TQ\_NET, seconds.

- TQ\_NET\_MIN = Minimum value of TQ\_NET to allow TQ\_NORM to update.

- TQ\_NORM\_UP = Maximum allowed change in TQ\_NORM per background pass.

PROCESS

STRATEGY MODULE: INTRN\_TQ\_INTR\_COM1

always -----------------------------| BTR\_BASE = FN1619A(NEBART, TP\_REL\_BAR)

| ;"base" torque, ft-lbs

BTR\_BASE <> 0 ----------------------| TQ\_NORM\_CUR = TQ\_NET / BTR\_BASE

| ;ratio of actual torque

| ;and base torque

|

| --- ELSE ---

|

| TQ\_NORM\_CUR = 1

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TRANSMISSION INPUT CONVERSIONS, TORQUE INTERPOLATION CALCULATION - CDAN2

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abs(TQ\_NET - TQ\_NET\_LST) >

TQ\_MAX\_DELT ---------| UPDATE\_TMR = TQ\_MAX\_TM

| ;wait for transient to settle

| TQ\_NORM\_NEW = TQ\_NORM\_LST

| ;do not update TQ\_NORM\_NEW

|

| --- ELSE ---

FLG\_SFT\_IN = 1 ---------------| |

;shift in progress | |

| |

TQ\_NET < TQ\_NET\_MIN ----------|OR --| TQ\_NORM\_NEW = TQ\_NORM\_LST

;TQ\_NET is too low | | ;do not update TQ\_NORM\_NEW

| |

UPDATE\_TMR > 0 ---------------| |

;waiting for a transient to |

;settle |

| --- ELSE ---

abs(TQ\_NORM\_CUR - TQ\_NORM\_LST) |

< TQ\_NORM\_UP ----| TQ\_NORM\_NEW = TQ\_NORM\_CUR

;maximum amount TQ\_NORM\_NEW can |

;change is set by TQ\_NORM\_UP |

| --- ELSE ---

|

TQ\_NORM\_CUR > TQ\_NORM\_LST ----------| TQ\_NORM\_NEW = TQ\_NORM\_LST

| + TQ\_NORM\_UP

|

| --- ELSE ---

|

| TQ\_NORM\_NEW = TQ\_NORM\_LST

| - TQ\_NORM\_UP

always -----------------------------| TQ\_NORM =

| ROLAV(TQ\_NORM\_NEW,TCTQ\_NORM)

|

| TQ\_INTRP = FN615TQ(TQ\_NORM)

| ;torque interpolation factor

|

| TQ\_NORM\_LST = TQ\_NORM\_NEW

| ;save last unfiltered value of

| ;the ratio of TQ\_NORM

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TRANSMISSION INPUT CONVERSIONS, AODE OVERVIEW - CDAN2

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25.13 AODE SHIFT CONTROL OVERVIEW (CDAN0)

The AODE strategy and software are comprised of a set of distinct,

independent modules, each with a specific function. The modules are designed

to minimize the software impact of different transmission hardware and can

thus be re-used in other future transmission strategies. The main modules

and subroutines are show on the following page. They are executed in the

order shown except for INTRN\_AODE\_INPUT\_EQNS\_COMx which are done immediately

after input conversion. Also shown are the main output parameters of the

modules.

All modules listed are executed if TSTRAT = 7 (AODE transmission present).

For TSTRAT not equal to 7, ONLY those modules marked by an asterisk (\*) are

executed.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

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\*\*\* \*\*\*

\*\*\* All references to "PDL", "PRNDL", or variations thereof \*\*\*

\*\*\* with respect to electronic transmission controls are \*\*\*

\*\*\* synonymous with "Manual Level Indicated Position" as deter- \*\*\*

\*\*\* mined from the manual lever position sensor. \*\*\*

\*\*\* \*\*\*

\*\*\* All references to "TV", "ETV", or terms containing "TV" \*\*\*

\*\*\* with respect to electronic transmission controls are synon- \*\*\*

\*\*\* ymous with "Electronic Pressure Control", and are not \*\*\*

\*\*\* associated with any control function of the engine throttle.\*\*\*

\*\*\* \*\*\*

\*\*\* \*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

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TRANSMISSION INPUT CONVERSIONS, AODE OVERVIEW - CDAN2

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STRATEGY MODULE: INTRN\_AODE\_OVERVIEW\_COM2

STRUCTURE

If TSTRAT = 7, execute the following modules. Otherwise, execute only those

modules that are marked with an asterisk.

MAIN ROUTINE

SUBROUTINES OUTPUT PARAMETERS

---------------------------------------------------------------------------

DESRD\_GR\_DETR\_COMx GR\_DS

SC\_GR\_DS\_AUTO\_COMx FLG\_FRST\_DS

SC\_VER\_AUTO\_SHFT\_COMx FLG\_SFT\_UP

SC\_GR\_SEQ\_PNTR\_COMx GR\_DS\_TV

FLG\_SFT\_DN

SC\_CM\_GR\_DETR\_COMx GR\_CM

SC\_CM\_GR\_MAN1\_COMx GR\_OLD

SC\_CM\_GR\_MAN2\_COMx RT\_GR\_OLD

SC\_CM\_GR\_AUTO\_UP\_COMx FLG\_FRST\_CM

SC\_CM\_GR\_AUTO\_DWN\_COMx

SC\_TIMER\_COMx TM\_SFT\_IN

FLG\_SFT\_IN

FLG\_SFT\_MDN

SC\_SOL\_CTL\_COMx FLG\_SS\_1

SC\_SS1\_OBDII\_COMx FLG\_SS\_2

SC\_SS2\_OBDII\_COMx RT\_GR\_CUR

GEAR\_CUR

SC\_VALID\_COMx SFT\_FM\_FLG

FLG\_SFT\_VER

FLG\_SFT\_VAL

SC\_TQMOD\_COMx NICT\_TRIG\_ENT

NICT\_TRIG\_ST

\*SC\_RLS\_COM1 FLG\_RLS

EPC\_GUIDE\_COMx TV\_PRES

EPC\_ASILT\_COMx FLG\_ASILT

EPC\_STARTUP\_COMx TV\_STAT

EPC\_ENGMT\_STALL\_COMx TV\_COUNTS

EPC\_NORM\_COMx TV\_DYN

EPC\_TQ\_IALPHA\_COMx

EPC\_DYNAMIC\_COMx

EPC\_VFS\_OBDII\_COMx DUCE\_VFS\_1

EPC\_VFS\_DUCE\_REPEATER\_COMx VFS\_OUT\_6

VFS\_OUT\_FLG

EPC\_OTEMP\_TEST\_OBDII\_COMx OTEMP\_FM\_FLG

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TRANSMISSION INPUT CONVERSIONS, AODE OVERVIEW - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MAIN ROUTINE

SUBROUTINES OUTPUT PARAMETERS

---------------------------------------------------------------------------

CCC\_BYP\_CLTCH\_CTL\_COMx FLG\_OT\_LK

CCC\_HOT\_LCK\_COMx FLG\_HDR\_LK

CCC\_FMEM\_COMx FLG\_FMM\_LK

CCC\_SCHLD\_LCK\_UNLCK\_COMx TM\_CRV\_UNLK

CCC\_SCHLD\_BYP\_SLIP\_COMx FLG\_CRV\_LK

CCC\_UNCOND\_UNLK\_COMx FLG\_STRK\_UNLK

CCC\_MOD\_COMx FLG\_UNC\_UNLK

CCC\_BCSDC\_CALC\_COMx FLG\_ENG\_LK

CCC\_BYP\_PID\_CTL\_COMx BCSDC

CCC\_BYP\_SLIP\_CALC\_COMx

CCC\_MLUS\_OBDII\_COMx BCSDC\_OUT

LUS\_PW\_DUCE

INTRN\_TCIL\_CONTROL\_COMx

INTRN\_TCS\_COMx FLG\_TCS

INTRN\_TCIL\_STATE\_COMx TCIL\_STATE

INTRN\_TCIL\_REPEAT\_COMx

\*INTRN\_TQ\_INTR\_COMx TQ\_INTR

\*INTRN\_TRANS\_TQ\_NET\_CALC\_COMx TQ\_NET

INTRN\_CALC\_VS\_RATE\_COMx VS\_RATE

INTRN\_RT\_NOVS\_KAM\_CALC\_COMx RT\_NOVS

INTRN\_AODE\_INPUT\_EQNS\_COMx NEBART

TPBART

TPVARTV

TPBARTC

TP\_RATE

NTBART

BP\_INTR

SPD\_RATIO

SLIP\_ABS

INTRN\_CSM\_COMx CS\_SFT\_MULT

\*INTRN\_MLPS\_CONV\_COMx PDL

\*INTRN\_AC\_EN\_TRANS\_COMx AC\_EN\_TRANS

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TRANSMISSION INPUT CONVERSIONS, 4 x 4 LOW SWITCH - CDAN2

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25.14 THE 4 X 4 LOW SWITCH INPUT PROCESSING AND SELF TEST (CDAJ0)

OVERVIEW

This module contains 4x4L input processing and self test. The 4 x 4 switch

indicates that the driver has attempted to shift the transfer case to low

range. In the "shift on the fly" package, the 4 x 4 light will flash if the

transfer case has not been allowed to shift into 4 x 4 low. If the transfer

case has been allowed to shift into 4 x 4 low or in the non-electronic

system, the light will remain steadily on if in 4 x 4 low mode. If in this

mode, the shift schedule will be adjusted by the transfer case ratio to get

shifts at the correct output shift speed. This is done by modifying RT\_NOVS.

Since 12 volts at the module pin means normal mode and 0 volts means 4 x 4

mode, the input to the CPU is read as an inverted input.

During Engine Off on demand self test, the 4x4L switch must indicate "normal

mode", or code 1781 will be set.

DEFINITIONS

INPUTS

Registers:

- I4X4L = 4x4 input.

- I4X4L\_LST = 4x4 input, last pass.

- TM\_4X4L\_RES = 4x4 low switch input residence timer.

Bit Flags:

- CCM\_EO\_ENA = Engine Off CCM test enable flag; 1 -> Engine Off CCM enabled

by OBDII sequencer.

Calibration Contants:

- HP\_4X4L = 4X4L hardware present switch, 1 = 4X4L input present.

- TM4X4L = 4x4 low switch residence time.

OUTPUTS

Registers:

- I4X4L\_LST = See above.

- TM\_4X4L\_RES = See above.

Bit Flags:

- FLG\_4X4L = 4x4 low flag.

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TRANSMISSION INPUT CONVERSIONS, 4 x 4 LOW SWITCH - CDAN2

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OTHER

- 4x4\_codes = set of 4x4L switch error codes {P1781}

- P1781 = 4x4L switch indicating 4x4L during engine off self test.

- store\_code(Pxxx) = Stores the fault code specified by Pxxx.

PROCESS

STRATEGY MODULE: INTRN\_4X4L\_OBDII\_COM1

HP\_4X4L = 0 -----------------------| EXIT

(No 4x4L hardware) |

I4X4L\_LST <> I4X4L ----------------| I4X4L\_LST = I4X4L

| (update state change register)

| TM\_4X4L\_RES = TM4X4L

| (load residence timer)

TM\_4X4L\_RES = 0 -------------------| FLG\_4X4L = I4X4L

| (pass along current state,

| FLG\_4X4L = 1 is 4 x 4 mode)

When On-Demand self test is run, the operator is told to place the vehicle

in "normal mode". If the 4x4L switch indicates 4x4L mode during engine off

self test, code 1781 will be set.

CCM\_EO\_ENA = 1 --------------|

(Engine Off CCM enabled) |

|AND -| P1781MALF = 1

| | store\_code(P1781)

I4X4L = 1 -------------------| | (4x4L switch closed

(Switch indicates 4X4L mode) | during Engine Off

| self test)

|

| --- ELSE ---

|

| P1781MALF = 0

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TRANSMISSION INPUT CONVERSIONS, PWM FUNCTIONALITY TEST - CDAN2

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25.15 PWM FUNCTIONALITY TEST (CDAK0)

OVERVIEW

This module determines if the PWM solenoid is mechanically "on" when it is

commanded "off" (commanded EEC MLUS duty cycle is zero).

The PWM mechanically "on" when commanded "off" determination is accomplished

by comparing 1st gear actual converter clutch slip (SLIP\_ACT) with a open

converter slip value (SLIP\_OPEN1) calculated using a torque converter clutch

model. If actual slip is considerably less the the open converter model

based value, then the converter clutch is being applied.

By monitoring the apply state of the converter clutch in 1st gear, the "on"

state of the bypass clutch control valve can be determined, since the

application of the converter clutch is hydraulically locked out in 1st. If

the bypass valve is "on" in first gear, the mechanical state of the PWM

solenoid cannot be determined because the converter will always be applied

regardless of the PWM state.

If the bypass valve is monitored in 1st gear, and is determined to not be

stuck "on", then if the converter is applied in 2nd, 3rd, or 4th when the EEC

is not trying to apply the clutch, the PWM is said to be mechanically "on".

DEFINITIONS

INPUTS

Registers:

- BCSDC = Modulated bypass clutch duty cycle.

- BCV\_OFF\_CNT = Counter tracking number of samples bypass valve NOT stuck

"on" in first gear.

- BCV\_ON\_CNT = Counter tracking number of samples bypass valve stuck "on"

in first gear.

- CC\_OFF\_CNT = Counter tracking number of samples converter is not applied.

- CC\_ON\_CNT = Counter to track number of samples converter is applied.

- GR\_CM = Commanded gear for shift solenoids.

- INIT\_TOT = TOT at start-up; arithmetic average of the first 8 TOT

readings.

- NOBART = Filtered transmission output shaft speed, rpm.

- NTBART = Filtered transmission turbine speed, rpm.

- PWM\_OFF\_CNT = Counter tracking number of samples PWM solenoid is

mechanically "off" when commanded "off".

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TRANSMISSION INPUT CONVERSIONS, PWM FUNCTIONALITY TEST - CDAN2

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- PWM\_ON\_CNT = Coutner tracking number of samples PWM solenoid is

mechanically "on" when commanded "off".

- SLIP\_ACT = Actual torque converter slip signed, rpm.

- SLIP\_DIF = Difference between calculated open converter slip and actual,

rpm.

- SLIP\_OPEN1 = Calculated open converter slip, rpm.

- SPD\_RATIO = Speed ratio across the torque converter.

- TOT = Transmission oil temperature, deg. F.

- TP = Throttle position sensor.

- TPBART = Filtered throttle position.

- TP\_REL = Relative throttle position, counts.

- TQ\_BAR = Filtered TQ\_NET.

- TQ\_BAR\_LST = Last pass value of TQ\_BAR.

- TQ\_BAR\_PWM = Filtered TQ\_NET for PWM functionality test, ft-lbs.

- TQ\_NET = Net torque into the torque converter, ft-lbs.

- TST\_DLY\_TMR = PWM functionality test transient delay timer, secs.

Bit Flags:

- FLG\_BCV\_MON = Flag indicating bypass clutch control valve state in first

gear monitiored; 1 -> state monitored.

- FLG\_BCV\_ON = Flag indicating "on" state of the bypass clutch control

valve; 1 -> bypass valve stuck "on".

- FLG\_PWM\_MON = Flag indicating PWM solenoid state monitored; 1 -> state

monitored.

- FLG\_PWM\_ON = PWM solenoid "on" state flag; 1 -> PWM solenoid mechanically

"on" when commanded "off".

- FLG\_SFT\_IN = Shift in progress flag; 1 -> shift is in progress.

- FLG\_SS\_MON = Flag indicating all shifts have been monitored; 1 -> all

shifts monitored.

- FLG\_TST\_CMP = Flag indicating if a test has been compeleted this entry; 1

-> test completed.

- FLG\_TST\_FP = PWM functionality test first pass flag; 1 -> not first pass.

Calibration Constants:

- BCVOFFDN = Down count for bypass valve "off" in 1st gear counter.

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TRANSMISSION INPUT CONVERSIONS, PWM FUNCTIONALITY TEST - CDAN2

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- BCVOFFUP = Up count for bypass valve "off" in 1st gear counter.

- BCVONDN = Down count for bypass valve "on" in 1st gear counter.

- BCVONUP = Up count for bypass valve "on" in 1st gear counter.

- BCV\_OFF\_LVL = Threshold to determine if bypass valve NOT stuck "on" in

first gear.

- BCV\_ON\_LVL = Threshold to determine if bypass valve stuck "on" in first.

- CCOFFDN = Down count for converter "not-applied" counter.

- CCOFFUP = Up count for converter "not-applied" counter.

- CCONDN = Down count for converter "applied" counter.

- CCONUP = Up count for converter "applied" counter.

- CC\_OFF\_LVL = Threshold to determine if converter not-applied.

- CC\_ON\_LVL = Threshold to determine if converter applied.

- CC\_NO\_DL = Output shaft speed threshold below which PWM test disabled,

rpm.

- CC\_SR\_DL = Speed Ratio threshold below which PWM test disabled.

- CC\_SR\_DH = Speed Ratio threshold above which PWM test disabled.

- CC\_TOT\_DL = TOT threshold below which PWM test disabled, deg F.

- CC\_TOT\_DH = TOT threshold above which PWM test disabled, deg F.

- CC\_TP\_DL = Throttle threshold below which PWM test disabled, counts.

- CC\_TP\_DH = Throttle threshold above which PWM test disabled, counts.

- CC\_TP\_SS = Maximum allow able change in TP\_REQ to allow PWM test, counts.

- CC\_TQ\_DH = Input torque threshold above which PWM test disabled, ft-lbs.

- CC\_TQ\_DL = Input torque threshold below which PWM test disabled, ft-lbs.

- CC\_TQ\_SS = Maximum allowable change in input torque to allow PWM test,

ft-lbs.

- CC\_TQ\_SS1 = Maximum allowable change in input torque to allow PWM test,

ft-lbs.

- FN690B(INIT\_TOT) = TOT required to allow enable PWM functionality test,

deg F.

- K\_CONV1 = Torque converter coefficient that relates input torque to slip,

multiplied by turbine speed; ft-lbs/rpm\*rpm.

- PWMOFFDN = Down count for PWM "mechanically off" counter.

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TRANSMISSION INPUT CONVERSIONS, PWM FUNCTIONALITY TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PWMOFFUP = Up count for PWM "mechanically off" counter.

- PWMONDN = Down count for PWM "mechanically on" counter.

- PWMONUP = Up count for PWM "mechanically on" counter.

- PWM\_OFF\_LVL = Threshold to determine if PWM solenoid mechanically "off"

when commanded "off".

- PWM\_ON\_LVL = Threshold to determine if PWM solenoid mechanically "on"

when commanded "off".

- SLIP\_ACT\_LK = Threshold of slip below which converter is locked, rpm.

- SLP\_CC\_ON = Slip difference (SLIP\_OPEN1 - SLIP\_ACT) threshold above which

converter is said to be applied.

- SLP\_OPN\_MIN = Threshold of SLIP\_OPEN1 above which the state of the

converter can be determined, rpm.

- SW\_PWM\_TST = Test switch to disable BCSDC criteria to allow test; 1 ->

disable BCSDC criteria for test entry.

- SW\_1742\_MIL = Switch to allow setting a MIL code for a P1742 fault; 1 ->

set MIL code.

- SW\_1743\_NMIL = Switch to allow setting a NON-MIL code for a P1743 fault;

1 -> set the NON-MIL code.

- TCTQPWM = Time constant for TQ\_BAR\_PWM.

- TSTDLYTM = PWM functionality test delay time, secs.

OUTPUTS

Registers:

- BCV\_OFF\_CNT = See above.

- BCV\_ON\_CNT = See above.

- CC\_OFF\_CNT = See above.

- CC\_ON\_CNT = See above.

- PWM\_OFF\_CNT = See above.

- PWM\_ON\_CNT = See above.

- SLIP\_ACT = See above.

- SLIP\_DIF = See above.

- SLIP\_OPEN1 = See above.

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TRANSMISSION INPUT CONVERSIONS, PWM FUNCTIONALITY TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TQ\_BAR\_LST = See above.

- TQ\_BAR\_PWM = See above.

- TST\_DLY\_TMR = See above.

Bit Flags:

- FLG\_BCV\_MON = See above.

- FLG\_BCV\_ON = See above.

- FLG\_PWM\_MON = See above.

- FLG\_PWM\_ON = See above.

- FLG\_TST\_CMP = See above.

- FLG\_TST\_FP = See above.

- P1742 = See above.

- P1743 = See above.

- P1742MALF = Malfunction flag for P1742 code; 1 -> a malfunction currently

exists for fault P1742.

- P1743MALF = Malfunction flag for P1743 code; 1 -> a malfunction currently

exists for fault P1743.

OTHER

- malfunction(ccm,P1742) = Logic process, imported from the MIL control

module; P1742 indicates a fault code.

- P1742 = Fault code, PWM mechanically "on" failure (MIL code).

- P1743 = Fault code, PWM mechanically "on" failure (NON MIL code).

- store\_code(Pxxxx) = Logic process, used when NON\_MIL faults are detected.

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TRANSMISSION INPUT CONVERSIONS, PWM FUNCTIONALITY TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_PWM\_FUNCT\_TEST\_COM3

TOT < FN690B(INIT\_TOT) -----------|

|

TOT < CC\_TOT\_DL ------------------|

|

TOT > CC\_TOT\_DH ------------------|

|

TP\_REL < CC\_TP\_DL ----------------|

|

TP\_REL > CC\_TP\_DH ----------------|

|

abs(TP - TPBART) > CC\_TP\_SS ------|

|

abs(TQ\_BAR - TQ\_BAR\_LST) > |

CC\_TQ\_SS -----|

|

abs(TQ\_NET - TQ\_BAR\_PWM) > |OR --| FLG\_TST\_FP = 0

CC\_TQ\_SS1 ----| | FLG\_TST\_CMP = 0

| | TQ\_BAR\_LST = TQ\_BAR

TQ\_BAR\_PWM < CC\_TQ\_DL ------------| | TQ\_BAR\_PWM =

| | ROLAV(TQ\_NET,TCTQPWM)

TQ\_BAR\_PWM > CC\_TQ\_DH ------------| | EXIT THIS MODULE

|

NOBART < CC\_NO\_DL ----------------|

|

SPD\_RATIO < CC\_SR\_DL -------------|

|

SPD\_RATIO > CC\_SR\_DH -------------|

|

FLG\_SFT\_IN = 1 -------------------|

|

BCSDC > 0 ------------------| |

(converter commanded "on") |AND -|

|

SW\_PWM\_TST = 0 -------------|

(enable BCSDC criteria for

test validation)

NTBART = 0 -----------------------------| SLIP\_OPEN1 = 0

|

| --- ELSE ---

|

| SLIP\_OPEN1 = TQ\_BAR / (K\_CONV1

\* NTBART)

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TRANSMISSION INPUT CONVERSIONS, PWM FUNCTIONALITY TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

always ---------------------------------| SLIP\_DIF = SLIP\_OPEN1 - SLIP\_ACT

| TQ\_BAR\_LST = TQ\_BAR

| TQ\_BAR\_PWM = ROLAV(TQ\_NET,TCTQPWM)

FLG\_TST\_FP = 0 -------------------------| TST\_DLY\_TMR = TSTDLYTM

(first pass; initialize appropriate | CC\_ON\_CNT = 0

registers) | CC\_OFF\_CNT = 0

| FLG\_TST\_FP = 1

TST\_DLY\_TMR > 0 ------------------------| EXIT THIS MODULE

(transient delay timer not expired)

GR\_CM = 1 ------------------|

|AND -|

SLIP\_DIF >= SLP\_CC\_ON ------| |

|

GR\_CM > 1 ------------------| |OR --| CC\_ON\_CNT = CC\_ON\_CNT + CCONUP

| | | CC\_OFF\_CNT = CC\_OFF\_CNT - CCOFFDN

SLIP\_OPEN1 >= SLP\_OPN\_MIN --| | |

(normal open slip value |AND -| |

large enough insure | |

accurate test) | |

| |

SLIP\_ACT <= SLIP\_ACT\_LK ----| |

(converter physically |

locked) |

| --- ELSE ---

|

| CC\_ON\_CNT = CC\_ON\_CNT - CCONDN

| CC\_OFF\_CNT = CC\_OFF\_CNT + CCOFFUP

25-64

TRANSMISSION INPUT CONVERSIONS, PWM FUNCTIONALITY TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_TST\_CMP = 0 ------------------|

(test has not completed |

this entry) |

|AND -| FLG\_TST\_CMP = 1

GR\_CM = 1 ------------------------| | BCV\_ON\_CNT = BCV\_ON\_CNT + BCVONUP

| | BCV\_OFF\_CNT = BCV\_OFF\_CNT -

CC\_ON\_CNT >= CC\_ON\_LVL -----------| | BCVOFFDN

(converter physically applied |

when it is commanded open) |

| --- ELSE ---

FLG\_TST\_CMP = 0 ------------------| |

| |

GR\_CM = 1 ------------------------|AND -| FLG\_TST\_CMP = 1

| | BCV\_ON\_CNT = BCV\_ON\_CNT - BCVONDN

CC\_OFF\_CNT >= CC\_OFF\_LVL ---------| | BCV\_OFF\_CNT = BCV\_OFF\_CNT +

(converter phsically open | BCVOFFUP

when it is commanded open) |

| --- ELSE ---

FLG\_TST\_CMP = 0 ------------------| |

|AND -| FLG\_TST\_CMP = 1

CC\_OFF\_CNT >= CC\_OFF\_LVL ---------| | BCV\_ON\_CNT = BCV\_ON\_CNT - BCVONDN

| BCV\_OFF\_CNT = BCV\_OFF\_CNT +

| BCVOFFUP

| PWM\_ON\_CNT = PWM\_ON\_CNT - PWMONDN

| PWM\_OFF\_CNT = PWM\_OFF\_CNT +

| PWMOFFUP

|

| --- ELSE ---

FLG\_TST\_CMP = 0 ------------------| |

| |

GR\_CM > 1 ------------------------| |

| |

FLG\_BCV\_ON = 0 -------------------| |

(bypass clutch valve not "on") | |

|AND -| FLG\_TST\_CMP = 1

FLG\_BCV\_MON = 1 ------------------| | PWM\_ON\_CNT = PWM\_ON\_CNT + PWMONUP

(bypass clutch valve state | | PWM\_OFF\_CNT = PWM\_OFF\_CNT -

monitored) | | PWMOFFDN

| |

CC\_ON\_CNT >= CC\_ON\_LVL -----------| |

| --- ELSE ---

|

| no action

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TRANSMISSION INPUT CONVERSIONS, PWM FUNCTIONALITY TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BCV\_ON\_CNT >= BCV\_ON\_LVL ---------------| FLG\_BCV\_ON = 1

(bypass valve verified "on") | FLG\_BCV\_MON = 1

| FLG\_PWM\_ON = 0

| (bypass valve "on"; assume

| PWM "off")

| FLG\_PWM\_MON = 1

|

| --- ELSE ---

|

BCV\_OFF\_CNT >= BCV\_OFF\_LVL -------------| FLG\_BCV\_ON = 0

(bypass valve verified "off") | FLG\_BCV\_MON = 1

|

| --- ELSE ---

|

| no action

PWM\_OFF\_CNT >= PWM\_OFF\_LVL -------------| FLG\_PWM\_ON = 0

(pwm verified "off") | FLG\_PWM\_MON = 1

|

| --- ELSE ---

|

PWM\_ON\_CNT >= PWM\_ON\_LVL ---------------| FLG\_PWM\_ON = 1

(PWM verified "on") | FLG\_PWM\_MON = 1

|

| --- ELSE ---

|

| no action

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TRANSMISSION INPUT CONVERSIONS, PWM FUNCTIONALITY TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SW\_1742\_MIL = 1 ------------------|

(set MIL code for this fault) |

|

FLG\_PWM\_ON = 1 -------------------|AND -| malfunction (CCM,P1742)

(PWM is "ON") | | P1742MALF = 1

| |

FLG\_SS\_MON = 1 -------------------| |

(all shift solenoids have |

been verified as functioning) |

| --- ELSE ---

FLG\_SS\_MON = 0 -------------------| |

|OR --| P1742MALF = 0

FLG\_PWM\_ON = 0 -------------| | |

|AND -| |

FLG\_PWM\_MON = 1 ------------| |

(PWM state montitored) |

| --- ELSE ---

|

| no action

SW\_1743\_NMIL = 1 -----------------|

(set NON-MIL code for this fault)|

|

FLG\_PWM\_ON = 1 -------------------|AND -| store\_code (P1743)

(PWM is "ON") | | P1743MALF = 1

| | (NOTE: This is a NON-MIL code

FLG\_SS\_MON = 1 -------------------| | used to flash the TCIL)

(all shift solenoids have |

been verified as functioning) |

| --- ELSE ---

FLG\_SS\_MON = 0 -------------------| |

|OR --| P1743MALF = 0

FLG\_PWM\_ON = 0 -------------| | |

|AND -| |

FLG\_PWM\_MON = 1 ------------| |

(PWM state montitored) |

| --- ELSE ---

|

| no action

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TRANSMISSION INPUT CONVERSIONS, A/C ENABLE CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.16 A/C ENABLE CONTROL (CDAK0)

OVERVIEW

The modulated bypass A/C clutch compensation determines the closed loop

control region that will use ACSLP for slip target. This is done to provide

sufficient slip in the converter to absorb torque disturbances which could be

transmitted through the driveline when the A/C fan and/or compressor are

activated.

This module also disables the A/C during shifts to prevent distrubances in

the engine speed trace that may cause false torque modulation triggers.

The output of this module is a flag (AC\_EN\_TRANS) which indicates that either

the converter is controlling to the A/C compensation slip target, a shift is

in progress, or that a default timer threshold has been exceeded. When any

of the conditions are met, normal A/C operation will be allowed. The feature

which uses the modulated bypass clutch to decouple the A/C hits from the rest

of the powertrains can be calibrated out by setting AC\_SLP\_WDOG = 0. Normal

slip control will be returned when the A/C timer (ACITMR) exceeds AC\_CTL\_OFF.

Disabling the A/C during shifts cannot be calibrated out; it is

unconditional.

Additional logic is provided to protect against a low A/C charge situation.

When the A/C charge level is low, the A/C compressor will tend to cycle

rapidly. The A/C cycle period is monitored. When the cycling frequency

becomes too high, the Anticipatory A/C compensation logic is de-activated. A

special option is provided in regards to disabling the Anticipatory logic. A

fault filter type structure is used to disable (fault filter update logic is

located in the A/C strategy section) However, if the rapid cycling situation

ceases, the Anticipatory logic could be re-enabled during the same EEC

power-up (fault filter counts down). Therefore, a switch is provided

(SW\_DAC\_NPU) which can be used to keep the Anticapatory logic disabled until

the next EEC power-up.

If the calibration indicates a manual transmission (TSTRAT <= 3), the A/C is

allowed to function normally.

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TRANSMISSION INPUT CONVERSIONS, A/C ENABLE CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- ACITMR = Closed throttle A/C clutch enable delay timer, sec. Used to

delay A/C clutch engagement at closed throttle to allow the Idle speed

Control strategy to anticipate the compressor load application.

- AC\_CTL\_TMR = Slip in control timer after A/C requested.

- AC\_SLP\_TMR = Default timer to activate A/C engagement process if slip

control not established.

- ERR\_T0 = Current slip error (SLIP\_DES\_S - SLIP\_ACT).

- GR\_DS = Desired Gear

- GR\_CM = Current Commanded Gear For Shift Solenoids.

- P1469MALF = Malfunction flag for A/C cycling period to short.

- SLIP\_DES\_S = Desired value of slip measured in rpm, signed.

- SLIP\_TRG\_S = Target slip value measured in rpm, signed.

Bit Flags:

- ACRQST = A/C requested flag; 1 -> request.

- AC\_EN\_TRANS = Flag used to delay A/C engagement process; 0 -> delay

process.

- FLG\_AC\_CMP = Flag indicating A/C compensation cycle complete, return to

normal operating conditions; 1 -> process complete.

- FLG\_AC\_CTL = Flag indicating when to use A/C compensation slip target

(ACSLP); 1 -> use ACSLP.

- FLG\_SFT\_IN = Shift in progress flag; 1 -> shift in progress.

- FLG\_SLP\_CTL = Slip in control after A/C requested; 1 -> slip in control.

- FLG\_CRV\_LK = Scheduled curve lockup flag; 1 -> Scheduled lockup.

- FLG\_VE\_DSGR = Verify Desired Gear First Pass Flag.

Calibration Constants:

- AC\_CTL\_OFF = Timer threshold to de-activate A/C compensation.

- AC\_CTL\_TM = Timer threshold indicating converter slip in control.

- AC\_SLP\_WDOG = Timer threshold to allow A/C engagement if slip control not

established

- ERR\_T0\_AC = Error threshold establishing control region.

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TRANSMISSION INPUT CONVERSIONS, A/C ENABLE CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SLIP\_DIF\_AC = Threshold to determine when slip should start being in

control.

- SW\_DAC\_NPU = Switch to disable Anticipatory A/C logic till next power-up;

1 -> disable till next power up.

- TSTRAT = Transmission Strategy Switch; The TSTRAT software switch

controls which transmission control strategy is executed:

0 -> No transmission control (Manual transmission, AOD, ATX, C6,

C3, etc.)

1 -> SIL (Shift indicator light)

2 -> A4LD with 3-4 shift control and converter clutch control

3 -> AXOD

4 -> C64E (E4OD)

5 -> A41DE

6 -> FAX-4

7 -> AOD-E (AOD-I)

8 -> 4EAT

9 -> CD4E

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TRANSMISSION INPUT CONVERSIONS, A/C ENABLE CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_AC\_EN\_TRANS\_COM1

TSTRAT <= 3 ----------------------------| AC\_EN\_TRANS = 1

(manual transmission) | (allow A/C to operate

| normally)

|

| --- ELSE ---

FLG\_VE\_DSGR = 1 ------------------| |

(verifying a shift) | |

| |

GR\_DS <> GR\_CM -------------------|OR --| AC\_EN\_TRANS = 0

(shift is desired; or sequenced | | (delay engagment of

shift in progress) | | A/C clutch)

| | FLG\_AC\_CTL = 0

FLG\_SFT\_IN = 1 -------------------| | FLG\_SLP\_CTL = 0

(shift is in progress) | AC\_CTL\_TMR = 0

| AC\_SLP\_TMR = 0

| FLG\_AC\_CMP = 0

| EXIT THIS MODULE

|

| --- ELSE ---

|

P1469MALF = 1 --------------------------| AC\_EN\_TRANS = 1

(disable anticipatory A/C logic, | FLG\_AC\_CMP = 0

A/C cycle period too short) |

|

| --- ELSE ---

|

ACRQST = 0 -----------------------------| AC\_EN\_TRANS = 0

| FLG\_AC\_CMP = 0

|

| --- ELSE ---

|

| no action

P1469MALF = 1 --------------------|

|

ACRQST = 0 -----------------------|OR --| FLG\_AC\_CTL = 0

| | FLG\_SLP\_CTL = 0

FLG\_AC\_CMP = 1 -------------------| | AC\_CTL\_TMR = 0

| AC\_SLP\_TMR = 0

| EXIT THIS MODULE

|

| --- ELSE ---

|

| FLG\_AC\_CTL = 1

| Increment AC\_SLP\_TMR

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TRANSMISSION INPUT CONVERSIONS, A/C ENABLE CONTROL - CDAN2

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|ERR\_T0| <= ERR\_T0\_AC ------------|

|AND -| Increment AC\_CTL\_TMR

|SLIP\_TRG\_S - SLIP\_DES\_S| <= | |

SLIP\_DIF\_AC ------| |

| --- ELSE ---

|

| AC\_CTL\_TMR = 0

AC\_CTL\_TMR >= AC\_CTL\_TM ----------|

|OR --| FLG\_SLP\_CTL = 1

FLG\_SLP\_CTL = 1 ------------------| |

| --- ELSE ---

|

| FLG\_SLP\_CTL = 0

AC\_SLP\_TMR >= AC\_SLP\_WDOG --------|

|

FLG\_SLP\_CTL = 1 ------------------|OR --| AC\_EN\_TRANS = 1

| |

FLG\_CRV\_LK = 0 -------------------| |

| --- ELSE ---

|

| AC\_EN\_TRANS = 0

AC\_EN\_TRANS = 1 ------------------|

|AND -| FLG\_AC\_CMP = 1

ACITMR >= AC\_CTL\_OFF -------------| | FLG\_AC\_CTL = 0

|

| --- ELSE ---

|

| NO ACTION

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TRANSMISSION INPUT CONVERSIONS, Input Torque Calculation - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.17 TRANSMISSION INPUT TORQUE CALCULATION (CDAL0)

OVERVIEW

The engine torque calculation is used to determine the magnitude and sign of

torque being transmitted to the transmission. If transmission input torque

is positive, a load must be present (ie the vehicle is power on).

The logic works as follows:

TRANS\_TQ\_IN = TQ\_BRK\_SBAR - INERTIA\_ENG \* DNDT\_TQI

Where:

- TRANS\_TQ\_IN = Torque into the transmission.

- TQ\_BRK\_SBAR = Filtered engine combustion torque.

- INERTIA\_ENG = Engine intertia.

- DNDT\_TQI = Engine acceleration.

- INERTIA\_ENG \* DNDT\_TQI = Combustion torque required to

accelerate the engine.

DEFINITIONS

INPUTS

Registers:

- DNDT\_TQI = Derivative of engine RPM for use in transmission input torque

calculation, RPM/second.

- TQ\_BRAKE\_S = Net engine torque (signed).

- TQ\_BRK\_SBAR = Filtered net engine torque (signed).

Calibration Constants:

- INERTIA\_ENG = Engine intertia.

- TCTQBRKS = Time constant for filtered net engine torque (signed).

- TCDNDT\_TQI = Time constant for DNDT\_TQI.

OUTPUTS

Registers:

- DNDT\_TQI = See above

- TQ\_BRK\_SBAR = Filtered net engine torque (signed).

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TRANSMISSION INPUT CONVERSIONS, Input Torque Calculation - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TRANS\_TQ\_IN = Transmission input torque, used as power on/off indicator.

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TRANSMISSION INPUT CONVERSIONS, Input Torque Calculation - CDAN2

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PROCESS

STRATEGY MODULE: INTRN\_TQ\_IN\_CALC\_COM2

Once per Background the following logic is executed:

unconditionally ------------------------| TQ\_BRK\_SBAR = ROLAV(TQ\_BRAKE\_S,

| TCTQBRKS)

| ;Calculate filtered signed torque

|

| DNDT\_TQI = ROLAV(DNDTI, TCDNDT\_TQI)

| ;Calculate filtered engine

| ;acceleration

|

| TRANS\_TQ\_IN = (TQ\_BRK\_SBAR -

| INERTIA\_ENG \* DNDT\_TQI)

| ;Calculate input torque

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TRANSMISSION INPUT CONVERSIONS, DIGITAL TRS CONVERSION - CDAN2

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25.18 DIGITAL TRANSMISSION RANGE SENSOR INPUT CONVERSION (CDAN0)

OVERVIEW

This module determines whether to execute the analog Manual Lever Position

Sensor (MLPS) input conversion logic or the digital Transmission Range Sensor

(TRS) input conversion logic. Which strategy is executed is dependent upon

the value of TRS\_TYPE. The following is a guide to calibration switch

settings for the MLPS/TRS/NDS conversion strategies:

Application TSTRAT TRS\_TYPE

-------------------------- ------ --------

A/T with analog MLPS >3 0

A/T with digital TRS xxx 1

M/T with Neutral/Drive Switch <4 xxx

NOTE: "xxx" indicates the setting is irrelevant.

The digital Transmission Range Sensor (TRS) utilizes four binary inputs which

together can be decoded into a gear selector position. The inputs, TR1, TR2,

TR3, and TR4, are decoded as follows:

gear selector

TR4 TR3 TR2 TR1 position (PDL)

--- --- --- --- -------------

0 0 0 0 PARK (7)

1 1 0 0 REVERSE (6)

0 1 1 0 NEUTRAL (5)

1 1 1 1 DRIVE (3/4)

1 0 0 1 SECOND (2)

0 0 1 1 FIRST (1)

0 = Switch closed

1 = Switch open

Inputs TR4, TR2, and TR1 are read from EEC digital inputs. TR3 is converted

from the MLPS/NDS analog input. The analog-to-digital conversion follows the

follwing logic:

Input condition TR3 setting

------------------------ ----------------------

0 <= INDS <= TR3A\_CLOSED Switch closed (0)

TR3A\_CLOSED < INDS <= TR3A\_OPEN Switch open (1)

INDS > TR3A\_OPEN ERROR - Open SIG RTN

Base values: TR3A\_CLOSED = 266 counts (1.3V)

TR3A\_OPEN = 532 counts (2.6V)

During a transition from one gear selector position to another, all four

switches will be momentarily open. Since this is the same state as DRIVE,

the logic employs a state transition timer (TM\_PDL\_RES) to prevent false

recognition of the DRIVE position. The transition bit pattern (0100) is the

same between Reverse to Park and Reverse to Neutral. The transition bit

pattern (1110) identifies the TRS between Neutral and Drive. The transition

bit pattern between Drive to Manual 2 and Manual 2 to Manual 1 is 1011.

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TRANSMISSION INPUT CONVERSIONS, DIGITAL TRS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- INDS = Neutral/Drive or MLPS analog input (A/D COUNTS).

- IPDL = Unverified MLPS/PRNDL position.

- IPDL\_LST = Last pass unverified MLPS/PRNDL position.

- PDL = PRNDL/TRS/MLPS position.

- PDL\_ERR\_TMR = MLPS/PRNDL malfunction test error timer (SECONDS).

- PDL\_MON\_TMR = MLPS monitor timer (SECONDS).

- TM\_PDL\_RES = MLPS/PRNDL input residence timer (SECONDS).

- TRNS\_ERR\_TMR = TRS/PRNDL transition malfunction test error timer,

(SECONDS).

Bit Flags:

- CCM\_EO\_ENA = Engine off on-demand test for CCM enabled.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enabled.

- FLG\_TCS = Transmission Control Switch Flag.

- FLG\_TRNS\_BIT = Indicate if the TRS is between positions, a transition bit

pattern has been decoded.

- OBDII\_RESET = Flag used to simulate the receipt of an OBD-II scan tool

reset message.

- OFMFLG = ETV solenoid failure flag.

- PxxxMALF = Malfunction flag for code Pxxx; 1 -> a malfunction currently

exists for Pxxx.

- PDL\_ERROR = MLPS/TRS FMEM failure mode flag.

- PDL\_MON = MLPS monitored flag.

- TR1 = Digital transmission range sensor input, Bit 1.

- TR2 = Digital transmission range sensor input, Bit 2.

- TR3 = Digital transmission range sensor input, Bit 3.

- TR3\_ERROR = Analog input TR3A out of range error flag.

- TR4 = Digital transmission range sensor input, Bit 4.

Calibration Constants:

- CCM\_TST\_SW = CCM test presetn calibration switch.

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TRANSMISSION INPUT CONVERSIONS, DIGITAL TRS CONVERSION - CDAN2

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- FMMMLP = PDL value when error present.

- FNCPTRS = Function to provide the PDL value from the output of the

digital TRS.

- MLPS\_KOEO\_EN = MLPS KOEO test enable switch.

- PDL\_ERR\_TM = MLPS/PRNDL malfunction test error time threshold (SECONDS).

- PDL\_MON\_TM = Minimum time MLPS/TRS must be observed to set monitor flag

(SECONDS).

- PDLTIM = Minimum time to recognize new MLPS/TRS state (SECONDS).

- TR3A\_CLOSED = A/D input value below which TR3 switch is considered closed

(A/D COUNTS).

- TR3A\_OPEN = A/D input value below which TR3 switch is considered open

(A/D COUNTS).

- TRS\_TYPE = Type of transmission range sensor; 0 -> Analog MLPS, 1 ->

Digital TRS.

- TRNS\_ERR\_TM = Minimum time for a transition bit pattern to be observed

before indicating a failure, (SECONDS).

OTHER

- P0705 = Transmission Range Sensor circuit malfunction (MIL).

- P1705 = Transmission Range Sensor not indicating required position during

KOEO (non-MIL).

- P1704 = Transmission Range Sensor is misaligned and is reading a value

between the indicated PRNDL position.

25-78

TRANSMISSION INPUT CONVERSIONS, DIGITAL TRS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_TRS\_COM1

BEGIN: transmission\_range\_sensor\_selection

; This process is executed once per background loop.

; Determine which strategy to execute:

TRS\_TYPE = 0 -------------------------| Do: INTRN\_MLPS\_CONV\_COMx

;Analog MLPS | call analog TRS module

|

| --- ELSE ---

|

| Do: digital\_transmission\_range\_sensor

END: transmission\_range\_sensor\_selection

BEGIN: digital\_transmission\_range\_sensor

; This process is executed only when called.

unconditionally ------------------------| IPDL\_LST := IPDL

| ; Save last decoded

| ; state of TRS

|

| Do: tr3a\_conversion

| Do: trs\_decode

| Do: trs\_self\_test

END: digital\_transmission\_range\_sensor

25-79

TRANSMISSION INPUT CONVERSIONS, DIGITAL TRS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: tr3a\_conversion

; This process is executed only when called.

; TRS input, bit 3, is received on an analog input.

; This signal must be converted to a binary value.

INDS <= TR3A\_CLOSED --------------------| TR3 := 0

;Analog input level indicates |

;switch is closed | TR3\_ERROR := 0

| ; Input is valid.

|

| --- ELSE ---

|

INDS <= TR3A\_OPEN ----------------------| TR3 := 1

;Analog input level indicates |

;switch is open | TR3\_ERROR := 0

| ; Input is valid.

|

| --- ELSE ---

|

| TR3\_ERROR := 1

| ; Analog input level

| ; indicates an open

| ; SIG RTN wire.

END: tr3a\_conversion

25-80

TRANSMISSION INPUT CONVERSIONS, DIGITAL TRS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

; A function FNCPTRS has been provided to calibrate the bit

; pattern for either levels of ditigal TRS', (SP or CP). The base

; DECIMAL calibration values for the funciton are set to work for

; the CP level of hardware and is listed below:

;FNCPTRS[0] = 7

;FNCPTRS[1] = 127.5

;FNCPTRS[2] = 127.5

;FNCPTRS[3] = 1

;FNCPTRS[4] = 7.5

;FNCPTRS[5] = 127.5

;FNCPTRS[6] = 5

;FNCPTRS[7] = 127.5

;FNCPTRS[8] = 127.5

;FNCPTRS[9] = 2

;FNCPTRS[10] = 127.5

;FNCPTRS[11] = 120

;FNCPTRS[12] = 6

;FNCPTRS[13] = 127.5

;FNCPTRS[14] = 0

;FNCPTRS[15] = 4

;Below is the recommendation for calibrating FNCPTRS for SP level of hardware

;for digital TRS.

;FNCPTRS[0] = 7

;FNCPTRS[1] = 127.5

;FNCPTRS[2] = 127.5

;FNCPTRS[3] = 1

;FNCPTRS[4] = 127.5

;FNCPTRS[5] = 2

;FNCPTRS[6] = 5

;FNCPTRS[7] = 127.5

;FNCPTRS[8] = 127.5

;FNCPTRS[9] = 127.5

;FNCPTRS[10] = 127.5

;FNCPTRS[11] = 127.5

;FNCPTRS[12] = 6

;FNCPTRS[13] = 127.5

;FNCPTRS[14] = 127.5

;FNCPTRS[15] = 4

25-81

TRANSMISSION INPUT CONVERSIONS, DIGITAL TRS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: trs\_decode

; This process is executed only when called.

; Decode the four binary TRS inputs and check their validity.

TR3\_ERROR = 0 --------------------------| trs\_input :=

;Valid analog input for TR3 | (TR4 \* 8) + (TR3 \* 4) +

| (TR2 \* 2) + TR1

| ; Convert the four binary

| ; inputs to an integer

|

| IPDL := FNCPTRS(trs\_input)

| ; Get TRS state corresponding

| ; to current switch positions

|

| --- ELSE ---

|

| IPDL := 0xFF

| ; Indicate invalid TRS state

25-82

TRANSMISSION INPUT CONVERSIONS, DIGITAL TRS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

;Determine value of PDL.

IPDL = 0xFF ----------------------------| PDL\_MON\_TMR := 0

;Current TRS state is invalid | ; Clear timer used to

| ; control monitor flag

|

| --- ELSE ---

|

IPDL <> IPDL\_LST -----------------------| TM\_PDL\_RES := PDLTIM

;TRS position has changed. | ; Initialize transition

| ; timer.

|

| PDL\_ERR\_TMR := 0

| ; Clear TRS error timer

|

| --- ELSE ---

|

TM\_PDL\_RES = 0 -------------------------| Do: save\_new\_pdl

;Transition timer has expired. | ; Assume TRS in valid

| ; state.

|

| PDL\_ERR\_TMR := 0

| ; Clear TRS error timer

|

| --- ELSE ---

|

| PDL\_ERR\_TMR := 0

| ; Clear TRS error timer

;If a transition bit pattern has been decoded indicate that the

;TRS is in transition and allow the transition error timer to

;continue to count up. Otherwise, clear the timer if the TRS

;is not within a transition region.

IPDL = 0xF0 -----------------------|

|

IPDL = 0x00 -----------------------|OR -| FLG\_TRNS\_BIT = 1

| |

IPDL = 0x0F -----------------------| | --- ELSE ---

|

| FLG\_TRNS\_BIT = 0

| TRNS\_ERR\_TMR = 0

END: trs\_decode

25-83

TRANSMISSION INPUT CONVERSIONS, DIGITAL TRS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: save\_new\_pdl

; This process is executed only when called.

IPDL = 0x0F ----------------------------| PDL = 6

|

| --- ELSE ---

|

IPDL = 0x00 ----------------------------| PDL = 4

|

| --- ELSE ---

|

IPDL = 0xF0 ----------------------------| PDL = 2

|

| --- ELSE ---

|

IPDL <> 4 ------------------------------| PDL := IPDL

|

| --- ELSE ---

FLG\_TCS = 1 ----------------------| |

;O/D cancel activated |OR --| PDL := 3

| |

OFMFLG = 1 -----------------------| |

;EPC VFS short circuit fault present |

| --- ELSE ---

|

| PDL := 4

END: save\_new\_pdl

BEGIN: trs\_fmem

; This process is executed only when called.

; TRS position cannot be determined.

; Substitute FMEM value.

FMMMLP = 4 -----------------------|

;PDL FMEM value |

;is O/D |AND -| PDL := 3

| |

FLG\_TCS = 1 ----------------| | |

;O/D cancelled |OR --| |

| |

OFMFLG = 1 -----------------| |

;VFS EPC short circuit fault |

| --- ELSE ---

|

| PDL := FMMMLP

END: trs\_fmem

25-84

TRANSMISSION INPUT CONVERSIONS, DIGITAL TRS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: trs\_self\_test

; This process is executed only when called.

; Check entry conditions for self test.

CCM\_EO\_ENA = 1 -------------------|

;Engine Off test enabled |AND -| Do: trs\_engine\_off\_test

| |

MLPS\_KOEO\_EN = 1 -----------------| |

;MLPS KOEO test enabled |

| --- ELSE ---

CCM\_TST\_ENA = 1 ------------------| |

;Continuous CCM enabled | |

| |

CCM\_TST\_SW = 1 -------------------|AND -| Do: trs\_continuous\_test

;Continuous CCM present | |

| |

OBDII\_RESET = 0 ------------------| |

| --- ELSE ---

|

| Do: clear\_malf(P1705)

| Do: clear\_malf(P0705)

BEGIN: trs\_engine\_off\_test

; This process is executed only when called.

; Insure TRS indicates vechicle is in PARK.

IPDL <> 5 ------------------------|

|AND -| Do: store\_code(P1705)

IPDL <> 7 ------------------------| |

;TRS not indicating PARK | --- ELSE ---

|

| Do: clear\_malf(P1705)

END: trs\_engine\_off\_test

BEGIN: trs\_continuous\_test

; This process is executed only when called.

; Perform continuous tests on transmission range sensor.

IPDL = 0xFF ----------------------|

;Invalid TRS state |AND -| Do: trs\_fmem

| | Do: malfunction(ccm,P0705)

PDL\_ERR\_TMR > PDL\_ERR\_TM ---------| | PDL\_ERROR := 1

;Error present long enough |

| --- ELSE ---

|

FLG\_TRNS\_BIT = 1 -----------------| | Do: trs\_fmem

|AND -| Do: malfunction(ccm,P1704)

TRNS\_ERR\_TMR > TRNS\_ERR\_TM -------| | PDL\_ERROR = 1

;Transition error present long |

;enough | --- ELSE ---

|

| Do: clear\_malf(P0705)

| Do: clear\_malf(P1704)

| PDL\_ERROR := 0

25-85

TRANSMISSION INPUT CONVERSIONS, DIGITAL TRS CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P1704MALF = 1 --------------------|

|

P0705MALF = 1 --------------------|OR --| PDL\_MON := 1

| | ;TRS has been monitored

PDL\_MON\_TMR > PDL\_MON\_TM ---------| | ;this power-up.

END: trs\_continuous\_test

25-86

TRANSMISSION INPUT CONVERSIONS, IMRC/TRANSMISSION INTERACTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.19 IMRC/TRANSMISSION INTERACTION CONTROL (CDAN0)

OVERVIEW

Movement of the IMRC during a shift event will create a torque disturbance

that negatively affects shift feel. If the IMRC is scheduled to open or

close during the shift, it's position should not change. Rather, the IMRC

will hold its position from the time that a new gear is commnded up until the

end of the shift (end of the inertia phase).

The upshift torque modulation flag, FLG\_UP\_TQM, will be used to tie the

opening or closing of the IMRC to the actual end of the interia phase.

Because FLG\_UP\_TQM will not pinpoint the end exactly, a timer will be added

to compensate. The IMRC logic will also use a calibration switch, IMRC\_SFT,

in conjunction with FLG\_IMRC\_HLD. The switch will be used to enable or

disable this "hold during a shift" feature.

Note: Timer values need to be considered carefully. If the IMRC is held

closed too long after the end of the shift, and are then allowed to open, the

vehicle will exhibit a delayed surge of power.

DEFINITIONS

Registers:

- HLD\_IMRC\_TMR = Timer to control how long past the end of the inertia

phase to hold the IMRC in its current position.

Bit Flags:

- FLG\_UP\_TQM = Upshift torque modulation flag.

- FLG\_IMRC\_HLD = Indicates that IMRC should not change state during a shift

event.

- FLG\_IMRC\_TM = Indicates imrc\_hld\_timer is counting down.

Calibration Constants:

- HLD\_IMRC\_TM = Time to to disallow the IMRC to change position after the

end of a shift is detected.

25-87

TRANSMISSION INPUT CONVERSIONS, IMRC/TRANSMISSION INTERACTION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_IMRC\_CTL\_COM1

Set timer value after inertia phase of upshift has completed

FLG\_UP\_TQM = 0 ----------------------------|

(end of shift is detected) |

|

FLG\_IMRC\_HLD = 1 --------------------------|

(IMRC state is being held) |AND -| HLD\_IMRC\_TMR = HLD\_IMRC\_TM

| | FLG\_IMRC\_TM = 1

FLG\_IMRC\_TM = 0 ---------------------------| | (load IMRC hold timer)

| |

HLD\_IMRC\_TMR = 0 --------------------------| |

(IMRC hold timer has not been set) | --- ELSE ---

|

FLG\_IMRC\_HLD = 0 --------------------------------| FLG\_IMRC\_TM = 0

| (Reset flag for next

| upshift)

Determine state of FLG\_IMRC\_HLD

FLG\_UP\_TQM = 1 ----------------------------------|

(An upshift has been commanded) |OR --| FLG\_IMRC\_HLD = 1

| | (disallow IMRC from

HLD\_IMRC\_TMR > 0 --------------------------------| | changing state

(or, timer is set) | during an upshift)

|

| --- ELSE ---

|

| FLG\_IMRC\_HLD = 0

25-88

TRANSMISSION INPUT CONVERSIONS, OSS INPUT PROCESSING AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.20 OSS INPUT PROCESSING AND SELF TEST (CDAN0)

OVERVIEW

This module performs the foreground processing of the output shaft speed

input, the calculation of unfiltered output shaft speed (NO), and output

shaft speed sensor testing.

The foreground processing logic counts the number of rising edges since the

last output shaft speed calculation was performed in background, and records

the time of the most recent rising edge.

Once a background loop, the ouput shaft speed is calculated if at least one

new rising edge occurred since the last calculation. If the time since the

last edge becomes large, the shaft speed is set to zero, indicating the shaft

is stopped, or the sensor has failed.

The output shaft speed sensor test verifies sensor output is present when the

vehicle is moving. The test relies on the inferred vehicle motion detector

flag (VMOVING) to determine vehicle motion. If a failure is present (no

output when output is expected) for a sufficient amount of time, a

malfunction flag is set (P0720MALF), and failure mode action is initiated.

In the event that a failure is intermittent, failure mode action will be

executed for a calibratable amount of time after the sensor begins to

function again.

Once a fault has been detected, or the output shaft speed sensor has been

observed to function for a calibratable amount of time, the output shaft

speed sensor monitor flag (P0720MON) will be set.

DEFINITIONS

Registers:

- NO = Transmission output shaft speed, rpm.

- NO\_PREV = Last background pass value of unfiltered transmission output

shaft speed, rpm.

- NOBART = Filtered transmission output shaft speed.

- OSCTR = Count of unrealistic changes of output speed.

- OSSCNT = Number of OSS rising edges since last sample.

- OSSTIM1 = Time of the last valid edge event captured by the DARC, DARC

ticks.

- OSSTIM2 = Time interval between background samples, DARC ticks.

25-89

TRANSMISSION INPUT CONVERSIONS, OSS INPUT PROCESSING AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- OSSTMR = Output (shaft) speed sensor fault timer.

- OSS\_FM\_TMR = Output (shaft) speed sensor failure mode timer.

- OSS\_MON\_TMR = Output (shaft) speed sensor monitor timer.

- OS\_NOISE\_CTR = Count of unrealistic changes in output shaft speed

observed during the current power-up.

- TCR\_OSS = Time capture register for the OSS input signal to the DARC,

DARC ticks.

- TSLOSS = Time since last OSS interrupt, sec.

- TSLOS\_SPK = Time since last OS spike, seconds.

- TSTRAT = Transmission strategy switch; The TSTRAT software switch

controls which transmission control strategy is executed.

0 -> No transmission control (Manual trans., AOD, ATX, C6, C3, etc.)

1 -> SIL (Shift indicator light)

2 -> A4LD with 3-4 shift control and converter clutch control

3 -> AXOD

4 -> C64E (E4OD)

5 -> A4LDE

6 -> FAX-4

7 -> AOD-E (AOD-I)

8 -> 4EAT

9 -> CD4E

Bit Flags:

- CCM\_TST\_ENA = comprehensive components monitor test enable flag; 1 ->

diagnostic executive has determined that codintions to perform ccm

testing have been met.

- OSFMFLG = Output (shaft) speed sensor failure mode flag.

- P0720MON = OBDII fault 0720 monitor flag; 1 -> fault 0720 has been

sufficiently monitored this "trip". (the sensor has been tested and is

functioning or a fault was detected.)

- PXXXMALF = OBDII fault xxx malfunction flag; 1 -> a malfunction for fault

xxx currently exists.

- VMOVING = Flag indicating inferred vehicle motion.

Calibration Constants:

- MAX\_NODELT = Maximum realistic change in unfiltered output shaft speed

from one background loop to the next.

- MNOSSPER = Minimum time between OSS rising edges for the edge to be

valid, ticks. Value depends on maximum engine rpm, number of edges per

revolution and clock frequency.

- MX\_TSLOS\_SPK = Maximum time between OS spikes for which the noise counter

will be updated.

25-90

TRANSMISSION INPUT CONVERSIONS, OSS INPUT PROCESSING AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- OSCNT = Upcount for unrealistic changes in output shaft speed.

- OSSPUL = Number of OSS pulses per revolution.

- OSSMIN = Minimum acceptable oss output when vehicle motion is inferred.

- OSSTIM = Minimum time with inferred vehicle motion and no output (shaft)

speed sensor output required to recognize a fault.

- OSS\_FM\_TIM = Minimum time the output (shaft) speed sensor must function

after a detected failure before the sensor failure mode will be exited.

- OSS\_MON\_TIM = Minimum time the output (shaft) speed sensor must be

observed to function before the monitor flag will be set.

- OSS\_SW = Output shaft speed sensor test calibration switch; 1 -> oss test

cal'ed in.

- OS\_NOISE\_LVL = Noisy OSS fault threshold.

OTHER

- oss\_codes = SET OF {P0720, P0721} the set of OBDII fault codes that

relate to the oss.

- ccm\_malfunction {P0720} = Logic process, imported from MIL control

module; Pxxx indicates a fault code.

- clear\_malf(Pxxx) = Logic process, used to clear malfunction flag

indicated by Pxxx.

- P0720 = Fault code, oss failure.

- P0721 = Fault code, noisy OSS failure.

25-91

TRANSMISSION INPUT CONVERSIONS, OSS INPUT PROCESSING AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_OSS\_OBDII\_COM1

Do the following in foreground.

always ---------------------------------| OSSTIM1 = TCR\_OSS

FIRST\_OSS = 0 --------------------------| OSSTIM2 = OSSTIM1

| OSSCNT = 0

| FIRST\_OSS = 1

|

| --- ELSE ---

|

DT\_OSS < MNOSSPER ----------------------| OSS period too short,

(OSS noise filter) | must be noise, ignore edge

| Exit OSS routine

|

| --- ELSE ---

|

| OSSCNT = OSSCNT + 1

Do the following once per background loop:

unconditionally ------------------------| NO\_PREV = NO

| ;Save the last background value

| ;of unfiltered output shaft speed

TSTRAT <= 3 ----------------------------| EXIT MODULE

(manual/non-electric transmission) |

| --- ELSE ---

|

TSLOSS >= 255 msec ---------------------| NO = 0

(less than 59 rpm if 4 pulses/rev) | NOBART = 0

|

| --- ELSE ---

|

| NO = ((60 \* OSSCNT) / (OSSPUL \*

| (OSSTIM1 - OSSTIM2) \* dtscf))

| TSLOSS = 0

Where, dtscf = DARC ticks to seconds conversion factor.

25-92

TRANSMISSION INPUT CONVERSIONS, OSS INPUT PROCESSING AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Check for unrealistic changes in output shaft speed:

abs(NO - NO\_PREV) > MAX\_NODELT ---------| OSCTR = OSCTR + OSCNT

;Unrealistic change in NO | ;Upcount OSCTR for bad event

|

| increment(OS\_NOISE\_CTR)

| ;Upcount the noisy OSS event

| ;counter

|

| TSLOS\_SPK = 0

| ;Zero time since last OS spike

|

| --- ELSE ---

|

NO > 0 ---------------------------------| Decrement OSCTR

;Output from OSS present | ;Downcount OSCTR if there is

| ;output from the OSS

Check to see if enough unrealistic changes in output speed have occurred

to store a fault code.

NOTE: It has been observed driver induced spikes due to operation of ice

or due to high engine rpm engagements (where the driver squawks the

tires) or any time the brakes are applied quickly (tiers locked up),

are always followed by long periods (seconds) of time where OS is

stable.

A maximum time since last OS spike will be used to clear the bad event

counter - which will prevent driver induced spikes from tricking the

test into setting false OS noise fault codes.

TSLOS\_SPK > MX\_TSLOS\_SPK ---------------| OS\_NOISE\_CTR = 0

;Time since last OS spike indicates | ;zero the OS noise counter

;spike was NOT due to noise |

OS\_NOISE\_CTR > OS\_NOISE\_LVL ------------| store\_code(P0721)

;enough bad events to store a code | ;store a noisy

| ;OSS fault code

25-93

TRANSMISSION INPUT CONVERSIONS, OSS INPUT PROCESSING AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The output shaft speed sensor test verifies that sensor output is present

when output is expected.

OSS\_SW = 0 -----------------------|

(test cal'ed out) |OR --| OSSTMR = 0

| | OSS\_MON\_TMR = 0

CCM\_TST\_ENA = 0 ------------------| | EXIT

(CCM tests disabled) |

| --- ELSE ---

VMOVING = 1 ----------------------| |

(vehicle motion inferred) | |

| |

NOBART < OSSMIN ------------------|AND -| malfunction(ccm,P0720)

(no output from output) | |

shaft speed sensor) | | OSFMFLG = 1

| | OSS\_FM\_TMR = 0

OSSTMR > OSSTIM ------------------| |

(error present long enough) |

|

| --- ELSE ---

OSFMFLG = 1 ----------------------| |

(currently in FMEM) |AND -| OSS\_FM\_TMR = 0

| | (no sensor signal, clear FMEM

NOBART < OSSMIN ------------------| | timer - remain in FMEM for

(no output from sensor) | a calibratable amount of time

| after signal returns)

|

| --- ELSE ---

OSFMFLG = 1 ----------------------| |

(currently in FMEM) | |

| |

OSS\_FM\_TMR > OSS\_FM\_TIM ----------|AND -| OSFMFLG = 0

(minimum time in FMEM | | (exit FMEM)

has passed) | |

| | clear\_malf(P0720)

NOBART >= OSSMIN -----------------| |

(sensor output present) |

| --- ELSE ---

NOBART >= OSSMIN -----------------| |

(sensor output present) |OR --| OSSTMR = 0

|

VMOVING = 0 ----------------------|

(no inferred vehicle motion)

OSS\_MON\_TMR > OSS\_MON\_TIM --------|

|OR --| P0720MON = 1

P0720MALF = 1 --------------------| | (the output shaft speed sensor has

| been monitored - the sensor is

| functioning or a fault has been

| detected)

|

| --- ELSE ---

|

NOBART < OSSMIN ------------------------| OSS\_MON\_TMR = 0

25-94

TRANSMISSION INPUT CONVERSIONS, VEHICLE SPEED SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

25.21 VEHICLE SPEED SELF TEST (CDAN0)

OVERVIEW

This module contains four vehicle speed sensor routines:

- unrealistic\_delta\_vs\_check = A check for for unrealistic changes in

unfiltered vehicle speed.

- vss\_reliable\_check = An instantaneous check on VSS reliability (FFG\_VS

logic).

- vehicle\_speed\_sensor\_test = The VSS self test logic.

- vss\_monitor = additional fault filtering logic for manual applications.

The vehicle speed sensor test verifies sensor output is present when the

vehicle is moving. The test relies on the inferred vehicle motion detector

flag (VMOVING) to determine vehicle motion. If a failure is present (no VSS

output when output is expected) for a sufficient amount of time, a

malfunction flag is set (P0500MALF), and failure mode action is initiated.

In the event that a failure is intermittent, failure mode action will be

executed for a calibratable amount of time after the sensor begins to

function again.

Once a fault has been detected, or the vehicle speed sensor has been observed

to function for a calibratable amount of time, the vehicle speed sensor

monitor flag (P0500MON) will be set.

Additional fault filter logic has been added for manual transmissons which

utilizes and error counter (VSS\_ERR\_CTR) and a calibratable error level

(VSS\_ERR\_LVL) to control the P0500MALF malfunction flag.

DEFINITIONS

Registers:

- TSLVS\_SPK = Time since last VS spike, seconds.

- VS\_NOISE\_CTR = Count of unrealistic changes in vehicle speed observed

this power-up.

- VS\_HW = Unfiltered vehicle speed from VSS hardware.

- VS\_PREV = Previous calculated value of VS (not updated every background).

- VSS\_ERR\_CTR = VSS error counter

- VSBARV = Filtered vehicle speed for self test.

25-95

TRANSMISSION INPUT CONVERSIONS, VEHICLE SPEED SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- VSCTR = Count of unrealistic vehicle speed changes.

- VSSTMR = Vehicle speed sensor fault timer.

- VSS\_FM\_TMR = Vehicle speed sensor failure mode timer.

- VSS\_MON\_TMR = Vehicle speed sensor monitor timer.

Bit Flags:

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag; 1 -> test

enabled.

- FFG\_VS = OBD-II system FMEM flag for the VSS; 1 -> VSS signal is

currently unreliable.

- PxxxMALF = OBDII malfunction flag for fault Pxxx; 1 -> a malfunction

currently exists for fault Pxxx.

- PxxxMON = OBDII monitor flag for fault Pxxx; 1 -> fault Pxxx has been

monitored at least once since power-up.

- VMOVING = Flag indicating inferred vehicle motion.

- VSFMFLG = Vehicle speed sensor failure mode flag.

- VSS\_MON\_FLG = Vehicle speed sensor monitor flag; 1 -> vehicle speed has

been monitored functioning this power-up.

Calibration Constants:

- MAX\_VSDELT = Maximum realistic change in unfiltered vehicle from one

background loop to the next, ignoring slick surfaces.

- MX\_TSLVS\_SPK = Maximum time between VS spikes for which the noise counter

will be updated.

- VSCNT = Increment to VSCTR indicating failed MPH sensor.

- VSSMN1 = Minimum acceptable vehicle speed sensor output when vehicle

motion is inferred.

- VSSTIM = Minimum time with inferred vehicle motion and no vehicle speed

sensor output required to recognize a fault.

- VSS\_ERR\_LVL = VSS error fault threshold.

- VSS\_ERR\_UP = VSS error upcount.

- VSS\_FM\_TIM = Minimum time the vehicle speed sensor must function after a

detected failure before the vehicle speed sensor failure mode will be

exited.

- VSS\_MON\_TIM = Minimum time the vehicle speed sensor must be observed to

function before the VSS monitor flag will be set.

- VS\_NOISE\_LVL = Fault threshold for a noisy VSS malfunction.

25-96

TRANSMISSION INPUT CONVERSIONS, VEHICLE SPEED SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OTHER

- vs\_codes = SET OF {P0500} the set of OBDII fault codes that relate to the

vehicle speed sensor.

- malfunction(ccm,Pxxx) = Locic process, imported from the MIL control

module; Pxxx indicates a fault code.

- P0500 = Fault code, vehicle speed sensor failure.

- P0503 = Fault code, vehicle speed sensor noisy.

25-97

TRANSMISSION INPUT CONVERSIONS, VEHICLE SPEED SELF TEST - CDAN2

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PROCESS

STRATEGY MODULE: INTRN\_VSS\_TEST\_COM3

The following logic is called from the VSS input processing module after

vehicle speed calculations are made:

unconditionally -----------------------| Do: unrealistic\_delta\_vs\_check

| Do: vss\_reliable\_check

CCM\_TST\_ENA = 1 -----------------------| Do: vehicle\_speed\_sensor\_test

;Continuous CCM testing enabled |

| --- ELSE ---

|

| VSSTMR = 0

| ;Hold VSS error timer at zero

| when the VSS test is not run

BEGIN: unrealistic\_delta\_vs\_check

Check for unrealistic changes in vehicle speed:

abs(VS\_HW - VS\_PREV) > MAX\_VSDELT ------| VSCTR = VSCTR + VSCNT

;Unrealistic change in vs | ;Upcount VSCTR for bad event

|

| increment(VS\_NOISE\_CTR)

| ;Upcount the noisy VS event

| ;counter

|

| TSLVS\_SPK = 0

| ;Zero time since last VS spike

|

| --- ELSE ---

|

VS\_HW > 0 ------------------------------| Decrement VSCTR

;Output from VSS present | ;Downcount VSCTR if there is

| ;output from the VSS

25-98

TRANSMISSION INPUT CONVERSIONS, VEHICLE SPEED SELF TEST - CDAN2

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Check to see if enough unrealistic changes in vehicle speed have occurred

to store a fault code.

NOTE:

the vehcile speed sensor does not sense actual vehicle speed - it

senses a shaft or wheel speed. This means calculated vehicle speed can

change by large, unrealistic amounts any time the tires slip (even

though true vehicle speed has not changed unrealistically).

It has been observed driver induced spikes due to operation on ice or

due to a high engine rpm engagements (where the driver squawks the

tires) or any time the brakes are applied quickly (tires locked up),

are always followed by long periods (seconds) of time where VS is

stable.

A maximum time since last VS spike will be used to clear the bad event

counter - which will prevent driver induced spikes from tricking the

test into setting false VS noise fault codes.

TSLVS\_SPK > MX\_TSLVS\_SPK ---------------| VS\_NOISE\_CTR = 0

;Time since last VS spike indicates | ;zero the VS noise counter

;spike was NOT due to noise |

VS\_NOISE\_CTR > VS\_NOISE\_LVL ------------| store\_code(P0503)

;enough bad events to store a code | ;store a noisy

| ;VSS fault code

END: unrealistic\_delta\_vs\_check

BEGIN: vss\_reliable\_check

Determine if the vehicle speed sensor signal is reliable enough to be used

in OBD-II CAT, EGO, and PURGE monitor entry conditions:

VSBARV < VSSMN1 ------------|

;No output from the VSS |AND -|

| |

VMOVING = 1 ----------------| |

;Output from the VSS is |

expected |OR --| FFG\_VS = 1

| | ;VSS signal suspect

VSCTR > 0 ------------------------| |

;Unrealistic change in VS | |

| |

VSFMFLG = 1 ----------------------| |

;In vehicle speed sensor FMEM |

| --- ELSE ---

|

| FFG\_VS = 0

| ;VSS signal ok

END: vss\_reliable\_check

25-99

TRANSMISSION INPUT CONVERSIONS, VEHICLE SPEED SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: vehicle\_speed\_sensor\_test

VSS\_MON\_TMR > VSS\_MON\_TIM --------------| decrement VSS\_ERR\_CTR

| Do: vss\_monitor

| VSS\_MON\_TMR = 0

| ;VSS output present long enough to

| ;call event good, decrement error

| ;counter, call vss monitor, and

| ;zero timer for next event

|

| --- ELSE ---

|

VSBARV < VSSMN1 ------------------------| VSS\_MON\_TMR = 0

(No VSS output present) | ;Zero monitor timer

VMOVING = 1 ----------------------|

;vehicle motion inferred |

|

VSBARV < VSSMN1 ------------------|AND -| VSS\_ERR\_CTR = VSS\_ERR\_CTR +

;no output from VSS | | VSS\_ERR\_UP

| | Do: vss monitor

VSSTMR >= VSSTIM -----------------| | VSSTMR = 0

;error present long enough | VSFMFLG = 1

| VSS\_FM\_TMR = 0

| ;Upcount VSS fault filter,

| ;Zero error timer for next

| ;bad event, enter fmem on

| ;automatic transmission

| ;after 1 bad event

|

| --- ELSE ---

VSFMFLG = 1 ----------------------| |

;currently in FMEM |AND -| VSS\_FM\_TMR = 0

| | ;no VSS signal, clear FMEM

VSBARV < VSSMN1 ------------------| | timer - remain in FMEM for

;no output from VSS | a calibratable amount of time

| after VSS returns

|

| --- ELSE ---

VSFMFLG = 1 ----------------------| |

;currently in FMEM | |

| |

VSS\_FM\_TMR > VSS\_FM\_TIM ----------|AND -| VSFMFLG = 0

;minimum time in FMEM | | ;exit fmem

has passed | | ;Note: VSS fmem will be exited

| | ;if VSS output is present for

VSBARV >= VSSMN1 -----------------| | ;VSS\_FM\_TIM (even if VSS\_ERR\_CTR

;VSS output present | ;is non-zero).

|

| --- ELSE ---

VSBARV >= VSSMN1 -----------------| |

;VSS output present |OR --| VSSTMR = 0

| | ;VSS is functioning, or

VMOVING = 0 ----------------------| | not enough information is

;no inferred vehicle motion | present to test the sensor

END: vehicle\_speed\_sensor\_test

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TRANSMISSION INPUT CONVERSIONS, VEHICLE SPEED SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: vss\_monitor

Use the VSS error counter (VSS\_ERR\_CTR) to determine the status of the VSS.

NOTE: This logic has been added because a robust VMOVING strategy/calibration

for manual transmissions has not been developed. It is assumed the second

level of fault filtering (VSSTMR is the first) will not be used on automatic

transmission applications (for which VMOVING is robust).

VSS\_ERR\_CTR > VSS\_ERR\_LVL --------------| malfunction(ccm, p0500)

;enough bad events | P0500MON = 1

| ;VSS malfunctioning, store code

| ;and indicate VSS monitored.

|

| --- ELSE ---

|

VSS\_ERR\_CTR = 0 ------------------------| clear\_malf(P0500)

;no bad events | P0500MON = 1

| ;VSS functioning, clear malfunction

| ;and indicate VSS monitored.

END: vss\_monitor

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TRANSMISSION INPUT CONVERSIONS, VEHICLE SPEED SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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CHAPTER 26

SHIFT CONTROL

26-1

SHIFT CONTROL, PRNDL BASED DESIRED GEAR DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.1 PRNDL BASED DESIRED GEAR DETERMINATION (CDAN2)

OVERVIEW

The desired transmission gear is calculated based on PRNDL position.

Possible gears are:

GR\_CM Transmission State GEAR\_CUR RT\_GR\_CUR

------ ------------------ -------- ---------

1 1ST 1 GRRAT1

2 2ND 2 GRRAT2

3 3RD 3 GRRAT3

4 4TH 4 GRRAT4

In the normal Drive/Overdrive position, the desired gear is calculated based

on a maximum WOT RPM shift point or as a function of throttle position versus

vehicle speed. All shift points are adjusted for altitude. There are no

excluded shifts in automatic mode, that is 1 - 4 shifts or 3 - 1 shifts are

permitted if the calibration calls for it. In addition, the gear sequence

for a multi-step shift is completely calibratable.

In manual 2 or 1, desired gear is set to the ultimate desired gear: 2 in

manual 2 and 1 in manual 1. Sequencing through the downshift routine is left

to the commanded gear routine.

The main outputs of the desired gear routine are:

- GR\_DS, the desired gear;

- FLG\_FRST\_DS, global flag to indicate a shift is desired this background

pass.

DEFINITIONS

INPUTS

Registers:

- GEAR\_CUR = Global gear indicator, reflects only.

- GEAR\_OLD = Global gear indicator for last commanded.

- GR\_DS = Desired transmission gear.

- GR\_DS\_LST = Desired gear in the last background pass.

- GR\_DS\_TV = Commanded gear for TV.

- PDL = Current PRNDL position.

- PDL\_LST = Last PRNDL position.

26-2

SHIFT CONTROL, PRNDL BASED DESIRED GEAR DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- FLG\_SFT\_IN = Shift in progress flag.

Calibration Constants:

- SW\_SFTIN = Desired gear shift in progress switch; 0 -> FLG\_SFT\_IN = 0 for

new desired gear, 1 -> always determine new desired gear.

- TM\_M12 = Time that third gear solenoid states should be commanded on a

manual 1-2 shift.

OUTPUTS

Registers:

- GR\_DS = See above.

- GR\_DS\_LST = See above.

- GR\_DS\_TV = See above.

- IGR\_DS = Unverified desired transmission gear.

- TMR\_M12 = Timer used to control commanding 3rd gear shift solenoid states

at a manual 1-2 shift.

- TM\_SFT\_IN = Shift in progress timer.

Bit Flags:

- FLG\_FRST\_DS = First time a shift is desired flag; 0 -> no shift desired,

1 -> shift desired this background pass.

- FLG\_SFT\_DN = Downshift flag.

- FLG\_SFT\_IN = See above.

- FLG\_SFT\_UP = Upshift flag.

26-3

SHIFT CONTROL, PRNDL BASED DESIRED GEAR DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_DESRD\_GR\_DETR\_COM10

PDL = 3 --------------------|

|OR --|

PDL = 4 --------------------| |

|AND -| TM\_SFT\_IN = 0

PDL\_LST <> 3 ---------------------| | FLG\_SFT\_IN = 0

| |

PDL\_LST <> 4 ---------------------| | (clear timer/flag if

| you are making a manual

| shift)

| always ---------------------------------| Do: INTRN\_SHFT\_SCHLD\_COMP\_CALC

| | (calculate predictive vehicle

| | and engine speed)

| | GR\_DS\_LST = GR\_DS

PDL\_LST = 1 ----------------------|

|

PDL = 2 --------------------------|AND -| TMR\_M12 = TM\_M12

|

GEAR\_CUR = 1 ---------------------|

PDL = 1 --------------------------------| IGR\_DS = 1

(PRNDL in manual 1) | GR\_DS = 1

|

| --- ELSE ---

|

PDL = 2 --------------------------------| IGR\_DS = 2

(PRNDL in manual 2) | GR\_DS = 2

|

| --- ELSE ---

SW\_SFTIN = 1 ---------------| |

|OR --| |

FLG\_SFT\_IN = 0 -------------| | |

(no shift in progress) | |

|AND -| Do "GR\_DS, PRNDL = 3 OR 4" Logic

PDL = 3 --------------------| | | Do "DELAY/VERIFY SHIFT" Logic

(PRNDL in overdrive cancel)|OR --| | Do "GR\_SEQ\_PNTR CALCULATION"

| |

PDL = 4 --------------------| |

(PRNDL in overdrive) |

| --- ELSE ---

PDL = 6 --------------------------| |

(PRNDL in reverse) | |

| |

PDL = 7 --------------------------|OR --| IGR\_DS = 1

(PRNDL in park) | | GR\_DS = 1

| | GR\_DS\_TV = 1

PDL = 5 --------------------------|

26-4

SHIFT CONTROL, PRNDL BASED DESIRED GEAR DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

GR\_DS\_TV > GEAR\_CUR --------------|

(upshift is being verified or |

will be commanded this pass) |

|OR --| FLG\_SFT\_UP = 1

GR\_DS\_TV = GEAR\_CUR --------| | | FLG\_SFT\_DN = 0

(no shift pending) | | | (indicate upshift)

|AND -| |

GEAR\_CUR >= GEAR\_OLD -------| |

(last shift was an upshift) |

| --- ELSE ---

|

| FLG\_SFT\_UP = 0

| FLG\_SFT\_DN = 1

| (indicate downshift)

GR\_DS <> GR\_DS\_LST ---------------------| FLG\_FRST\_DS = 1

(desired gear has changed) | (new desired gear for

| this program pass only)

|

| --- ELSE ---

|

| FLG\_FRST\_DS = 0

26-5

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.2 GR\_DS, PRNDL = 3 OR 4 LOGIC (CDAM0)

OVERVIEW

This module handles the Desired Gear computation when PRNDL = 3 or 4 based on

shift curves of vehicle speed vs relative throttle position. Vehicle

acceleration rate compensation is accomplished by comparing the output of the

shift curves to a predicted vehicle speed.

DEFINITIONS

Registers:

- BP\_INTR = BP interpolation factor.

- COMP\_FCTR = Compensation factor for shfit schedules.

- COOL\_PI\_INT = Integer PI controller output; number of cylinders active

during fail-safe cooling.

- CS\_SFT\_MULT = Cold start shift multiplier.

- FSC\_ADD\_U = Value added to FN689U to lower shift points for fail safe

cooling mode.

- FSC\_ADD\_D = Value added to FN689U to lower shift points for fail safe

cooling mode.

- GR\_CM = Commanded gear for shift solenoids.

- HOT21\_ADDR = 2-1 downshift adder (FN21\_HOT) when transmission is

overtemperature; 0 -> when not overtemperature.

- IGR\_DS = Unverified desired transmission gear.

- NEBART = Filtered engine RPM for transmission.

- NEBART\_PU = Predicted engine speed for an upshift from current gear.

- OSCTR = Count of unrealistic changes in output shaft speed.

- PDL = Current PRNDL position.

- PDL\_LST = PRNDL position last background pass.

- PNWF = Performance and Normal Weighting Factor.

- RT\_NOVS = Ratio of actual N/V to base N/V in KAM.

- TOT = Transmission oil temperature (degrees F).

- TP\_REL = Relative throttle position, counts.

- TP\_REL\_H = Relative TP (TP - RATCH); high byte only.

26-6

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TQ\_INTRP = Torque interpolation factor.

- VSBART\_RT\_PD = Filtered predicted downshift vehicle speed (vehicle

acceleration compensation).

- VSBART\_RT\_PU = Filtered predicted upshift vehicle speed (vehicle

acceleration compensation).

- VS\_RATEPH = Vehicle acceleration rate for Powertrain Hunting.

Bit Flags:

- COOL\_FLG = Overtemperature Flag : 1 -> overtemperature

- FLG\_4X4L = 4x4 low flag.

- FLG\_NE\_WAIT = Wot engine RPM upshift has begun - wait for RPM drop before

checking for another.

- FLG\_UP\_NE = WOT engine RPM upshift flag; 1 -> upshift due to WOT RPM, 0

-> upshift due to shift curves.

- OSFMFLG = Output shaft speed sensor FMEM flag.

- VSFMFLG = Vehicle Speed Sensor FMEM flag.

Calibration Constants:

- FN12COMP(TP\_REL\_H) = Vehicle speed adjustment for 1 - 2 upshift for

altitude or engine output torque loss.

- FN12P(TP\_REL\_H) = Delta vehicle speed for 1-2 upshift in performance

mode.

- FN12S(TP\_REL\_H) = Vehicle speed for 1 - 2 upshift at sea level.

- FN12S\_4X4L(TP\_REL\_H) = Vehicle speed for 1 - 1 upshift at sea level in

4X4L.

- FN21COMP(TP\_REL\_H) = Vehicle speed adjustment for 2 - 1 downshift for

altitude or engine output torque loss.

- FN21\_HOT(TP\_REL\_H) = 2-1 downshift adder when transmission is

overtemperature.

- FN21P(TP\_REL\_H) = Delta vehicle speed for 2-1 downshift in performance

mode.

- FN21S(TP\_REL\_H) = Vehicle speed for 2 - 1 downshift at sea level.

- FN21S\_4X4L(TP\_REL\_H) = Vehicle speed for 2 - 1 downshift at sea level in

4X4L.

- FN23COMP(TP\_REL\_H) = Vehicle speed adjustment for 2 - 3 upshift for

altitude or engine output torque loss.

- FN23P(TP\_REL\_H) = Delta vehicle speed for 2-3 upshift in performance

mode.

26-7

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FN23PPH(TP\_REL) = Min VS\_RATEPH to allow 2 - 3 upshift.

- FN23S(TP\_REL\_H) = Vehicle speed for 2 - 3 upshift at sea level.

- FN23S\_4X4L(TP\_REL\_H) = Vehicle speed for 2 - 3 upshift at sea level in

4x4l.

- FN32COMP(TP\_REL\_H) = Vehicle speed adjustment for 3 - 2 downshift for

altitude or engine output torque loss.

- FN32P(TP\_REL\_H) = Delta vehicle speed for 3-2 downshift in performance

mode.

- FN32S(TP\_REL\_H) = Vehicle speed for 3 - 2 downshift at sea level.

- FN32S\_4X4L(TP\_REL\_H) = Vehicle speed for 3 - 2 downshift at sea level in

4x4l.

- FN34COMP(TP\_REL\_H) = Vehicle speed adjustment for 3 - 4 upshift for

altitude or engine output torque loss.

- FN34P(TP\_REL\_H) = Delta vehicle speed for 3-4 upshift in performance

mode.

- FN34PPH(TP\_REL) = Minimum VS\_RATEPH to allow 3 - 4 upshift.

- FN34S(TP\_REL\_H) = Vehicle speed for 3 - 4 upshift at sea level.

- FN34S\_4X4L(TP\_REL\_H) = Vehicle speed for 3 - 4 upshift at sea level in

4x4l.

- FN43COMP(TP\_REL\_H) = Vehicle speed adjustment for 4 - 3 downshift for

altitude or engine output torque loss.

- FN43P(TP\_REL\_H) = Delta vehicle speed for 4-3 downshift in performance

mode.

- FN43S(TP\_REL\_H) = Vehicle speed for 4 - 3 downshift at sea level.

- FN43S\_4X4L(TP\_REL\_H) = Vehicle speed for 4 - 3 downshift at sea level in

4x4l.

- FN689D(TP\_REL) = Engine speed for downshifts during VSS failure.

- FN689U(TP\_REL) = Engine speed for upshifts during VSS failure.

- FNFSC\_CYL = Multiplication value based on active cylinders for reducing

shift points in Fail Safe Cooling mode.

- FNFSC\_TPD = Multiplication value based on throttle position for reducing

downshift points in Fail Safe Cooling.

- FNFSC\_TPU = Multiplication value based on throttle position for reducing

upshift points in Fail Safe Cooling.

- HOT21\_C = Temperature at which the hot 2-1 shift schedule is no longer

used.

26-8

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- HOT21\_S = Temperature at which the hot 2-1 shift schedule is used.

- NE12COMP = WOT RPM 1 - 2 shift point adjustment for altitude or engine

output torque loss.

- NE12S = WOT RPM 1 - 2 shift point, sea level.

- NE12S4L = WOT RPM 1 - 2 shift point in 4X4L.

- NE23COMP = WOT RPM 2 - 3 shift point adjustment for altitude or engine

output torque loss.

- NE23S = WOT RPM 2 - 3 shift point, sea level.

- NE23S4L = WOT RPM 2 - 3 shift point in 4X4L.

- NE34COMP = WOT RPM 3 - 4 shift point adjustment for altitude or engine

output torque loss.

- NE34S = WOT RPM 3 - 4 shift point, sea level.

- NE34S4L = WOT RPM 3 - 4 shift point in 4X4L.

- NEDROP = Engine RPM to drop before checking for another engine RPM

upshift.

- SFT\_MPH = Minimum Vehicle speed to use VS in Shift logic, MPH. Typical

value is 0 mph.

- SW\_BP\_INTR = 1 -> Select BP\_INTR for shift schedule compensation; 0 ->

select TQ\_INTRP for shift schedule compensation.

26-9

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_GR\_DS\_AUTO\_COM22

OSCTR = 0 ---------------------|

(OSS not noisy) |OR --|

| |

OSFMFLG = 1 -------------------| |

(Vehicle speed is being |

substituted for output speed) |

|AND -| Do: "OUTPUT SHAFT SPEED SENSOR

OSFMFLG = 0 -------------------| | | OK SHIFT LOGIC"

(output shaft sensor OK) |OR --| |

| | |

VSFMFLG = 0 -------------------| | |

(Vehicle Speed Sensor OK) | |

| |

COOL\_FLG = 0 ------------------------| |

(Fail Safe Cooling inactive) |

| --- ELSE ---

|

FLG\_UP\_NE = 0 -----------------------------| Do: "OUTPUT SHAFT SPEED SENSOR

| FAILURE SHIFT LOGIC"

|

| --- ELSE ---

|

| EXIT MODULE

OUTPUT SHAFT SPEED SENSOR OK SHIFT LOGIC

TOT > HOT21\_S --------------------- ------| HOT21\_ADDR = FN21\_HOT(TP\_REL\_H)

(Transmission is hot; alter 2-1 |

shift schedule) | --- ELSE ---

|

TOT < HOT21\_C -----------------------------| HOT21\_ADDR = 0

|

| --- ELSE ---

|

| NO Action

SW\_BP\_INTR = 1 ----------------------------| COMP\_FCTR = BP\_INTR

|

| --- ELSE ---

|

| COMP\_FCTR = TQ\_INTRP

FLG\_SFT\_IN = 0 ----------------------------| FLG\_NE\_WAIT = 0

(no engine spd upshift in progress) |

| --- ELSE ---

|

| No Action

26-10

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

GR\_CM = 1 -----------------------------|

|

NEBART\_PU > NE12S + |

[COMP\_FCTR \* NE12COMP] --| |AND ------| IGR\_DS = 2

|AND -| | | FLG\_UP\_NE = 1

FLG\_4X4L = 0 ---------------| | | | FLG\_NE\_WAIT = 1

|OR -| |

NEBART\_PU > NE12S4L --------| | |

|AND -| |

FLG\_4X4L = 1 ---------------| |

|

| --- ELSE ---

FLG\_NE\_WAIT = 0 -----------------------| |

| |

GR\_CM = 2 -----------------------------| |

|AND ------| IGR\_DS = 3

NEBART\_PU > NE23S + | | FLG\_UP\_NE = 1

[COMP\_FCTR \* NE23COMP] --| | | FLG\_NE\_WAIT = 1

|AND -| | |

FLG\_4X4L = 0 ---------------| | | |

|OR -| |

NEBART\_PU > NE23S4L --------| | |

|AND -| |

FLG\_4X4L = 1 ---------------| |

|

| --- ELSE ---

PDL = 4 -------------------------------| |

| |

FLG\_NE\_WAIT = 0 -----------------------| |

| |

GR\_CM >= 3 ----------------------------|AND ------| IGR\_DS = 4

| | FLG\_UP\_NE = 1

NEBART\_PU > NE34S + | | FLG\_NE\_WAIT = 1

[COMP\_FCTR \* NE34COMP] --| | |

|AND -| | |

FLG\_4X4L = 0 ---------------| | | |

|OR -| |

NEBART\_PU > NE34S4L --------| | |

|AND -| |

FLG\_4X4L = 1 ---------------| |

|

| --- ELSE ---

(continued on next page)

26-11

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

GR\_CM < 4 ----------------------------------| |

| |

PDL = 4 ------------------------------------| |

| |

PDL <> PDL\_LST ------------------| | |

| | |

VS\_RATEPH > FN34PPH \* RT\_NOVS ---|OR -------| |

| | |

IGR\_DS = 4 ----------------------| |AND -| IGR\_DS = 4

| | FLG\_UP\_NE = 0

VSBART\_RT\_PU > [FN34S + | | FLG\_NE\_WAIT = 1

(COMP\_FCTR \* FN34COMP) + (PNWF | |

\* FN34P)] \* CS\_SFT\_MULT -------| | |

|AND -| | |

FLG\_4X4L = 0 --------------------| | | |

|OR -| |

VSBART\_RT\_PU > [FN34S\_4X4L + | |

(COMP\_FCTR \* FN34COMP) + (PNWF | |

\* FN34P)} \* CS\_SFT\_MULT -------| | |

|AND -| |

FLG\_4X4L = 1 --------------------| |

| --- ELSE ---

GR\_CM < 3 ----------------------------------| |

| |

PDL <> PDL\_LST ----------------| | |

| | |

VS\_RATEPH > FN23PPH \* | | |

RT\_NOVS ---------|OR ---------|AND -| IGR\_DS = 3

(min. accel. threshold met) | | | FLG\_UP\_NE = 0

| | | FLG\_NE\_WAIT = 1

IGR\_DS = 3 --------------------| | |

| |

VSBART\_RT\_PU > [FN23S + | |

(COMP\_FCTR \* FN23COMP) + | |

(PNWF \* FN23P)] \* CS\_SFT\_MULT -| | |

|AND -| | |

FLG\_4X4L = 0 --------------------| | | |

|OR -| |

VSBART\_RT\_PU > [FN23S\_4X4L + | |

(COMP\_FCTR \* FN23COMP) + | |

(PNWF \* FN23P)] \* CS\_SFT\_MULT -| | |

|AND -| |

FLG\_4X4L = 1 --------------------| |

|

| --- ELSE ---

(continued on next page)

26-12

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

GR\_CM < 2 ----------------------------------| |

| |

VSBART\_RT\_PU > [FN12S + | |

(COMP\_FCTR \* FN12COMP) + |AND -| IGR\_DS = 2

(PNWF \* FN12P)] \* CS\_SFT\_MULT -| | | FLG\_UP\_NE = 0

|AND -| | | FLG\_NE\_WAIT = 1

FLG\_4X4L = 0 --------------------| | | |

|OR -| |

VSBART\_RT\_PU > [FN12S\_4X4L + | |

(COMP\_FCTR \* FN12COMP) + | |

(PNWF \* FN12P)] \* CS\_SFT\_MULT -| | |

|AND -| |

FLG\_4X4L = 1 --------------------| |

|

| --- ELSE ---

GR\_CM > 1 ----------------------------------| |

| |

VSBART\_RT\_PD < [FN21S + | |

HOT21\_ADDR + (COMP\_FCTR | |

\* FN21COMP) + (PNWF \* |AND -| IGR\_DS = 1

FN21P)] \* CS\_SFT\_MULT ---------| | | FLG\_UP\_NE = 0

|AND -| | | FLG\_NE\_WAIT = 0

FLG\_4X4L = 0 --------------------| | | |

| | |

VSBART\_RT\_PD < [FN21S\_4X4L + |OR -| |

HOT21\_ADDR + (COMP\_FCTR | |

\* FN21COMP) + (PNWF \* | |

FN21P)] \* CS\_SFT\_MULT ---------| | |

|AND -| |

FLG\_4X4L = 1 --------------------| |

| --- ELSE ---

|

GR\_CM > 2 ----------------------------------| |

| |

VSBART\_RT\_PD < [FN32S + | |

+ (COMP\_FCTR \* FN32COMP) + |AND -| IGR\_DS = 2

(PNWF \* FN32P)] \* CS\_SFT\_MULT -| | | FLG\_UP\_NE = 0

|AND -| | | FLG\_NE\_WAIT = 0

FLG\_4X4L = 0 --------------------| | | |

| | |

VSBART\_RT\_PD < [FN32S\_4X4L + |OR -| |

+ (COMP\_FCTR \* FN32COMP) + | |

(PNWF \* FN32P)] \* CS\_SFT\_MULT -| | |

|AND -| |

FLG\_4X4L = 1 --------------------| |

|

| --- ELSE ---

(continued on next page)

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SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

GR\_CM > 3 ----------------------------------| |

| |

VSBART\_RT\_PD < [FN43S + | |

+ (COMP\_FCTR \* FN43COMP) + |AND -| IGR\_DS = 3

(PNWF \* FN43P)] \* CS\_SFT\_MULT -| | | FLG\_UP\_NE = 0

|AND -| | | FLG\_NE\_WAIT = 0

FLG\_4X4L = 0 --------------------| | | |

| | |

VSBART\_RT\_PD < [FN43S\_4X4L + | | |

+ (COMP\_FCTR \* FN43COMP) + |OR -| |

(PNWF \* FN43P)] \* CS\_SFT\_MULT -| | |

|AND -| |

FLG\_4X4L = 1 --------------------| | |

| |

PDL = 3 -------------------------------| |

|

| --- ELSE ---

|

| IGR\_DS = GR\_CM

OUTPUT SHAFT SPEED SENSOR FAILURE AND FAIL SAFE COOLING SHIFT LOGIC

COOL\_FLG = 1 ------------------------------| FSC\_ADD\_U = FNFSC\_TPU(TP\_REL)

| \* FNFSC\_CYL

| (COOL\_PI\_INT)

| FSC\_ADD\_D = FNFSC\_TPD(TP\_REL)

| \* FNFSC\_CYL

| (COOL\_PI\_INT)

|

| --- ELSE ---

|

| FSC\_ADD\_U = 0

| FSC\_ADD\_D = 0

NEBART > FN689U(TP\_REL) + FSC\_ADD\_U -|

|AND -| IGR\_DS = GR\_CM + 1

GR\_CM < 4 ---------------------------| | FLG\_UP\_NE = 1

|

| --- ELSE ---

NEBART < FN689D(TP\_REL) + FSC\_ADD\_D -| |

|AND -| IGR\_DS = GR\_CM - 1

GR\_CM > 1 ---------------------------| | FLG\_UP\_NE = 1

|

| --- ELSE ---

|

| IGR\_DS = GR\_CM

IGR\_DS = 4 --------------------------|

|AND -| IGR\_DS = 3

PDL = 3 -----------------------------| | FLG\_UP\_NE = 0

26-14

SHIFT CONTROL, DELAY/VERIFY SHIFT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.3 DELAY/VERIFY SHIFT LOGIC (CDAJ0)

OVERVIEW

This logic delays the commanding of the desired gears a calibratable amount

of time to:

- Allow for the TV pressure to ramp-up prior to commanding the shift. TV

is increased tremendously during a shift. It is necessary to start

commanding the extra TV prior to the shift to overcome the delays

associated with the time constant of the TV solenoid.

- Allow the RPM to decrease before commanding a tip-out upshift.

Commanding an upshift immediately after a tip-out feels harsh, since the

clutches will be used to slow the engine down. Waiting a period of time

before commanding this shift, smoothes the shift significantly.

- Verify a shift. Noise perturbations may result in incorrect gears being

desired for one or two background loops. Delaying the shift, verifies

that a gear is truly desired, and that it is not just noise.

Entering into this logic is the parameter, GR\_DS, the desired gear.

The delay logic then proceeds to delay the shift by setting the GR\_DS to its

previous value until the delay timer runs out. When the timer expires, the

GR\_DS is no longer set to its previous value, but is allowed to pass through

to the Commanded Gear Determination logic and Shift Solenoid logic which

actually processes the GR\_DS into shift solenoid commands; i.e., the shift is

commanded.

By the time the shift is commanded, the necessary TV required for the shift

will have been commanded, the engine RPM will have slowed some to make the

tip-out upshifts feel smooth, and the shift will have been verified.

If the GR\_DS changes prior to the timer expiring, the timer continues to

count down. The timer does not affect the amount of TV which is commanded,

because GR\_DS\_TV will always be set to the gear in sequence, and the TV will

be commanded based on that value. Worst case, the TV pressure will be

unnecessarily increased for a short period of time if the GR\_DS/GR\_DS\_TV

fluctuates due to a noise spike. When the timer becomes zero, the latest

GR\_DS is passed through.

NOTES:

The delay timer is set to one of four values. These are:

- delay to allow TV to ramp up for an upshift, and/or the delay to verify a

gear; TMVEUP

- delay to allow TV to ramp up for an upshift, and/or the delay to verify a

gear in 4X4L; TMVEUP\_4X4L

- delay to allow TV to ramp up for a downshift, and/or the delay to verify

a gear; TMVEDN

26-15

SHIFT CONTROL, DELAY/VERIFY SHIFT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- delay for a tip-out upshift to allow the RPM decrease, TMVETOUP

26-16

SHIFT CONTROL, DELAY/VERIFY SHIFT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- GR\_DS\_LST = Desired gear in last background pass.

- IGR\_DS = Unverified desired transmission gear.

- PDL = Current PRNDL position.

- PDL\_LST = Last PRNDL position.

- TM\_VER\_SFT = Time to delay/verify automatic desired shift.

- TP\_RATE = Throttle rate = TP - TPBART.

Bit Flags:

- FLG\_4X4L = 4X4L Flag.

- FLG\_VE\_DSGR = Delay desired gear first pass flag; 0 -> First pass through

DELAY DESIRED GEAR, 1 -> Delay desired gear in process.

Calibration Constants:

- TMVEDN = Time to delay/verify a downshift.

- TMVETOUP = Time to delay a tip-out upshift.

- TMVEUP = Time to delay/verify an upshift.

- TMVEUP\_4X4L = Time to delay/verify an upshift in 4X4L.

- TO\_TP\_RATE = TP\_RATE required to recognize a tip-out.

OUTPUTS

Registers:

- GR\_DS = Desired transmission gear.

- TM\_VER\_SFT = See above.

Bit Flags:

- FLG\_NV\_SHFT = Flag indicating if shift verification failed; 0 -> did not

fail verification, 1 -> failed verification.

- FLG\_VE\_DSGR = See above.

- FLG\_TIP\_OUT = Flag which indicates a tip-out upshift in progress; 0 -> no

tip-out upshift in progress, 1 -> a tip-out upshift in progress.

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SHIFT CONTROL, DELAY/VERIFY SHIFT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_VER\_AUTO\_SHFT\_COM2

PDL = 3 OR 4 -----------------|

|AND -| GR\_DS = IGR\_DS

PDL\_LST <> 3 OR 4 ------------| | (PDL moved to 3 or 4; allow first

| desired gear to pass through

| with no delay)

| FLG\_VE\_DSGR = 0

|

| --- ELSE ---

IGR\_DS <> GR\_DS\_LST ----------| |

(shift is desired) | |

| |

FLG\_VE\_DSGR = 1 --------------|AND -| GR\_DS = GR\_DS\_LST

(delay in process) | | (hold original desired gear until new

| | desired gear is verified)

TM\_VER\_SFT > 0 ---------------| |

(timer not expired) |

| --- ELSE ---

IGR\_DS <> GR\_DS\_LST ----------| |

(shift is desired) | |

| |

FLG\_VE\_DSGR = 1 --------------|AND -| GR\_DS = IGR\_DS

(delay in process) | | (new desired gear is delayed, allow it

| | to pass through to commanded gear

TM\_VER\_SFT = 0 ---------------| | module)

(timer expired) | FLG\_VE\_DSGR = 0

|

| --- ELSE ---

IGR\_DS > GR\_DS\_LST -----------| |

(upshift is desired) |AND -| GR\_DS = GR\_DS\_LST

| | (hold original desired gear until new

FLG\_VE\_DSGR = 0 --------------| | desired gear is delayed)

(first pass through) | FLG\_VE\_DSGR = 1

| (set first pass flag)

| FLG\_NV\_SHFT = 0

| (clear "failed verify" flag)

| DO "LOAD TM\_VER\_SFT FOR UPSHIFTS"

| (load timer)

|

| --- ELSE ---

(continued on next page)

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SHIFT CONTROL, DELAY/VERIFY SHIFT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

IGR\_DS < GR\_DS\_LST -----------| |

(downshift is desired) |AND -| GR\_DS = GR\_DS\_LST

| | (hold original desired gear until

FLG\_VE\_DSGR = 0 --------------| | new desired gear is delayed)

(first pass through) | FLG\_VE\_DSGR = 1

| (set first pass flag)

| TM\_VER\_SFT = TMVEDN

| (load timer)

| FLG\_TIP\_OUT = 0

|

| --- ELSE ---

IGR\_DS = GR\_DS\_LST -----------| |

|AND -| GR\_DS = IGR\_DS

FLG\_VE\_DSGR = 1 --------------| | (pass through current desired gear)

| FLG\_VE\_DSGR = 0

| FLG\_NV\_SHFT = 1

| (set no shift verify, first pass flag)

|

| --- ELSE ---

|

| GR\_DS = IGR\_DS

| (pass through current desired gear)

| FLG\_VE\_DSGR = 0

| (clear first pass flag)

| FLG\_NV\_SHFT = 0

LOAD TM\_VER\_SFT FOR UPSHIFTS LOGIC

FLG\_4X4L = 1 -----------------------| TM\_VER\_SFT = TMVEUP\_4X4L

| FLG\_TIP\_OUT = 0

|

| --- ELSE ---

|

TP\_RATE < TO\_TP\_RATE ---------------| TM\_VER\_SFT = TMVETOUP

| FLG\_TIP\_OUT = 1

|

| --- ELSE ---

|

| TM\_VER\_SFT = TMVEUP

| FLG\_TIP\_OUT = 0

26-19

SHIFT CONTROL, GR\_SEQ\_PNTR CALCULATION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.4 GR\_SEQ\_PNTR CALCULATION (CDAA0)

OVERVIEW

The GR\_SEQ\_PNTR calculation allows for the sequencing of multi-step shifts.

For example, if GR\_DS = 4 and GEAR\_CUR = 1, the 1-4 shift can be accomplished

in four different ways: a direct 1-4 shift, a 1-2-4 shift, a 1-3-4 shift or

a 1-2-3-4 shift. The particular shift sequence desired can be calibrated in

a series of calibration parameters. This sequence is used by the TV strategy

to allow TV pressure to build up prior to the shift as well as by the

commanded gear routine.

The GR\_SEQ\_PNTR register contains an address, not the next gear. The address

pointed to by GR\_SEQ\_PNTR is one of the cal parameters GR\_SEQ\_131, etc.,etc.

Thus, the contents of the address pointed to by GR\_SEQ\_PNTR contains the next

gear to be used in the shift sequence.

26-20

SHIFT CONTROL, GR\_SEQ\_PNTR CALCULATION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Desired Shift | Possible choices GR\_SEQ\_XXX

--------------------|----------------------------------------

1-3 | 2-3 3-3

|

1-4 | 2-3-4 3-4-4 2-4-4 4-4-4

|

2-4 | 3-4 4-4

|

3-1 | 2-1 1-1

|

4-1 | 3-2-1 3-1-1 2-1-1 1-1-1

|

4-2 | 3-2 2-2

GR\_SEQ\_PNTR | Cal Parameter | Possible

(pointer address) | Description | Choices (contents)

-------------------|--------------------------|--------------------

GR\_SEQ\_131 | first step of 1-3 shift | 2 or 3

GR\_SEQ\_132 | second step of 1-3 shift | 3

-------------------|--------------------------|--------------------

GR\_SEQ\_141 | first step of 1-4 shift | 2 or 3 or 4

GR\_SEQ\_142 | second step of 1-4 shift | 3 or 4

GR\_SEQ\_143 | third step of 1-4 shift | 4

-------------------|--------------------------|--------------------

GR\_SEQ\_241 | first step of 2-4 shift | 3 or 4

GR\_SEQ\_242 | second step of 2-4 shift | 4

-------------------|--------------------------|--------------------

GR\_SEQ\_311 | first step of 3-1 shift | 2 or 1

GR\_SEQ\_312 | second step of 3-1 shift | 1

-------------------|--------------------------|--------------------

GR\_SEQ\_411 | first step of 4-1 shift | 3 or 2 or 1

GR\_SEQ\_412 | second step of 4-1 shift | 2 or 1

GR\_SEQ\_413 | third step of 4-1 shift | 1

-------------------|--------------------------|--------------------

GR\_SEQ\_421 | first step of 4-2 shift | 3 or 2

GR\_SEQ\_422 | second step of 4-2 shift | 2

-------------------|--------------------------|--------------------

26-21

SHIFT CONTROL, GR\_SEQ\_PNTR CALCULATION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- GEAR\_CUR = Current transmission gear.

- GR\_CM = Commanded gear for shift solenoids.

- GR\_DS = Desired transmission gear.

- GR\_DS\_LST = Desired gear in last background pass.

- IGR\_DS = Unverified desired transmission gear.

- PDL = Current PRNDL position.

- PDL\_LST = Last PRNDL position.

Bit Flags:

- FLG\_SFT\_IN = Shift in progress flag.

Calibration Constants:

- GR\_SEQ\_XXX = See Overview section for descriptions.

OUTPUTS

Registers:

- GR\_SEQ\_PNTR = Commanded gear sequence pointer.

- GR\_DS\_TV = Gear to be used for dynamic TV calculation.

26-22

SHIFT CONTROL, GR\_SEQ\_PNTR CALCULATION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_GR\_SEQ\_PNTR\_COM4

FLG\_SFT\_IN = 0 --------------------| gr\_ds\_temp = IGR\_DS

(no shift in progress) | (use unverified desired gear)

|

| --- ELSE ---

|

| gr\_ds\_temp = GR\_DS

| (use verified desired gear)

TM\_SEQ\_SFT > 0 --------------------| Exit GR\_SEQ\_PNTR module

|

| --- ELSE ---

|

gr\_ds\_temp = GEAR\_CUR -------------| GR\_DS\_TV = GEAR\_CUR

| GR\_SEQ\_PNTR = address of GR\_DS\_TV

|

| --- ELSE ---

|

gr\_ds\_temp - GEAR\_CUR > 1 ---------| GR\_SEQ\_PNTR = address of cal

(upshift, multi step shift) | parameter GR\_SEQ\_131 if 1-3 shift

| GR\_SEQ-141 if 1-4 shift

| GR\_SEQ\_241 if 2-4 shift

| (first step of a multi step shift)

| GR\_DS\_TV = contents of GR\_SEQ\_PNTR

| (pass next gear on to TV routine)

|

| --- ELSE ---

|

gr\_ds\_temp - GEAR\_CUR = 1 ---------| GR\_DS\_TV = GR\_CM + 1

(upshift, single step shift) | GR\_SEQ\_PNTR = address of GR\_DS\_TV

|

| --- ELSE ---

|

gr\_ds\_temp - GEAR\_CUR < -1 --------| GR\_SEQ\_PNTR = address of cal

(downshift, multi step shift) | parameter GR\_SEQ\_311 if 3-1 shift

| GR\_SEQ\_411 if 4-1 shift

| GR\_SEQ\_421 if 4-2 shift

| (first step of a multi step shift)

| GR\_DS\_TV = contents of GR\_SEQ\_PNTR

| (pass next gear on to TV routine)

|

| --- ELSE ---

|

gr\_ds\_temp - GEAR\_CUR = -1 --------| GR\_DS\_TV = GR\_CM - 1

(downshift, single step shift) | GR\_SEQ\_PNTR = address of GR\_DS\_TV

26-23

SHIFT CONTROL, PRNDL BASED COMMANDED GEAR DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.5 PRNDL BASED COMMANDED GEAR DETERMINATION (CDAN0)

OVERVIEW

The commanded transmission gear is calculated based on PRNDL position. The

logic looks at the current gear and the desired gear to determine if an

upshift or a downshift is required and then commands the next appropriate

gear in the sequence.

In the drive or overdrive position, the shift sequence is controlled by the

calibration pointed to by the GR\_SEQ\_PNTR register. The only restriction is

that downshifts are done only after the converter clutch has unlocked.

In the manual 2 or 1 position, the downshift sequence is controlled solely by

the commanded gear routine. The GR\_SEQ\_PNTR is not used for manual

downshifts.

The main outputs of the commanded gear routine are:

- GR\_CM, commanded gear which reflects the actual shift solenoid states

- GR\_OLD, GEAR\_OLD, RT\_GR\_OLD, last gear the transmission was in

- FLG\_FRST\_CM, global flag to indicate a shift is commanded this background

pass

DEFINITIONS

Registers:

- GEAR\_CUR = Current transmission gear (global register).

- GEAR\_OLD = Last commanded transmission gear (global register).

- GR\_CM = Commanded gear for shift solenoids.

- GR\_CM\_KAM = KAM value equivalent of GR\_CM for reinit protection.

- GR\_CM\_LST = Commanded gear in last background pass.

- GR\_DS = Desired transmission gear.

- GR\_OLD = Last commanded gear.

- PDL = Current PRNDL position.

- RT\_GR\_CUR = Current transmission gear ratio.

- RT\_GR\_OLD = Last gear transmission gear ratio.

26-24

SHIFT CONTROL, PRNDL BASED COMMANDED GEAR DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SLIP\_ABS = Absolute value of slip.

- TM\_UNLK\_WDOG = Watch dog time to force downshift if SLIP\_ABS is not

greater than SLIP\_A\_UNLK.

- TMR\_41AUT = Timer to be loaded when leaving 4th gear to determine a 4-1,

sec.

- TMR\_42AUT = Timer to be loaded when leaving 4th gear to determine a 4-2,

sec.

- TM\_IN\_GR4 = Time in 4th gear used to improve 4-2 sequence times.

Bit Flags:

- FLG\_AUT41 = Identifies a Automatic 4-1 pull-in.

- FLG\_AUT42 = Identifies a Automatic 4-2 pull-in.

- FLG\_FRST\_CM = First time a shift is commanded flag; 1 -> shift commanded

this background pass, 0 -> no shift commanded this background pass.

- FLG\_FRST\_DS = First time a shift is desired flag; 0 -> no shift desired

this BG pass, 1 -> shift desired this BG pass.

- FLG\_MAN42 = Identifies a Manual 4-2 pull-in.

- FLG\_SF\_AUTO = Automatic upshift/downshift flag; 1 -> automatic shift

(PRNDL = 3 or 4), 0 -> manual shift (PRNDL = 2 or 1).

- FLG\_SFT\_IN = Shift in progress flag.

- LST\_SFT\_CMP = Last shift complete flag; 1 -> last commanded shift

completed (timed out).

- FLG\_UNLK\_DS = Converter unlock in progress flag; 1 -> unlock in progress.

Calibration Constants:

- GRMSFT = Gear commanded for manual shifting.

- SLIP\_A\_UNLK = Slip value above which converter is sufficiently unlocked

to allow downshift.

- SW\_MSF = Switch to select GR\_CM manually; 1 -> manual gear selection, NOT

1 -> automatic gear selection.

- TMDNUN = Time for converter clutch to unlock prior to commanding a

downshift.

- TM41AUT = Time to determine if a 4-1 was initiated, sec.

- TM42AUT = Time to determine if a 4-2 was initiated, sec.

26-25

SHIFT CONTROL, PRNDL BASED COMMANDED GEAR DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_CM\_GR\_DETR\_COM8

FLG\_FRST\_DS = 1 ------------------|

|

GR\_DS < GR\_CM --------------------|AND -| TM\_UNLK\_WDOG = TMDNUN

| | (maximum time to delay downshift

PDL = 3 OR 4 ---------------------| | due to low converter slip)

TM\_UNLK\_WDOG <> 0 ----------------|

|

SLIP\_ABS < SLIP\_A\_UNLK -----------|AND -| FLG\_UNLK\_DS = 1

| | (delay downshift; low converter

GR\_DS < GR\_CM --------------------| | slip)

|

| --- ELSE ---

|

| FLG\_UNLK\_DS = 0

| TM\_UNLK\_WDOG = 0

always ---------------------------------| GR\_CM\_LST = GR\_CM

| (update last pass current gear)

SW\_MSF = 1 -----------------------------| GR\_CM = GRMSFT

(manual shift selection) |

| --- ELSE ---

|

PDL = 1 --------------------------------| Do: "GR\_CM, PRNDL = 1" LOGIC

|

| --- ELSE ---

|

PDL = 2 --------------------------------| Do: "GR\_CM, PRNDL = 2" LOGIC

|

| --- ELSE ---

PDL = 3 OR 4 ---------------------| |

|AND -| Do: "GR\_CM, PRNDL = 3 OR 4

GR\_DS > GR\_CM --------------------| | UPSHIFT" LOGIC

|

| --- ELSE ---

PDL = 3 OR 4 ---------------------| |

|AND -| Do: "GR\_CM, PRNDL = 3 OR 4

GR\_DS < GR\_CM --------------------| | DOWNSHIFT" LOGIC

|

| --- ELSE ---

PDL = 5 --------------------------| |

(neutral) | |

| |

PDL = 6 --------------------------|OR --| GR\_CM = 1

(reverse) |

|

PDL = 7 --------------------------|

(park)

26-26

SHIFT CONTROL, PRNDL BASED COMMANDED GEAR DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

always ---------------------------------| Do: substitute(8,GR\_CM)

| (output state control override)

| GR\_CM\_KAM = GR\_CM

GR\_CM\_LST <> GR\_CM ---------------|

(a shift has been commanded) |AND -| LST\_SFT\_CMP = 0

| | ;Indicate last shift incomplete

FLG\_SFT\_IN = 1 -------------------| |

(Last shift has not completed) |

| --- ELSE ---

|

FLG\_SFT\_IN = 0 -------------------------| LST\_SFT\_CMP = 1

| ;current commanded shift has

| ;completed

GR\_CM\_LST <> GR\_CM ---------------------| FLG\_FRST\_CM = 1

(a shift has been commanded) | (new commanded gear for

| this program pass only)

| GR\_OLD = GR\_CM\_LST

| (update old gear)

| GEAR\_OLD = GEAR\_CUR

| RT\_GR\_OLD = RT\_GR\_CUR

|

| --- ELSE ---

|

| FLG\_FRST\_CM = 0

| (no shift this program pass)

FLG\_FRST\_CM = 1 ------------------|

|

PDL <> 3 OR 4 --------------| |AND -| FLG\_SF\_AUTO = 0

| | | (manual shift)

PDL = 3 --------------| |OR --| |

| | |

GR\_OLD = 4 -----------|AND -| |

| |

GR\_CM = 3 ------------| |

| --- ELSE ---

|

FLG\_FRST\_CM = 1 ------------------------| FLG\_SF\_AUTO = 1

| (automatic shift)

FLG\_FRST\_CM = 1 ------------|

|

PDL = 2 --------------------|AND -|

| |

GR\_CM\_LST = 4 --------------| |OR --| FLG\_MAN42 = 1

| | (Manual 4-2 pull-in flag)

FLG\_MAN42 = 1 --------------| | |

|AND -| |

FLG\_SFT\_IN = 1 -------------| |

| --- ELSE ---

|

| FLG\_MAN42 = 0

26-27

SHIFT CONTROL, PRNDL BASED COMMANDED GEAR DETERMINATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

GR\_CM = 4 ------------------------|

|AND -| TMR\_41AUT = 0

FLG\_FRST\_CM = 1 ------------------| | TMR\_42AUT = 0

| TM\_IN\_GR4 = 0

(reset time-in-4th timer)

PDL = 4 --------------------------|

|

GR\_CM\_LST = 4 --------------------|AND -| TMR\_41AUT = TM41AUT

| | TMR\_42AUT = TM42AUT

FLG\_FRST\_CM = 1 ------------------|

FLG\_AUT41 = 1 --------------------|

|AND -| FLG\_AUT41 = 0

GR\_DS > 1 ------------------------| | (Backout of 4-1)

|

GR\_DS = 1 ------------------| | --- ELSE ---

|AND -| |

TMR\_41AUT <> 0 -------------| | |

|OR --| FLG\_AUT41 = 1

FLG\_AUT41 = 1 --------------| | | (Automatic 4-1 pull-in flag)

|AND -| | FLG\_AUT42 = 0

FLG\_SFT\_IN = 1 -------------| |

| --- ELSE ---

|

| FLG\_AUT41 = 0

FLG\_AUT42 = 1 --------------------|

|AND -| FLG\_AUT42 = 0

GR\_DS > 2 ------------------------| | FLG\_AUT41 = 0

| (Backout of 4-2)

|

GR\_DS = 2 ------------------| | --- ELSE ---

|AND -| |

TMR\_42AUT <> 0 -------------| | |

|OR --| FLG\_AUT42 = 1

FLG\_AUT42 = 1 --------------| | | (Automatic 4-2 pull-in flag)

|AND -| | FLG\_AUT41 = 0

FLG\_SFT\_IN = 1 -------------| |

| --- ELSE ---

|

| FLG\_AUT42 = 0

26-28

SHIFT CONTROL, GR\_CM, PRNDL = 1 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.6 GR\_CM, PRNDL = 1 LOGIC (CDAM0)

OVERVIEW

This logic determines the commanded gear when PRNDL = 1.

DEFINITIONS

Registers:

- GR\_CM = Current transmission gear.

- GR\_DS\_TV = Gear to be used for dynamic TV calculation.

- NEBART = Filtered engine speed.

- PDL\_LST = Manual lever position previous background pass.

- RT\_NOVS = Ratio of actual N/V to base N/V in KAM.

- TMR\_HS\_M1 = Timer which determines when second may be forced.

- TMR\_M12 = Control timer for manual 1-2 shift.

- TM\_SEQ\_SFT = Shift sequencing timer.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission.

Bit Flags:

- OSFMFLG = Output shaft speed sensor FMEM flag.

- FLG\_HS\_M1 = Force second in manual one when high engine speed for a long

period of time; 1 -> forcing second.

Calibration Constants:

- GR\_CM\_LST = Commanded Gear Last Background Pass.

- NEHSM1 = Engine speed above which second may be forced.

- TM\_HS\_M12 = Time to command 3rd gr sol. st. on Manual 1 high speed

kickout upshift, seconds.

- TMSQ21P1 = Minimum time in 2nd gear prior to 3 - 1 shift, PRNDL = 1.

- TMHSM1 = Time that engine speed must stay above calibration before

forcing second gear.

- VSHSM1 = Vehicle speed below which forcing second may be exited.

- VS21PI = Maximum vehicle speed for 2 - 1 pull in.

26-29

SHIFT CONTROL, GR\_CM, PRNDL = 1 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_CM\_GR\_MAN1\_COM5

GR\_CM = 1 -------------------|

|AND -| NO ACTION

NEBART > NEHSM1 -------------| |

| --- ELSE ---

|

| TMR\_HS\_M1 = TMHSM1

TMR\_HS\_M1 = 0 ---------------------| FLG\_HS\_M1 = 1

|

| --- ELSE ---

|

VSBART\_RT < VSHSM1 ----------------| FLG\_HS\_M1 = 0

FLG\_HS\_M1 = 1 ---------------------| GR\_CM = 2

| GR\_DS\_TV = 2

|

| --- ELSE ---

|

GR\_CM >= 3 ------------------------| GR\_CM = 2

| TM\_SEQ\_SFT = TMSQ21P1

| GR\_DS\_TV = 2

|

| --- ELSE ---

GR\_CM = 2 -------------| |

|OR --| |

PDL\_LST = 5 -----------| | |

| |

TM\_SEQ\_SFT > 0 --------| |AND -| GR\_CM = 2

| | | GR\_DS\_TV = 2

OSFMFLG = 1 -----------| | |

(failed output shaft |OR --| |

speed sensor) | |

| |

VSBART\_RT > VS21PI ----| |

(above 1st gear pull-in) |

| --- ELSE ---

|

| GR\_CM = 1

| GR\_DS\_TV = 1

FLG\_HS\_M1 = 1 ---------------|

(Manual 1 kickout upshift) |

|AND -| TMR\_M12 = TM\_HS\_M12

GR\_CM = 2 -------------------| | (Load timer to control

| | commanding 3rd gear

GR\_CM\_LST = 1 ---------------| | shift solenoid states

| before 2nd gear shift

| solenoid states)

26-30

SHIFT CONTROL, GR\_CM, PRNDL = 2 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.7 GR\_CM, PRNDL = 2 LOGIC (CDAG0)

OVERVIEW

This module determines the commanded gear when PRNDL = 2.

DEFINITIONS

INPUTS

Registers:

- GR\_CM = Current transmission gear.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission.

- PDL\_LST = PRNDL Position Last Background Pass.

Calibration Constants:

- SW\_SEQ\_MAN2 = Switch used to allow or disallow a direct 4-2 manual

pull-in; 1 -> sequence through 3rd gear on a manaul 4-2 pull-in, 0 ->

direct 4-2 pull-in.

- TMSQ32P2 = Minimum time in third gear prior to 3-2, PRNDL = 2, seconds.

- VS32P2 = 3-2 VS pull-in when PDL = 2.

OUTPUTS

Registers:

- GR\_CM = See above.

- GR\_DS\_TV = Gear to be used for dynamic TV calculation.

26-31

SHIFT CONTROL, GR\_CM, PRNDL = 2 LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_CM\_GR\_MAN2\_COM5

GR\_CM = 4 ------------------------|

|AND -| GR\_CM = 3

SW\_SEQ\_MAN2 = 1 ------------------| | GR\_DS\_TV = 3

(sequence through 3rd gear) | TM\_SEQ\_SFT = TMSQ32P2

| (trans in 2nd, no engine

| braking, set timer)

|

| --- ELSE ---

GR\_CM = 3 ------------------| |

| |

PDL\_LST = 5 ----------------|OR --| |

| | |

SW\_SEQ\_MAN2 = 0 ------------| | |

(direct 4-2; use vehicle |AND -| GR\_CM = 3

speed threshold only) | | GR\_DS\_TV = 3

| |

TM\_SEQ\_SFT > 0 -------------| | |

|OR --| |

VSBART\_RT > VS32P2 ---------| |

| --- ELSE ---

|

| GR\_CM = 2

| GR\_DS\_TV = 2

26-32

SHIFT CONTROL, COMMANDED GEAR, AUTO UPSHIFT LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.8 COMMANDED GEAR, AUTO UPSHIFT LOGIC (CDAJ0)

OVERVIEW

This module determines the commanded gear on an upshift when PRNDL = 3 or 4.

The sequence for multi-step shifts is calibratable (see GR\_SEQ\_PNTR

calculation). The time spent in intermediate gears on a multi-step shift is

calibrated in this module.

DEFINITIONS

INPUTS

Registers:

- DELTA\_RATIO = Delta Shift Ratio change since command of shift.

- GR\_CM = Commanded gear for shift solenoids.

- GR\_DS\_TV = Gear to be used for dynamic TV calculation.

- GR\_SEQ\_PNTR = Address of next gear in the shift sequence.

- TM\_DEL\_SFT = Time to delay a shift to allow TV pressure to build,

- TM\_SEQ\_SFT = Shift sequencing timer.

Bit Flags:

- FLG\_4X4L = 4X4L Flag.

- FLG\_DE\_CMGR = First pass through shift delay timer.

- FLG\_FRST\_DS = First time a shift is desired flag; 0 -> no shift desired

this BG pass, 1 -> shift desired this BG pass.

Calibration Constants:

- DRC23 = DELTA\_RATIO when 2-3 is judged complete.

- DRC34 = DELTA\_RATIO when 3-4 is judged complete.

- TMDELUP = Time to delay upshift for TV buildup, sec.

- TMSQ23P4 = Minimum time in second gear prior to 2-3 PRNDL = 3 or 4, sec.

- TMSQ34P4 = Minimum time in third gear prior to 3-4 PRNDL = 3 or 4, sec.

26-33

SHIFT CONTROL, COMMANDED GEAR, AUTO UPSHIFT LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- GR\_CM = See above.

- GR\_DS\_TV = See above.

- TM\_DEL\_SFT = See above.

- TM\_SEQ\_SFT = See above.

Bit Flags:

- FLG\_DE\_CMGR = See above.

26-34

SHIFT CONTROL, COMMANDED GEAR, AUTO UPSHIFT LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_CM\_GR\_AUTO\_UP\_COM7

always ------------------------------| If GR\_SEQ\_PNTR is not pointing at a

| GR\_SEQ\_xxx term, then it is set to

| the address of GR\_DS\_TV.

TM\_SEQ\_SFT > 0 ----------|

|AND -|

GR\_CM < GR\_OLD ----------| |

(downshift) |

|

TM\_SEQ\_SFT > 0 ----------| |

| |

GR\_CM = 2 ---------------|AND -|OR --| TM\_SEQ\_SFT = 0

| | | (Override gear sequence

DELTA\_RATIO > DRC23 -----| | | timer. Ratio change has

| | been completed.)

TM\_SEQ\_SFT > 0 ----------| | |

| | |

GR\_CM = 3 ---------------|AND -| |

| |

DELTA\_RATIO > DRC34 -----| |

| --- ELSE ---

FLG\_DE\_CMGR = 1 ---------| |

|AND -| |

TM\_DEL\_SFT > 0 ----------| |OR --| no action

| |

TM\_SEQ\_SFT > 0 ----------------| |

| --- ELSE ---

FLG\_DE\_CMGR = 1 ---------| |

|AND -| |

TM\_DEL\_SFT = 0 ----------| | |

| |

FLG\_FRST\_DS = 1 ---------------|OR --| FLG\_DE\_CMGR = 0

| | GR\_DS\_TV = contents of address

TMDELUP = 0 -------------------| | pointed to by GR\_SEQ\_PNTR

(no delay desired) | GR\_CM = GR\_DS\_TV

| Increment GR\_SEQ\_PNTR

| Do: "UPSHIFT DELAY" logic

|

| --- ELSE ---

|

FLG\_DE\_CMGR = 0 ---------------------| FLG\_DE\_CMGR = 1

| TM\_DEL\_SFT = TMDELUP

| GR\_DS\_TV = contents of address

| pointed to by GR\_SEQ\_PNTR

| (first pass through shift sequence;

| don't command new gear yet, allow

| TV pressure to ramp up)

26-35

SHIFT CONTROL, COMMANDED GEAR, AUTO UPSHIFT LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

"UPSHIFT DELAY" LOGIC

FLG\_4X4L = 1 ------------------------| TM\_SEQ\_SFT = 0

| (no sequence time required in

| 4X4L)

|

| --- ELSE ---

|

GR\_CM = 2 ---------------------------| TM\_SEQ\_SFT = TMSQ23P4

(upshift to 2nd gear) |

| --- ELSE ---

|

GR\_CM = 3 ---------------------------| TM\_SEQ\_SFT = TMSQ34P4

(upshift to 3rd gear) |

| --- ELSE ---

|

| TM\_SEQ\_SFT = 0

| (no sequence time required)

26-36

SHIFT CONTROL, GR\_CM, PRNDL = 3 OR 4, DOWNSHIFT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.9 GR\_CM, PRNDL = 3 OR 4, DOWNSHIFT LOGIC (CDAN0)

OVERVIEW

This module determines the commanded gear on an downshift when PRNDL = 3 or

4. The sequence for multi-step shifts is calibratable (see GR\_SEQ\_PNTR

calculation). The time spent in intermediate gears on a multi-step shift is

calibrated in this module.

DEFINITIONS

Registers:

- DELTA\_RATIO = Delta Shift Ratio change since command of shift.

- GR\_CM = Commanded gear for shift solenoids.

- GR\_DS\_TV = Gear to be used for dynamic TV calculation.

- GR\_SEQ\_PNTR = Address of next gear in the shift sequence.

- SPD\_RATIO = Speed ratio across the torque converter (output/input).

- TM\_DEL\_SFT = Time to delay a shift to allow TV pressure to build.

- TM\_IN\_GR4 = Time in 4th gear used to improve 4-2 sequence times, secs.

- TM\_SEQ\_SFT = Shift sequencing timer.

- VSBART\_RT = Filtered vehicle speed, adjusted for N/V (mph).

Bit Flags:

- FLG\_DE\_CMGR = First pass through shift delay timer.

- FLG\_FRST\_DS = First time a shift is desired flag; 0 -> no shift desired

this BG pass, 1 -> shift desired this BG pass.

- FLG\_UNLK\_DS = Converter unlock in progress flag.

Calibration Constants:

- DRC21 = DELTA\_RATIO when 2-1 is judged complete.

- TMDELDN = Time to delay downshift to allow TV pressure to build.

- TMSQ21P4 = Minimum time in 2nd gear prior to a 2-1 shift, PRNDL = 3 or 4.

- FNTMSEQ32P4(FNXVSBART\_RT,FNXTMINGR4) = Minimum time in 3rd gear prior to

a 3-2 shift, PRNDL = 3 or 4, as a function of normalized VSBART\_RT and

TM\_IN\_GR4. Time in 4th is used to reduce sequence times if time in 4th

(forward clutch off) is less than a calibratable amount of time.

26-37

SHIFT CONTROL, GR\_CM, PRNDL = 3 OR 4, DOWNSHIFT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FNXTMINGR4 = Normalized time in 4th gear (TM\_IN\_GR4) used to improve 4-2

sequence times.

- FNXVSBART\_RT = Normalized filtered vehicle speed, VSBART\_RT.

26-38

SHIFT CONTROL, GR\_CM, PRNDL = 3 OR 4, DOWNSHIFT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_CM\_GR\_AUTO\_DWN\_COM7

always ------------------------------| If GR\_SEQ\_PNTR is not pointing at a

| GR\_SEQ\_xxx term, then it is set to

| the address of GR\_DS\_TV.

TM\_SEQ\_SFT > 0 ----------|

|AND -|

GR\_CM > GR\_OLD ----------| |

(upshift) |

|OR --|TM\_SEQ\_SFT = 0

TM\_SEQ\_SFT > 0 ----------| | | (Override gear sequence

| | | timer. Ratio change has

GR\_CM = 2 ---------------|AND -| | been completed).

| |

DELTA\_RATIO > DRC21 -----| |

| --- ELSE ---

FLG\_DE\_CMGR = 1 ---------| |

|AND -| |

TM\_DEL\_SFT > 0 ----------| | |

| |

TM\_SEQ\_SFT > 0 ----------------|OR --| no action

| |

FLG\_UNLK\_DS = 1 ---------------| |

| --- ELSE ---

FLG\_DE\_CMGR = 1 ---------| |

|AND -| |

TM\_DEL\_SFT = 0 ----------| | |

|OR --| FLG\_DE\_CMGR = 0

FLG\_FRST\_DS = 1 ---------------| | GR\_DS\_TV = contents of address

| | pointed to by GR\_SEQ\_PNTR

TMDELDN = 0 -------------------| | GR\_CM = GR\_DS\_TV

(no delay desired) | Increment GR\_SEQ\_PNTR

| Do: "DOWNSHIFT DELAY" logic

|

| --- ELSE ---

|

FLG\_DE\_CMGR = 0 ---------------------| FLG\_DE\_CMGR = 1

| TM\_DEL\_SFT = TMDELDN

| GR\_DS\_TV = contents of address

| pointed to by GR\_SEQ\_PNTR

| (first pass through shift sequence;

| don't command new gear yet, allow

| TV pressure to ramp up)

26-39

SHIFT CONTROL, GR\_CM, PRNDL = 3 OR 4, DOWNSHIFT LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

"DOWNSHIFT DELAY" LOGIC

GR\_CM = 3 ---------------------------| TM\_SEQ\_SFT = FNTMSEQ32P4(FNXVSBART\_RT,

(downshift to 3rd gear) | FNXTMINGR4)

|

| --- ELSE ---

|

GR\_CM = 2 ---------------------------| TM\_SEQ\_SFT = TMSQ21P4

(downshift to 2nd gear) |

| --- ELSE ---

|

| TM\_SEQ\_SFT = 0

| (no sequence time required)

26-40

SHIFT CONTROL, LOAD SHIFT IN PROGRESS TIMER - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.10 LOAD SHIFT IN PROGRESS TIMER (CDAA0)

OVERVIEW

The shift in progress timer (TM\_SFT\_IN) is a down-counting timer which is

used in many places in the strategy to determine that a shift is currently

taking place. When the timer has a value of 0, no shift is taking place. A

worst case time is loaded into the timer at the start of a shift. The only

exception is a power-off manual downshift. Different default values are

provided for upshifts, downshifts, power on, and power off.

DEFINITIONS

INPUTS

Registers:

- GR\_CM = Commanded gear for shift solenoids.

- GR\_OLD = Last commanded gear.

- TM\_SFT\_IN = Time during which shift is in progress.

- TM\_VER\_SFT = Time to delay/verify automatic desired shift.

Bit Flags:

- FLG\_FRST\_CM = First time a shift is commanded flag: 1 -> shift commanded

this background pass; 0 -> no shift commanded this background pass.

- FLG\_PWR = Power mode flag: 1 -> power on mode; 0 -> power off mode.

- FLG\_SF\_AUTO = Automatic upshift/downshift flag: 1 -> automatic shift

(PRNDL = 3 or 4); 0 -> manual shift (PRNDL = 2 or 1).

- FLG\_SFT\_MDN = Power off manual downshift flag: 1 -> power off manual

downshift in progress; 0 -> power off manual downshift not in progress.

26-41

SHIFT CONTROL, LOAD SHIFT IN PROGRESS TIMER - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- TCD43AOF = Time to complete 4/3 downshift, automatic, power off.

- TCD43ON = Time to complete 4/3 downshift, power on.

- TCDNAF = Time to complete auto downshift, power off (all except 4/3).

- TCDNMF = Time to complete manual downshift, power off.

- TCDNON = Time to complete downshift, power on (all except 4/3).

- TCUPOF = Time to complete upshift, power off.

- TCUPON = Time to complete upshift, power on.

OUTPUTS

Registers:

- TM\_SFT\_IN = See above.

Bit Flags:

- FLG\_SF\_AUTO = See above.

- FLG\_SFT\_IN = Shift in progress flag; 0 -> no shift in progress, 1 ->

shift in progress.

- FLG\_SFT\_MDN = See above.

- FLG\_TIP\_OUT = 0 -> no tip-out upshift in progress; 1 -> a tip-out upshift

in progress.

- FLG\_UP\_NE = RPM based upshift flag.

26-42

SHIFT CONTROL, LOAD SHIFT IN PROGRESS TIMER - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_TIMER\_COM2

FLG\_FRST\_CM = 1 ------------------|

(shift has been commanded) |

|

GR\_CM > GR\_OLD -------------------|AND -| TM\_SFT\_IN = TCUPON

(upshift) | | (time to complete upshift,

| | power on)

FLG\_PWR = 1 ----------------------| | FLG\_SFT\_MDN = 0

(power on) | (not power off manual downshift)

|

| --- ELSE ---

FLG\_FRST\_CM = 1 ------------------| |

(shift has been commanded) | |

| |

GR\_CM > GR\_OLD -------------------|AND -| TM\_SFT\_IN = TCUPOF

(upshift) | | (time to complete

| | upshift, power off)

FLG\_PWR = 0 ----------------------| | FLG\_SFT\_MDN = 0

(power off) |

| --- ELSE ---

FLG\_FRST\_CM = 1 ------------------| |

(shift has been commanded) | |

| |

GR\_OLD = 4 -----------------------|AND -| TM\_SFT\_IN = TCD43ON

| | (time to complete 4/3 downshift,

GR\_CM = 3 ------------------------| | power on)

| | FLG\_SFT\_MDN = 0

FLG\_PWR = 1 ----------------------| |

(power on) |

| --- ELSE ---

FLG\_FRST\_CM = 1 ------------------| |

(shift has been commanded) | |

| |

GR\_OLD = 4 -----------------------| |

| |

GR\_CM = 3 ------------------------|AND -| TM\_SFT\_IN = TCD43AOF

| | (time to complete 4/3 downshift,

FLG\_PWR = 0 ----------------------| | auto, power off)

(power off) | | FLG\_SFT\_MDN = 0

| |

FLG\_SF\_AUTO = 1 ------------------| |

(automatic shift) |

| --- ELSE ---

FLG\_FRST\_CM = 1 ------------------| |

(shift has been commanded) | |

| |

GR\_CM < GR\_OLD -------------------|AND -| TM\_SFT\_IN = TCDNON

(downshift) | | (time to complete downshift,

| | power on)

FLG\_PWR = 1 ----------------------| | FLG\_SFT\_MDN = 0

(power on) |

| --- ELSE ---

(continued on next page)

26-43

SHIFT CONTROL, LOAD SHIFT IN PROGRESS TIMER - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

FLG\_FRST\_CM = 1 ------------------| |

(shift has been commanded) | |

| |

GR\_CM < GR\_OLD -------------------| |

(downshift) | |

|AND -| TM\_SFT\_IN = TCDNAF

FLG\_PWR = 0 ----------------------| | (time to complete downshift,

(power off) | | auto, power off)

| | FLG\_SFT\_MDN = 0

FLG\_SF\_AUTO = 1 ------------------| |

(automatic shift) |

| --- ELSE ---

FLG\_FRST\_CM = 1 ------------------| |

(shift has been commanded) | |

| |

GR\_CM < GR\_OLD -------------------| |

(downshift) | | TM\_SFT\_IN = TCDNMF

|AND -| (time to complete downshift,

FLG\_PWR = 0 ----------------------| | manual, power off)

(power off) | | FLG\_SFT\_MDN = 1

| | (manual power off downshift

FLG\_SF\_AUTO = 0 ------------------| | in progress)

(manual shift) |

|

| --- ELSE ---

FLG\_SFT\_MDN = 1 ------------------| |

(manual power off downshift | |

in progress) |AND -| TM\_SFT\_IN = TCDNON

| | (reset timer to power on value

FLG\_PWR = 1 ----------------------| | if power mode changes in the

(suddenly becomes power on) | middle of a downshift)

| FLG\_SFT\_MDN = 0

| (clear manual downshift flag)

TM\_SFT\_IN = 0 --------------------------| FLG\_SFT\_MDN = 0

(timer expired) | (manual downshift is complete)

| FLG\_SF\_AUTO = 0

| (clear auto shift flag)

| FLG\_SFT\_IN = 0

| (no shift in progress)

| FLG\_UP\_NE = 0

|

| --- ELSE ---

|

| FLG\_SFT\_IN = 1

| (shift in progress)

TM\_SFT\_IN = 0 --------------------|

(no shift in progress) |AND -| FLG\_TIP\_OUT = 0

| | (reset tip-out flag)

TM\_VER\_SFT = 0 -------------------|

(no delay shift in progress)

26-44

SHIFT CONTROL, DETERMINE SHIFT SOLENOID STATES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.11 DETERMINE SHIFT SOLENOID STATES (CDAL0)

OVERVIEW

The shift solenoid state logic configures the shift solenoid output states

based on the PRNDL position and commanded gear during normal vehicle

operation, or the state of the Engine Off Output State Monitor flags

(EO\_OSM\_ON/OFF) during Engine Off On-Demand self test.

The main outputs of the shift solenoid routine, besides the shift solenoid

states, are RT\_GR\_CUR, current transmission gear ratio, and the shift

solenoid monitor and malfunction flags.

Shift solenoid state monitoring is done using feedback from the ML-II EEEC

driver. When the solenoid states are output in background the driver will

return a fault status:

SSn\_FAULT = 0 --> no fault present

SSn\_FAULT = 1 --> fault present

NOTE: The fault status lags commanded state by 1 background - ie is for the

last command. When a solenoid state change is commanded, the shift solenoid

monitors will be disabled for one background to allow the fault status to

update to the new state.

The shift solenoid monitor flags will be set when both the ON and OFF states

of that solenoid have been observed to function OR when a malfunction is

detected.

The shift solenoid malfunction flags are set when a fault is present long

enough to be defined as a malfunction.

DEFINITIONS

Registers:

- CYCCTR = Cold shift solenoid cycling counter.

- GEAR\_CUR = Current transmission gear (global register).

- GR\_CM = Commanded gear for shift solenoids.

- PDL = Current PRNDL position.

- RT\_GR\_CUR = Current transmission gear ratio.

- SS1\_ERR\_TMR = Shift Solenoid #1 test error timer.

- SS1\_FAULT = Fault status for SS1 returned from the driver; 0 -> no fault

present, 1 -> a fault has been detected.

26-45

SHIFT CONTROL, DETERMINE SHIFT SOLENOID STATES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SS2\_ERR\_TMR = Shift Solenoid #2 test error timer.

- SS2\_FAULT = Fault status for SS2 returned from the driver; 0 -> no fault

present, 1 -> a fault has been detected.

- TMR\_M12 = Timer which controls commanding 3rd gear solenoid states after

a manual 1-2 shift.

Bit Flags:

- CCM\_TST\_ENA = Comprehensive Component Enable Test Flag.

- FLG\_SS\_1 = Shift solenoid 1 output state; 1 -> SS1 energized, 0 -> SS1

de-energized.

- FLG\_SS\_2 = Shift solenoid 2 output state; 1 -> SS2 energized, 0 -> SS2

de-energized.

- OSM\_EO\_OFF = Engine Off Output State Monitor off test; 1 -> OSM Off test

in progress - command actuator off and monitor for off state.

- OSM\_EO\_ON = Engine Off Output State Monitor on test; 1 -> OSM On test in

progress - command actuator on and monitor for on state.

- PxxxMALF = OBDII malfunction flag for code xxx.

- PxxxMON = OBDII monitor flag for code XXX.

- FLG\_FRST\_TV = Start-up TV pressure flag; 0 -> do start-up TV logic, 1 ->

do not do start-up TV logic.

- FLG\_TVENG\_CD = Flag which indicates cold temperature for engagement TV; 0

-> don't use TVEMAX in engagement TV; 1 -> use TVEMAX in engagement TV.

- FLG\_TVENG\_MD = Flag which indicates moderate temperature for engagement

TV; 0 -> don't use TVEMOD in engagement TV; 1 -> use TVEMOD in engagement

TV.

- SS1\_COM = Shift solenoid #1 command flag; 1 -> solenoid #1 commanded on,

0 -> solenoid #1 commanded off.

- SS1\_COM\_LST = Last verified position of solenoid #1.

- SS1\_DES = Desired state of shift solenoid #1.

- SS1\_MON\_OFF = Shift Solenoid #1 monitor off flag.

- SS1\_MON\_ON = Shift Solenoid #1 monitor on flag.

- SS2\_COM = Shift solenoid #2 command flag; 1 -> solenoid #2 commanded on,

0 -> solenoid #2 commanded off.

- SS2\_COM\_LST = Last verified position of solenoid #2.

- SS2\_DES = Desired state of shift solenoid #2.

- SS2\_MON\_OFF = Shift Solenoid #2 monitor off flag.

26-46

SHIFT CONTROL, DETERMINE SHIFT SOLENOID STATES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SS2\_MON\_ON = Shift Solenoid #2 monitor on flag.

- SUBST\_REQ11 = Substitute requested flag for channel 11.

- SUBST\_REQ12 = Substitute requested flag for channel 12.

- UNDSP = Run/Underspeed flag; 1 -> Underspeed or Crank, 0 -> Run.

Calibration Constants:

- CLDCTM = Cold shift solenoid cycle time in background loops.

- FNSSCTL2 = Table of shift solenoid values, based on GR\_CM and PDL.

- GRRAT1 = First gear ratio.

- GRRAT2 = Second gear ratio.

- GRRAT3 = Third gear ratio.

- GRRAT4 = Fourth gear ratio.

- SS1\_ERROR\_TM = Shift Solenoid #1 time, minimum time error must be present

to set a code.

- SS2\_ERROR\_TM = Shift Solenoid #2 time, minimum time error must be present

to set a code.

- SSCYCCLD = Shift solenoid states for cold cycling.

- TSTRAT = Transmission strategy switch; The TSTRAT software switch

controls which transmission control strategy is executed:

0 -> No transmission control (Manual trans., AOD, ATX, C6, C3, etc.)

1 -> SIL (Shift indicator light)

2 -> A4LD with 3-4 shift control and converter clutch control

3 -> AXOD

4 -> C64E (E4OD)

5 -> A4LDE

6 -> FAX-4

7 -> AOD-E

8 -> 4EAT

9 -> CD4E

OTHER

- SS1\_CODES = Set of (P0750) SS1 OBDII fault code.

- P0750 = Fault code for shift solenoid #1

- SS2\_CODES = Set of (P0755) SS1 OBDII fault code.

- P0755 = Fault code for shift solenoid #2

26-47

SHIFT CONTROL, DETERMINE SHIFT SOLENOID STATES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_SOL\_CTL\_COM18

TSTRAT <= 3 ----------------------|

(Non-electronic trans) |AND -| Do: OSC\_RESPSONE(11,10h)

| | (send general reject)

SUBST\_REQ11 = 1 ------------------|

TSTRAT <= 3 ----------------------|

(Non-electronic trans) |AND -| Do: OSC\_RESPSONE(12,10h)

| | (send general reject)

SUBST\_REQ12 = 1 ------------------|

TSTRAT <= 3 ----------------------------| Exit module

(Non-electronic trans) |

| --- ELSE ---

|

| Increment CYCCTR

CYCCTR >= CLDCTM -----------------------| CYCCTR = 0

FLG\_FRST\_TV = 0 ------------------|

(no engagement yet) |

|

CYCCTR > CLDCTM/2 ----------------|

(cycle shift solenoids) |

|

FLG\_TVENG\_MD = 1 -----------| |

|OR --|AND -| SS1\_DES = bit 0 of SSCYCCLD

FLG\_TVENG\_CD = 1 -----------| | | SS2\_DES = bit 1 of SSCYCCLD

(moderately cold) | | RT\_GR\_CUR = GRRAT1

| | GEAR\_CUR = 1

UNDSP = 0 ------------------------| | (do cold shift solenoid

(RUN mode) | | cycling strategy)

| |

GR\_CM = 1 ------------------------| |

| --- ELSE ---

TMR\_M12 > 0 ----------------------| |

(man. 1-2 just started) |AND -| SS1\_DES = bit 0 of FNSSCTL2(2, 1)

| | SS2\_DES = bit 1 of FNSSCTL2(2, 1)

GR\_CM = 2 ------------------------| | (command third gear, PDL = 2

| solenoid states)

|

| --- ELSE ---

|

| SS1\_DES = bit 0 of FNSSCTL2

| (GR\_CM - 1, PDL - 1)

| SS2\_DES = bit 1 of FNSSCTL2

| (GR\_CM - 1, PDL - 1)

| RT\_GR\_CUR = GRRAT[GR\_CM]

| GEAR\_CUR = GR\_CM

26-48

SHIFT CONTROL, DETERMINE SHIFT SOLENOID STATES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

This is the calibration for the AODE transmission.

Cal. Const. Binary Decimal

SSCYCCLD 0010 2

FNSSCTL2 PDL - 1

0 1 2 3 4,5,6

GR\_CM - 1 = 0 0001 (1) 0001 (1) 0001 (1) 0001 (1) 0001 (1)

1 0000 (0) 0000 (0) 0000 (0) 0000 (0) 0000 (0)

2 0010 (2) 0010 (2) 0010 (2) 0010 (2) 0010 (2)

3 0011 (3) 0011 (3) 0011 (3) 0011 (3) 0011 (3)

NOTE: FNSSCTL2(commanded gear, PRNDL position) is indexed using GR\_CM - 1,

PDL - 1 to save bytes because the first row and column of a table

must both be zero.

OSM\_EO\_OFF = 1 -------------------------| SS1\_COM = 0

(Engine Off OSM off testing | SS2\_COM = 0

in progress) | (Turn all solenoids off)

|

| --- ELSE ---

|

OSM\_EO\_ON = 1 --------------------------| SS1\_COM = 1

(Engine Off OSM on testing | SS2\_COM = 1

in progress) | (Turn all solenoids on)

|

| --- ELSE ---

|

| SS1\_COM = SS1\_DES

| SS2\_COM = SS2\_DES

| (Pass through desired state)

unconditionally ------------------------| flg\_ss\_1 = SS1\_COM

| Do: substitute(11,flg\_ss\_1)

| FLG\_SS\_1 = flg\_ss\_1

| (output state control override)

| SS1\_COM\_LST = FLG\_SS\_1

|

| flg\_ss\_2 = SS2\_COM

| Do: substitute(12,flg\_ss\_2)

| FLG\_SS\_2 = flg\_ss\_2

| (output state control override)

| SS2\_COM\_LST = FLG\_SS\_2

26-49

SHIFT CONTROL, DETERMINE SHIFT SOLENOID STATES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OSM\_EO\_OFF = 1 -------------------|

(EO OFF self test enabled) |

|

OSM\_EO\_ON = 1 --------------------|OR --| Do: ss1\_mon

(EO ON self test enabled) | | Do: ss2\_mon

| |

CCM\_TST\_ENA = 1 ------------------| |

(CCM testing enabled) |

| --- ELSE ---

|

| SS1\_ERR\_TMR = 0

| SS2\_ERR\_TMR = 0

| EXIT

| (CCM testing disabled,

| hold error timers at zero

| and exit)

BEGIN: ss1\_mon

Monitor Shift Solenoid 1 using feedback from the driver:

FLG\_SS\_1 <> SS1\_COM\_LST ----------------| SS1\_ERR\_TMR = 0

(Solenoid state change) | (Wait 1 background

| for fault status to

| update to new state)

|

| --- ELSE ---

FLG\_SS\_1 = 1 ---------------------| |

(SS1 commanded on) |AND -| SS1\_MON\_ON = 1

| | SS1\_ERR\_TMR = 0

SS1\_FAULT = 0 --------------------| | clear\_malf(P0750)

(no fault present) | (On state commanded and observed,

| set SS1 monitored on flag, clear

| malf flag, and zero error timer)

|

| --- ELSE ---

FLG\_SS\_1 = 0 ---------------------| |

(SS1 commanded off) |AND -| SS1\_MON\_OFF = 1

| | SS1\_ERR\_TMR = 0

SS1\_FAULT = 0 --------------------| | clear\_malf(P0750)

(no fault present) | (Off state commanded and observed,

| set SS1 monitored off flag, clear

| malf flag, and zero error timer)

|

| --- ELSE ---

|

SS1\_ERR\_TMR >= SS1\_ERROR\_TM ------------| malfunction(ccm,P0750)

| (error present long enough,

| set SS1 error code)

26-50

SHIFT CONTROL, DETERMINE SHIFT SOLENOID STATES - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P0750MALF = 1 -------------|

(SS1 malfunction |

currently present) |OR --| P0750MON = 1

| | (SS1 has been monitored

SS1\_MON\_ON = 1 ------| | | for this power-up)

|AND -|

SS1\_MON\_OFF = 1 -----|

(Both states have

been observed)

END: ss1\_mon

BEGIN: ss2\_mon

Monitor Shift Solenoid 2 using feedback from the driver:

FLG\_SS\_2 <> SS2\_COM\_LST ----------------| SS2\_ERR\_TMR = 0

(Solenoid state change) | (Wait 1 background

| for fault status to

| update to new state)

|

| --- ELSE ---

FLG\_SS\_2 = 1 ---------------------| |

(SS2 commanded on) |AND -| SS2\_MON\_ON = 1

| | SS2\_ERR\_TMR = 0

SS2\_FAULT = 0 --------------------| | clear\_malf(P0755)

(no fault present) | (On state commanded and observed,

| set SS2 monitored on flag, clear

| malf flag, and zero error timer)

|

| --- ELSE ---

FLG\_SS\_2 = 0 ---------------------| |

(SS2 commanded off) |AND -| SS2\_MON\_OFF = 1

| | SS2\_ERR\_TMR = 0

SS2\_FAULT = 0 --------------------| | clear\_malf(P0755)

(no fault present) | (Off state commanded and observed,

| set SS2 monitored off flag, clear

| malf flag, and zero error timer)

|

| --- ELSE ---

|

SS2\_ERR\_TMR >= SS2\_ERROR\_TM ------------| malfunction(ccm,P0755)

| (error present long enough,

| set SS2 error code)

P0755MALF = 1 --------------------|

(SS2 malfunction currently |

present) |OR --| P0755MON = 1

| | (SS2 has been monitored

SS2\_MON\_ON = 1 -------------| | | for this power-up)

|AND -|

SS2\_MON\_OFF = 1 ------------|

(Both states have

been observed)

END: ss2\_mon

26-51

SHIFT CONTROL, SHIFT VALIDATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.12 SHIFT VALIDATION LOGIC (CDAN0)

OVERVIEW

The Shift Validation logic verifies that a shift has taken place after it is

commanded. This logic is only capable of verifying shifts which take place

under steady operating conditions. The shifts must be automatic upshifts,

with the vehicle off idle and the vehicle speed over a calibratable minimum

speed for each gear (designed to ensure that the vehicle is power on and the

torque converter is operating above the coupling point).

The logic works as follows: if a power on upshift is commanded, and the

vehicle speed entry condition is met, then TP, VS, and NE are recorded at the

start of the shift. The engine rpm drop that can be expected as a result of

the upshift is then determined based on the current state of the converter

clutch - a larger drop can be expected if the converter is locked at the

start (and end) of the shift. The shift is considered to be a shift which

can be validated as long as the TP and VS are steady. Engine rpm is

monitored until it peaks. Engine rpm must then drop from the peak by the

expected amount within the time allowed to complete the shift. If the engine

rpm drop lasts for a specified amount of time (verification the drop was due

to a shift and not due to noise), it is considered to represent a shift. If

engine rpm did not drop within the allowed time, it is noted that there was a

shift error (missed shift).

The results of shift validation are used by the shift solenoid functional

test, which decodes the missed shifts into the shift solenoid status. For

any solenoid failure at least two (of three) single step upshifts will be

"missed". It has been discovered that for certain solenoid failures it is

only possible to detect one of the two missed shifts (due to TCC control

causing an RPM drop during the shift - which looks the same as the shift

occurring).

Detecting both missed shift events for a solenoid failure is required to

comply with OBD-II. Logic has been added to revise TCC control in the event

that one shift error code is stored, which will allow the other shift error

to be dectected (if present). Shift validation will pass a shift error flag

(SFT\_ERR\_FLG) to the converter clutch control strategy. This flag will be

set when a shift error code is stored, and will remain set for the remainder

of the current power-up. Each subsequent power-up the failure must be

re-detected before this failure mode action will be initiated.

Additional fmem action of clipping EPC to TVFMMN and flashing the TCIL will

begin when a shift error code is stored, and will be executed for a

calibratable number of warm up cycles.

NOTE: If the converter clutch is applied at the beginning of shift

validation, and unlocks for any reason during shift validation,

shift validaiton will be exited. Unlocking the converter during

an upshift may result in an increase in engine speed which may

negate the engine speed drop due to the shift occurring -> tricking

the test into calling a "good" shift "missed".

26-52

SHIFT CONTROL, SHIFT VALIDATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- GR\_CM = Current commanded gear.

- GEAR\_OLD = Last commanded gear.

- IPDL = Unfiltered MLPS position.

- NE\_DROP\_EX = Expected engine rpm drop for the shift being validated.

- NE\_DROP\_TM = Current time (in milliseconds) when the engine speed drop

occurred during a verifiable shift.

- NEBART = Filtered engine speed.

- NEV\_PEAK\_SFT = Peak engine speed during a verifiable shift.

- P0781CNT = 1-2 shift error warm up counter.

- P0781FIL = 1-2 missed shift fault filter.

- P0782CNT = 2-3 shift error warm up counter.

- P0782FIL = 2-3 missed shift fault filter.

- P0783CNT = 3-4 shift error warm up counter.

- P0783FIL = 3-4 missed shift fault filter.

- SFT\_12\_CNT = Number of 1-2 shifts validated to be good.

- SFT\_23\_CNT = Number of 2-3 shifts validated to be good.

- SFT\_34\_CNT = Number of 3-4 shifts validated to be good.

- TOT = Transmission Oil Temperature, deg F.

- TP\_REL = Relative throttle position; TP - RATCH.

- TPV\_STRT\_SFT = Throttle position at start of the shift.

- TSTRAT = Transmission strategy switch; The TSTRAT software switch

controls which transmission control strategy is executed:

0 -> No transmission control (Manual trans., AOD, ATX, C6, C3, etc.)

1 -> SIL (Shift indicator light)

2 -> A4LD with 3-4 shift control and converter clutch control

3 -> AXOD

4 -> C64E (E4OD)

5 -> A4LDE

6 -> FAX-4

7 -> AOD-E (AOD-I)

8 -> 4EAT

9 -> CD4E

26-53

SHIFT CONTROL, SHIFT VALIDATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission,

mph.

- VSV\_STRT\_SFT = Vehicle speed at start of the shift.

Bit Flags:

- CCM\_TST\_ENA = Comprehensive component monitor enable flag; 1 -> the

diagnostic executive has decided that conditions are such that ccm tests

can be executed.

- CCV\_STRT\_SFT = Converter clutch state at the start of shift validation; 1

-> TCC applied at start of shift.

- FLG\_FRST\_CM = New commanded gear this pass flag.

- FLG\_NOV\_KAM = Flag indicating at least one update of RT\_NOVS\_KAM.

- FLG\_OPEN = Convertor clutch state flag; 1 -> CC open, 0 -> CC closed.

- FLG\_PWR = Power mode flag ; 1 -> power on mode, 0 -> power off mode.

- FLG\_SF\_AUTO = Automatic shift flag.

- FLG\_SFT\_IN = Shift in progress flag; 1 -> shift in progress.

- FLG\_SFT\_VAL = Shift validity flag; 0 -> Shift cannot be verified, 1 ->

Shift may be verified.

- FLG\_SFT\_VER = Shift verify flag; 0 -> Shift is not being verified, 1 ->

Shift is being verified.

- FLG\_SS\_MON = Flag indicating all shifts have been monitored and are good,

used to enable/disable converter clutch functional checks; 1 -> shifts

good, enable converter clutch tests.

- LST\_SFT\_CMP = Last shift complete flag; 1 -> last commanded shift

completed (timed out).

- OSFMFLG = Output Shaft speed sensor FMEM flag; 1 -> output shaft speed

sensor failure detected.

- P0781FAULT = 1-2 shift error detected.

- P0782FAULT = 2-3 shift error detected.

- P0783FAULT = 3-4 shift error detected.

- P0781MON = 1-2 shift monitor flag; 1 -> at least one 1-2 shift has been

validated.

- P0782MON = 2-3 shift monitor flag; 1 -> at least one 2-3 shift has been

validated.

- P0783MON = 3-4 shift monitor flag; 1 -> at least one 3-4 shift has been

validated.

26-54

SHIFT CONTROL, SHIFT VALIDATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TFMFLG = Throttle position FMEM flag; 1 -> throttle position failure

detected.

Calibration Constants:

- GOOD\_12\_LVL = Number of 1-2 shifts which must be validated good to set

the shift solenoid monitor flag.

- GOOD\_23\_LVL = Number of 2-3 shifts which must be validated good to set

the shift solenoid monitor flag.

- GOOD\_34\_LVL = Number of 3-4 shifts which must be validated good to set

the shift solenoid monitor flag.

- NE\_DROP\_OPEN = Epected engine rpm drop for a power on upshift started

with an open converter.

- NE\_DROP\_LCK = Epected engine rpm drop for a power on upshift started with

a locked converter.

- S\_VAL\_TPADD = Tolerance on TP to verify steady TP (positive direction)

during the shift validation.

- S\_VAL\_TPSUB = Tolerance on TP to verify steady TP (negative direction)

during the shift validation.

- S\_VAL\_VSADD = Tolerance on VS to verify steady vehicle speed (positive

direction) during the shift validation.

- S\_VAL\_VSSUB = Tolerance on VS to verify steady vehicle speed (negative

direction) during the shift validation.

- SFT\_ERR\_FLG = Shift error flag, used to revise TCC control; 1 -> a shift

error has been detected.

- SFT\_ERR\_LVL = Shift error level, the fault threshold for shift errors.

- SFT\_ERR\_UP = Shift error upcount, the amount PxxxFIL will be increased by

when a shift error is detected.

- SFT\_FM\_FLG = Shift error failure mode flag; 0 -> no failure mode action,

1 -> shift error failure mode action will be executed.

- SFT\_FM\_LVL = Total number of warm up cycles that failure mode action will

be executed after a shift error is detected.

- SFT\_VAL\_TM = Length of time to verify a shift (in milliseconds).

- TOT\_SFTV\_MX = Maximum TOT to allow shifts to be validated.

- TOT\_SFTV\_MN = Minimum TOT to allow shifts to be validated.

- TP\_SH\_VAL2 = Minimum TP to validate an upshift to second gear.

- TP\_SH\_VAL3 = Minimum TP to validate an upshift to third gear.

- TP\_SH\_VAL4 = Minimum TP to validate an upshift to fourth gear.

26-55

SHIFT CONTROL, SHIFT VALIDATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- VS\_SH\_VAL2 = Minimum vehicle speed to validate an upshift to 2nd gear.

- VS\_SH\_VAL3 = Minimum vehicle speed to validate an upshift to 3rd gear.

- VS\_SH\_VAL4 = Minimum vehicle speed to validate an upshift to 4th gear.

OTHER

- sft\_codes = Set of {P0781,P0782,P0783} OBDII fault codes that relate to

shift errors.

- malfunction(ccm,Pxxx) = Logic process, imported from the MIL control

module, Pxxx indicates a fault code.

- P0781 = Fault code for a 1-2 shift malfunction.

- P0782 = Fault code for a 2-3 shift malfunction.

- P0783 = Fault code for a 3-4 shift malfunction.

26-56

SHIFT CONTROL, SHIFT VALIDATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_VALID\_OBDII\_COM1

TSTRAT <= 3 --------------------------------| Exit module

(Manual/non-electric transmission) |

| --- ELSE ---

CCM\_TST\_ENA = 1 ----------------------| |

| |

FLG\_FRST\_CM = 1 ----------------------| |

| |

FLG\_SF\_AUTO = 1 ----------------------| |

| |

LST\_SFT\_CMP = 1 ----------------------| |

| |

IPDL <> 0 ----------------------------| |

| |

TOT <= TOT\_SFTV\_MX -------------------| |

| |

TOT > TOT\_SFTV\_MN --------------------| |

| |

GR\_CM = GEAR\_OLD + 1 -----------------| |

| |

GR\_CM = 2 ----------------| | |

| | |

VSBART\_RT > VS\_SH\_VAL2 ---|AND -| | |

| | | |

TP\_REL > TP\_SH\_VAL2 ------| | | |

| |AND -| Do: expected\_ne\_drop

GR\_CM = 3 ----------------| | | | (set expected engine rpm

| | | | drop based on CC state)

VSBART\_RT > VS\_SH\_VAL3 ---|AND -|OR --| | TPV\_STRT\_SFT = TP\_REL

| | | | (record TP at start

TP\_REL > TP\_SH\_VAL3 ------| | | | of shift)

| | | NEV\_PEAK\_SFT = NEBART

GR\_CM = 4 ----------------| | | | (record filtered engine

| | | | speed at start of shift)

VSBART\_RT > VS\_SH\_VAL4 ---|AND -| | | VSV\_STRT\_SFT = VSBART\_RT

| | | (record filtered vehicle

TP\_REL > TP\_SH\_VAL4 ------| | | speed at start of shift)

| | FLG\_SFT\_VAL = 1

FLG\_NOV\_KAM = 1 ----------------------| | (shift may be checked

| | for validity)

FLG\_PWR = 1 --------------------------| | FLG\_SFT\_VER = 0

(power on mode) | | (clear shift verify flag)

| | Exit module

TFMFLG = 0 ---------------------------| |

| |

OSFMFLG = 0 --------------------------| |

| --- ELSE ---

|

(continued on next page)

26-57

SHIFT CONTROL, SHIFT VALIDATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

FLG\_SFT\_VAL = 0 ----------------| |

|AND -| |

FLG\_SFT\_VER = 0 ----------------| | |

| |

CCV\_STRT\_SFT = 1 ---------------| | |

|AND -| |

FLG\_OPEN = 1 -------------------| | |

;TCC locked at start, open now | |

| |

VSBART\_RT < VSV\_STRT\_SFT - | |

S\_VAL\_VSSUB ----------| |

| |

VSBART\_RT > VSV\_STRT\_SFT + | |

S\_VAL\_VSADD ----------|OR --| FLG\_SFT\_VAL = 0

(unsteady vehicle speed) | | FLG\_SFT\_VER = 0

| | Exit module

TP\_REL < TPV\_STRT\_SFT - S\_VAL\_TPSUB --| |

| |

TP\_REL > TPV\_STRT\_SFT + S\_VAL\_TPADD --| |

(unsteady throttle) | |

| |

FLG\_FRST\_CM = 1 ----------------------| |

;shift which does not meet entry | |

;conditions commanded | |

| |

CCM\_TST\_ENA = 0 ----------------------| |

| --- ELSE ---

|

| Do: shift\_validation

BEGIN: expected\_ne\_drop

Determine the engine rpm drop that can be expected for the current upshift

based on the state of the converter clutch at the start of the shift (a

larger drop can be expected for a locked to locked shift).

FLG\_OPEN = 1 -------------------------------| NE\_DROP\_EX = NE\_DROP\_OPEN

(Conv. Cl. open at start of shift) | (Set expected engine rpm drop

| to the open to open/locked

| upshift value)

|

| CCV\_STRT\_SFT = 0

| ;TCC open at start of shift

|

| --- ELSE ---

|

| NE\_DROP\_EX = NE\_DROP\_LCK

| (Set expected engine rpm

| drop to the locked to locked

| upshift value)

|

| CCV\_STRT\_SFT = 1

| ;CTCC applied at start of shift

END: expected\_ne\_drop

26-58

SHIFT CONTROL, SHIFT VALIDATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: shift\_validation

FLG\_SFT\_IN = 0 -----------------------------| error\_detected = 1

(shift completed) | FLG\_SFT\_VAL = 0

| FLG\_SFT\_VER = 0

| Do: shift\_gear\_command\_logic

| Do: shift\_fmem\_logic

| FLG\_SS\_MON = 0

| (Disable converter clutch tests

| if a shift error is detected)

|

| --- ELSE ---

NEBART > NEV\_PEAK\_SFT ----------------| |

(check for peak engine speed) |AND -| NEV\_PEAK\_SFT = NEBART

| | (store new peak rpm)

FLG\_SFT\_VAL = 1 ----------------------| |

| --- ELSE ---

FLG\_SFT\_VAL = 1 ----------------------| |

(shift can be checked for validity) |AND -| FLG\_SFT\_VER = 1

| | (set shift verify flag)

NEBART <= NEV\_PEAK\_SFT - NE\_DROP\_EX --| | FLG\_SFT\_VAL = 0

(engine speed drop from peak | (clear shift validate

has occurred) | enable flag)

| NE\_DROP\_TM = store current

| time in

| milliseconds

|

| --- ELSE ---

FLG\_SFT\_VER = 1 ----------------------| |

| |

NEBART <= NEV\_PEAK\_SFT - NE\_DROP\_EX --|AND -| (shift verified as having

| | occurred, downcount the

current time - NE\_DROP\_TM >= | | fault filter for that shift)

SFT\_VAL\_TM ----| | FLG\_SFT\_VER = 0

(shift validation timer | (clear shift verify flag)

has run out) | error\_detected = 0

| Do: shift\_gear\_command\_logic

| Do: ss\_mon\_logic

| Do: shift\_fmem\_logic

|

| --- ELSE ---

FLG\_SFT\_VER = 1 ----------------------| |

|AND -| FLG\_SFT\_VER = 0

NEBART > NEV\_PEAK\_SFT - NE\_DROP\_EX ---| | FLG\_SFT\_VAL = 1

| (drop in rpm did not last

| long enough, re-enter

| validation)

END: shift\_validation

26-59

SHIFT CONTROL, SHIFT VALIDATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: shift\_gear\_command\_logic

This logic is used to distinguish between a missed shift and a valid shift to

either upcount or downcount the fault filter.

GR\_CM = 2 --------------------|

|AND -| P0781FIL = P0781FIL + SFT\_ERR\_UP

error\_detected = 1 -----------| | (missed 1-2 shift)

| Do: shift\_fault\_logic

|

| P0781MON = 1

|

| --- ELSE ---

|

GR\_CM = 2 --------------------------| P0781FIL = P0781FIL - 1

| (1-2 shift occurred)

|

| P0781MON = 1

| SFT\_12\_CNT = SFT\_12\_CNT + 1

| (Upcount good 1-2 shift counter)

|

| --- ELSE ---

GR\_CM = 3 --------------------| |

|AND -| P0782FIL = P0782FIL + SFT\_ERR\_UP

error\_detected = 1 -----------| | (missed 2-3 shift)

| Do: shift\_fault\_logic

|

| P0782MON = 1

|

| --- ELSE ---

|

GR\_CM = 3 --------------------------| P0782FIL = P0782FIL - 1

| (2-3 shift occurred)

|

| P0782MON = 1

| SFT\_23\_CNT = SFT\_23\_CNT + 1

| (Upcount good 2-3 shift counter)

|

| --- ELSE ---

GR\_CM = 4 --------------------| |

|AND -| P0783FIL = P0783FIL + SFT\_ERR\_UP

error\_detected = 1 -----------| | (missed 3-4 shift)

| Do: shift\_fault\_logic

|

| P0783MON = 1

|

| --- ELSE ---

|

GR\_CM = 4 --------------------------| P0783FIL = P0783FIL - 1

| (3-4 shift occurred)

|

| P0783MON = 1

| SFT\_34\_CNT = SFT\_34\_CNT + 1

| (Upcount good 3-4 shift counter)

END: shift\_gear\_command\_logic

26-60

SHIFT CONTROL, SHIFT VALIDATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: shift\_fault\_logic

This logic is designed to set the appropriate fault flag and KAM code in the

event that a fault is detected. This logic also sets the shift error flag

(SFT\_ERR\_FLG), which is used in the TCC control strategy to disable softlock

and prevent the TCC from changing states during upshifts.

GR\_CM = 2 ----------------------------|

|AND -| store\_code(P0781)

P0781FIL >= SFT\_ERR\_LVL --------------| | SFT\_ERR\_FLG = 1

|

| --- ELSE ---

GR\_CM = 3 ----------------------------| |

|AND -| store\_code(P0782)

P0782FIL >= SFT\_ERR\_LVL --------------| | SFT\_ERR\_FLG = 1

|

| --- ELSE ---

GR\_CM = 4 ----------------------------| |

|AND -| store\_code(P0783)

P0783FIL >= SFT\_ERR\_LVL --------------| |SFT\_ERR\_FLG = 1

END: shift\_fault\_logic

BEGIN: ss\_mon\_logic

When a "good" shift is completed, this logic is called to determine if enough

"good" shifts (without bad shifts being detected) have been validated to

allow the converter clutch functional tests to run:

SFT\_12\_CNT >= GOOD\_12\_LVL -----------|

(enough good 1-2 shifts) |

|

P0781FIL = 0 ------------------------|

(No bad 1-2 shifts) |

|

SFT\_23\_CNT >= GOOD\_23\_LVL -----------|

(enough good 2-3 shifts) |AND -| FLG\_SS\_MON = 1

| | (Enough "good" shifts

P0782FIL = 0 ------------------------| | have been seen to allow

(No bad 2-3 shifts) | | the converter clutch

| | functional tests to run)

SFT\_34\_CNT >= GOOD\_34\_LVL -----------| |

(enough good 3-4 shifts) | |

| |

P0783FIL = 0 ------------------------| |

(No bad 3-4 shifts) |

| --- ELSE ---

|

| FLG\_SS\_MON = 0

| (Either "missed" shifts have

| occurred or not enough "good"

| shifts to reliably run the

| converter clutch tests)

END ss\_mon\_logic

26-61

SHIFT CONTROL, SHIFT VALIDATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: shift\_fmem\_logic

This logic sets the failure mode flag so the appropriate failure mode action

can be taken.

P0781FAULT = 1 -----------------|

(1-2 shift error detected) |AND -|

| |

P0781CNT < SFT\_FM\_LVL ----------| |

(not enough warm up cycles |

have passed since failure |

detection) |

|

P0782FAULT = 1 -----------------| |

(2-3 shift error detected) |AND -|

| |OR --| SFT\_FM\_FLG = 1

P0782CNT < SFT\_FM\_LVL ----------| | | (a shift error has been

(not enough warm up cycles | | detected, perform failure

have passed since failure | | mode action for SFT\_FM\_LVL

detection) | | warm up cycles since the

| | last failure detection)

P0783FAULT = 1 -----------------| | |

(3-4 shift error detected) |AND -| |

| |

P0783CNT < SFT\_FM\_LVL ----------| |

(not enough warm up cycles have |

passed since failure detection) |

| --- ELSE ---

|

| SFT\_FM\_FLG = 0

END: shift\_fmem\_logic

26-62

SHIFT CONTROL, TORQUE MODULATION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

26.13 TORQUE MODULATION CONTROL (WITHOUT TURBINE SPEED) (CDAN0)

OVERVIEW

Torque Modulation is performed by retarding spark during the shift event.

For non turbine speed sensor applications, torque modulation occurs during

upshifts only.

Minimum TP\_REL and and steady throttle conditions must be met in order to do

torqe modulation. In addition, if trigger conditions are not met within a

certain time (TQ\_TIMEOUT), torque modulation is aborted.

The desired torque level during the shift is calculated by taking a

percentage of the current engine output torque. The spark control strategy

uses this information to adjust spark (to achieve this torque level

(TQ\_LEVEL).

In foreground, the maximum engine speed during the shift, in clock ticks, is

used to trigger the start of torque modulation. The max engine speed value

is then used to calculate a speed ratio. value for the end trigger. This is

tagged as the speed ratio at the start of the inertia phase (SPD\_RT\_MAX). To

end torque modulation, a calibratible delta speed ratio from SPD\_RT\_MAX,

covertered to clock ticks, is used.

DEFINITIONS

Registers:

- DT12S\_AVG = Filtered PIP delta for transmission, clock ticks.

- GR\_CM = Commanded gear for shift solenoids.

- GR\_OLD = Last commanded gear.

- NEBART = Filtered engine RPM for transmission.

- NEMAX = Maximum engine speed during an upshift.

- NE\_SFT\_END = Engine speed value to end torque modulation, base on delta

speed ratio, clock ticks.

- NE\_SFT\_STRT = Maximum engine speed detected at start of shift, ticks.

- NE\_TRIG\_STRT = Delta engine speed to trigger start of torque modulation,

clock ticks.

- NOBART = Filtered output shaft speed, RPM.

- PCT\_TQ = Percent of TQ\_NET to control to during torque modulation,

percent.

- RT\_GR\_CUR = Current transmission gear ratio, dimensionless.

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SHIFT CONTROL, TORQUE MODULATION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SPD\_RT\_MAX = Speed ratio across torque converter at start of shift.

- SR\_TRIG\_END = Delta speed ratio to trigger end of torque modulation,

dimensionless.

- TP\_REL = Relative TP ( TP - RATCH ).

- TP\_REL\_H = Relative TP, high byte.

- TP\_STRT\_SFT = TP\_REL\_H at the start of the shift, counts.

- TQ\_LEVEL = Torque level required by transmission for torque modulation,

ft-lbs.

- TQ\_MIN\_CLIP = Minimum TQ\_NET below which torque modulation does not take

place.

- TQMOD\_TMR = Torque Modulation default timer (msec)

- TQ\_NET = Net torque produced by the engine, ft-lbs.

Bit Flags:

- FLG\_EPC\_RMP = Flag to trigger the start of static EPC ramps at the end of

a s shift.

- FLG\_FRST\_CM = First time a shift is commanded flag; 0 -> no.

- FLG\_FRST\_SPK = Flag which indicates max engine speed has been reached

during torque modulation.

- FLG\_SFT\_IN = Shift in progress flag.

- FLG\_SPK\_TQM = Torque modulation spark retard flag.

- FLG\_TQM\_BGS = Torque modulation TV pressure flag.

- FLG\_UP\_TQM = Upshift torque modulation flag.

Calibration Constants:

- FNPCTQ12(TP\_REL\_H) = Percent of TQ\_NET to control to during 1-2 upshift

torque modulation, percent.

- FNPCTQ23(TP\_REL\_H) = Percent of TQ\_NET to control to during 2-3 upshift

torque modulation, percent.

- FNPCTQ34(TP\_REL\_H) = Percent of TQ\_NET to control to during 3-4 upshift

torque modulation, percent.

- FNTQ2SRE(TP\_REL\_H) = Delta Shift Ratio to end torque modulation on an

upshift to 2nd.

- FNTQ3SRE(TP\_REL\_H) = Delta Shift Ratio to end torque modulation on an

upshift to 3rd.

- FNTQ4SRE(TP\_REL\_H) = Delta Shift Ratio to end torque modulation on an

upshift to 4th.

26-64

SHIFT CONTROL, TORQUE MODULATION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- PUL\_PER\_REV = Pulses per revolution number of PIPs per engine revolution

for E4OD\_GAS 1/2 the number of fuel pump.

- TP\_DELTL = Lower limit on the delta counts that TP\_REL can move in order

to continue to do torque modulation, counts.

- TP\_DELTU = Upper limit on the delta counts that TP\_REL can move in order

to continue to do torque modulation, counts.

- TP\_MIN\_TQM = Minimum TP\_REL to do torque modulation, counts.

- TQMIN12 = Minimum TQ\_NET below which torque modulation does not take

place during a 1-2 upshift.

- TQMIN23 = Minimum TQ\_NET below which torque modulation does not take

place during a 2-3 upshift.

- TQMIN34 = Minimum TQ\_NET below which torque modulation does not take

place during a 3-4 upshift.

- TQ2DTS = Delta ticks to start torque modulation on an upshift to 2nd.

- TQ3DTS = Delta ticks to start torque modulation on an upshift to 3rd.

- TQ4DTS = Delta ticks to start torque modulaiton on an upshift to 4th.

- TQ\_TIMEOUT = Maximum time to look for starting triggers for torque

modulation (seconds).

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SHIFT CONTROL, TORQUE MODULATION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_TQMOD\_COM9

BEGIN: MAIN

FLG\_FRST\_CM = 1 ----------------|

|

GR\_CM > GR\_OLD -----------------|AND -| FLG\_SPK\_TQM = 0

| | FLG\_UP\_TQM = 1

TP\_REL\_H > TP\_MIN\_TQM ----------| | FLG\_FRST\_SPK = 0

| FLG\_EPC\_RMP = 0

| TQMOD\_TMR = 0

| (reset torque modulation

| timer)

| NE\_SFT\_STRT = DT12S\_AVG

| Do: "UPSHIFT TORQUE MODULATION

| SET-UP"

|

| --- ELSE ---

FLG\_FRST\_CM = 1 ----------------| |

|AND -| FLG\_SPK\_TQM = 0

GR\_CM <= GR\_OLD ---------------| | FLG\_UP\_TQM = 0

| FLG\_FRST\_SPK = 0

| FLG\_EPC\_RMP = 0

| EXIT MODULE

|

| --- ELSE ---

FLG\_UP\_TQM = 1 -----------------| |

|AND -| Do: "UPSHIFT TORQUE MODULATION

FLG\_SPK\_TQM = 0 ----------------| | SET-UP"

FLG\_UP\_TQM = 1 -----|

|AND -|

FLG\_SPK\_TQM = 0 ----| |

(torque modulation has |

not started) |

|

TQMOD\_TMR > |AND -|

TQ\_TIMEOUT ---| | |

| | |

TP\_REL\_H > | | |

TP\_STRT\_SFT + | | |

TP\_DELTU ---|OR --| |OR --| FLG\_SPK\_TQM = 0

| | | FLG\_UP\_TQM = 0

TP\_REL\_H < | | | FLG\_FRST\_SPK = 0

TP\_STRT\_SFT - | | | FLG\_EPC\_RMP = 0

TP\_DELTL ---| | | (Reset torque modulation

| | flags)

FLG\_SFT\_IN = 0 -----------------| | EXIT MODULE

|

| --- ELSE ---

|

FLG\_UP\_TQM = 0 -----------------------| EXIT MODULE

| (Torque modulation not requested;

| skip the rest of the module)

26-66

SHIFT CONTROL, TORQUE MODULATION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_FRST\_SPK = 0 ---------------------| NEMAX = 60 / (PUL\_PER\_REV \*

| NE\_SFT\_STRT \* tscf)

|

| SPD\_RT\_MAX = NTBART / NEMAX

|

| --- ELSE ---

|

| Do not update NEMAX or SPD\_RT\_MAX

FLG\_SPK\_TQM = 1 ----------------------| NE\_SFT\_END = (SPD\_RT\_MAX +

| SR\_TRIG\_END) \* 60 \* STCF /

| (NOBART \* RT\_GR\_CUR \* PUL\_PER\_REV)

|

| --- ELSE ---

|

| NE\_SFT\_END = 65535

| (set NE\_SFT\_END to its maximum

| value to avoid false triggers)

FLG\_SPK\_TQM = 1 ----------------|

|AND -| FLG\_FRST\_SPK = 1

FLG\_FRST\_SPK = 0 ---------------| | (Don't update NEMAX or SPD\_RT\_MAX)

END: MAIN

26-67

SHIFT CONTROL, TORQUE MODULATION CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: UPSHIFT TORQUE MODULATION SET-UP

GR\_CM = 2 ----------------------------| PCT\_TQ = FNPCTQ12(TP\_REL\_H)

| NE\_TRIG\_STRT = TQ2DTS

| SR\_TRIG\_END = FNTQ2SRE(TP\_REL)

| TQ\_LEVEL = PCT\_TQ \* TQ\_NET

| TQ\_MIN\_CLIP = TQMIN12

|

| --- ELSE ---

|

GR\_CM = 3 ----------------------------| PCT\_TQ = FNPCTQ23(TP\_REL\_H)

| NE\_TRIG\_STRT = TQ3DTS

| SR\_TRIG\_END = FNTQ3SRE(TP\_REL)

| TQ\_LEVEL = PCT\_TQ \* TQ\_NET

| TQ\_MIN\_CLIP = TQMIN23

|

| --- ELSE ---

|

| PCT\_TQ = FNPCTQ34(TP\_REL\_H)

| NE\_TRIG\_STRT = TQ4DTS

| SR\_TRIG\_END = FNTQ4SRE(TP\_REL)

| TQ\_LEVEL = PCT\_TQ \* TQ\_NET

| TQ\_MIN\_CLIP = TQMIN34

TQ\_LEVEL < TQ\_MIN\_CLIP ---------------| TQ\_LEVEL = TQ\_MIN\_CLIP

END: UPSHIFT TORQUE MODULATION SET-UP

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SHIFT CONTROL, TORQUE MODULATION FOREGROUND CONTROL - CDAN2

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26.14 TORQUE MODULATION FOREGROUND CONTROL (WITHOUT TURBINE SPEED) (CDAN0)

OVERVIEW

Torque modulation is triggered in foreground. The start trigger is based on

the maximum engine speed during the shift plus a calibratible delta engine

speed. The max engine speed (NICT\_SFT\_STRT) is found by ratcheting down

DT12S\_AVG, the PIP period in clock ticks, until the minimum value is found.

The trigger is then calculated by adding the delta engine speed to it

(NICT\_SFT\_STRT + NICT\_TRIG\_STRT). Torque modulation begins when DT12S\_AVG

reaches this value.

In background, the max engine speed is used to calculate a speed ratio. This

speed ratio is tagged as the speed ratio at the start of the inertia phase

(SPD\_RT\_MAX). To end torque modulation, a calibratible delta speed ratio

from SPD\_RT\_MAX, covertered to clock ticks, is used.

The default timer (TQMOD\_TMR) will time out torque modulation, in case the

end trigger criteria is not met.

When torque modulation ends, and flag is set to initalize a static EPC ramp

(FLG\_RMP\_EPC).

DEFINITIONS

Registers:

- DT12S\_AVG = Filtered PIP delta for transmission, clock ticks.

- NE\_SFT\_END = Engine speed value to end torque modulation, base on delta

speed ratio, clock ticks.

- NE\_SFT\_STRT = Maximum engine speed detected at start of shift, clock

ticks.

- NE\_TRIG\_STRT = Delta engine speed to trigger start of torque modulation,

clock ticks.

- RAMP\_TM\_IN = Default time for spark ramp at end of torque modulation,

msec.

- RAMP\_TM\_OUT = Default time for spark ramp at start of torque modulation,

msec.

- SAF\_DES = Spark advance required to achieve the desired torque level

during torque modulation, deg.

- SAF\_MOD = Maximum total spark advance during torque modulation, deg.

- SAF\_MOD\_LST = Last pass value of SAF\_MOD, deg.

- SAFTOT = Total spark advance, deg.

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SHIFT CONTROL, TORQUE MODULATION FOREGROUND CONTROL - CDAN2

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- SPK\_CLK\_LST = Last pass value of CLOCK; used to compute spark ramps for

toruqe modulation, msec.

- SPK\_DELT\_OUT = Delta spark stepped out during torque modulation, deg.

- SPK\_RMP\_TMR = Timer used to control the duration of spark ramps for

torque modulation, msec.

- SPKSLP = Spark ramp rate for torque modulation, deg/msec.

- TQMOD\_TMR = Torque Modulation default timer (msec)

Bit Flags:

- FLG\_EPC\_RMP = Indicates end of ratio change, begin ramping static

capacity.

- FLG\_REP\_ENA = Indicates 16 msec repeater is enabled for spark ramps for

torque modulation.

- FLG\_RMP\_INIT = Indicates the first pass spark retard is requested for

torque modulation; initialize ramp parameters.

- FLG\_SPK\_TQM = Torque modulation spark retard flag.

- FLG\_UP\_TQM = Upshift torque modulation flag.

Calibration Constants:

- TQMODTM = Maximum duration for torque modulation (seconds).

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SHIFT CONTROL, TORQUE MODULATION FOREGROUND CONTROL - CDAN2

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PROCESS

STRATEGY MODULE: SC\_TQMOD\_FG\_COM1

(Performed every PIP)

FLG\_UP\_TQM = 1 -----------------|

|

FLG\_SPK\_TQM = 0 ----------------|AND -| NE\_SFT\_STRT = DT12S\_AVG

| | (rachet up input shaft speed

DT12S\_AVG < NE\_SFT\_STRT --------| | to capture max speed during

| the shift)

FLG\_UP\_TQM = 1 -----------------|

|

FLG\_SPK\_TQM = 0 ----------------|AND -| FLG\_SPK\_TQM = 1

| | TQMOD\_TMR = 0

DT12S\_AVG > NE\_SFT\_STRT + | | (Reset Default Timer)

NE\_TRIG\_STRT ----| | SPK\_RMP\_TMR = RAMP\_TM\_OUT

| FLG\_RMP\_INIT = 1

| (Initialize spark ramp)

|

| --- ELSE ---

FLG\_UP\_TQM = 1 -----------------| |

| |

FLG\_SPK\_TQM = 1 ----------------|AND -| FLG\_SPK\_TQM = 0

| | FLG\_UP\_TQM = 0

DT12S\_AVG > NE\_SFT\_END ---| | | SPK\_RMP\_TMR = RAMP\_TM\_IN

|OR --| | FLG\_EPC\_RMP = 1

TQMOD\_TMR > TQMODTM ------| | (ramp static capacity)

(Default timer expires)

FLG\_RMP\_INIT = 1 ----------------------| SPK\_DELT\_OUT := SPKSLP \* (16 msec )

| ; assume one 16 msec interval to

| ; initialize ramp

| SAF\_MOD := SAFTOT - SPK\_DELT\_OUT

| SAF\_MOD := max( SAF\_MOD, SAF\_DES )

| SAF\_MOD\_LST := SAF\_MOD

| SPK\_CLK\_LST := current CLOCK time i

| in milliseconds

| FLG\_RMP\_INIT := 0

| FLG\_REP\_ENA := 1

| ; enable 16 msec repeater for

| ; spark ramps

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SHIFT CONTROL, REVERSE LOCK-OUT SOLENOID CONTROL - CDAN2

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26.15 REVERSE LOCK-OUT SOLENOID CONTROL (CDAI0)

OVERVIEW

The reverse lock-out solenoid, RLS, is used in manual transmissions to

prohibit shifting into reverse gear at vehicle speeds greater than a

calibration. This feature is intended to prevent catastrophic failure of the

T56 transmission. A calibratable hardware present switch is available.

DEFINITIONS

Registers:

- VSBART = Vehicle speed.

Bit Flags

- FLG\_RLS = Reverse lock-out flag; 1 -> Reverse allowed, 0 -> Reverse

locked-out.

Calibration Constants:

- FLG\_RLS\_HP = Reverse lock-out solenoid hardware present switch; 0 ->

Reverse lock-out solenoid not present, 1 -> Reverse lock-out solenoid

present.

- TSTRAT = Transmission hardware type definition.

- VS\_RLS = Vehicle speed at which reverse lock-out solenoid activates.

- VS\_RLSH = Hysteresis for reverse lock-out vehicle speed check.

OUTPUTS

Bit Flags

- FLG\_RLS = See above.

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SHIFT CONTROL, REVERSE LOCK-OUT SOLENOID CONTROL - CDAN2

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PROCESS

STRATEGY MODULE: SC\_RLS\_COM1

TSTRAT > 1 -----------------------|

(not a manual transmission) |OR --| EXIT MODULE

| |

FLG\_RLS\_HP = 0 -------------------| |

(reverse lock-out solenoid |

not present) |

| --- ELSE ---

|

VSBART > VS\_RLS ------------------------| FLG\_RLS = 0

|

| --- ELSE ---

|

VSBART < VS\_RLS - VS\_RLSH --------------| FLG\_RLS = 1

|

| --- ELSE ---

|

| NO UPDATE TO FLG\_RLS

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SHIFT CONTROL, SHIFT SOLENOID FUNCTIONAL TEST - CDAN2

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26.16 SHIFT SOLENOID FUNCITONAL TEST (CDAK0)

OVERVIEW

The shift solenoid functional test logic uses the results from the shift

validation logic to determine if shift solenoids are failed or not. After

1-2, 2-3 and 3-4 upshifts have been monitored, the combination of failed

upshifts is checked to determine if the failed shifts point to a solenoid

error. One failed shift could not be the result of a solenoid failure. Each

solenoid failure causes two shift failures. If both solenoids are failed,

all three shifts will fail.

The following information is used to determine if detected shift errors are

most likely due to solenoid failres (or other hydraulic/mechanical failures):

AODE

GEAR SS2 SS1

1 0 1

2 0 0

3 1 0

4 1 1

With no faults present, actual gear = commanded, all shifts will be good.

SS1 failed OFF SS1 failed ON

GR\_CM SS2 SS1 Actual gear GR\_CM SS2 SS1 Actual gear

1 0 0 2 1 0 1 1

2 0 0 2 2 0 1 1

3 1 0 3 3 1 1 4

4 1 0 3 4 1 1 4

1-2 and 3-4 shifts bad, 2-3 good 1-2 and 3-4 shifts bad, 2-3 good

SS2 failed OFF SS2 failed ON

GR\_CM SS2 SS1 Actual gear GR\_CM SS2 SS1 Actual gear

1 0 1 1 1 1 1 4

2 0 0 2 2 1 0 3

3 0 0 2 3 1 0 3

4 0 1 1 4 1 1 4

2-3 and 3-4 shifts bad, 1-2 good 1-2 and 2-3 shifts bad, 3-4 good

Double failure - all shifts bad.

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SHIFT CONTROL, SHIFT SOLENOID FUNCTIONAL TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- P0781FIL = 1-2 missed shift fault filter.

- P0782FIL = 2-3 missed shift fault filter.

- P0783FIL = 3-4 missed shift fault filter.

Bit Flags:

- P0781MON = 1-2 shift monitor flag.

- P0782MON = 2-3 shift monitor flag.

- P0783MON = 3-4 shift monitor flag.

Calibration Constants:

- SFT\_12\_ERR = Number of 1-2 shift errors for solenoid functionality test.

- SFT\_23\_ERR = Number of 2-3 shift errors for solenoid functionality test.

- SFT\_34\_ERR = Number of 3-4 shift errors for solenoid functionality test.

OUTPUTS

Bit Flags:

PxxxMALF = Malfunction flag for fault Pxxx; 1 -> malfunction Pxxx

currently exits.

- SS1MALF = Shift solenoid 1 malfunction flag; 1 -> SS1 currently

malfunctioning.

- SS2MALF = Shift solenoid 2 malfunction flag; 1 -> SS2 currently

malfunctioning.

- SS\_MALF\_FLG = Shift solenoid malfunction flag; 1 -> a shift solenoid

malfunction is currently present.

OTHER

- ss\_mil\_codes = Set of {P0751,P0756} OBDII MIL fault codes that relate to

shift solenoid functional test faults.

- ss\_non\_mil\_codes = Set of {P1751,P1756} OBDII NON-MIL fault codes that

relate to shift solenoid functional test faults.

- malfunction(ccm,Pxxx) = Logic process, imported from the MIL control

module, Pxxx indicates a fault code.

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SHIFT CONTROL, SHIFT SOLENOID FUNCTIONAL TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_SOL\_FN\_TEST\_COM1

P0781MON = 0 ---------------------|

(1-2 shift has not been |

monitored) |

|

P0782MON = 0 ---------------------|OR --| Exit module

(2-3 shift has not been | |

monitored) | |

| |

P0783MON = 0 ---------------------| |

(3-4 shift has not been |

monitored) |

| --- ELSE ---

P0781FIL > SFT\_12\_ERR ------------| |

(1-2 shifts bad) | |

| |

P0782FIL = 0 ---------------------|AND -| SS1MALF = 1

(Upshift occurred when 2-3 | | Do: ss1\_fault\_code\_logic

commanded) | |

| |

P0783FIL > SFT\_34\_ERR ------------| | SS2MALF = 0

(3-4 shifts bad) | P0756MALF = 0

| P1756MALF = 0

|

| (shift solenoid 1 failed)

|

| --- ELSE ---

P0781FIL = 0 ---------------| |

(Upshift occurred when 1-2 | |

commanded) | |

| |

P0782FIL > SFT\_23\_ERR ------|AND -| |

(2-3 shifts bad) | | |

| | |

P0783FIL > SFT\_34\_ERR ------| | |

(3-4 shifts bad) | |

|OR --| SS1MALF = 0

P0781FIL > SFT\_12\_ERR ------| | | P0751MALF = 0

(1-2 shifts bad) | | | P1751MALF = 0

| | |

P0782FIL > SFT\_23\_ERR ------|AND -| | SS2MALF = 1

(2-3 shifts bad) | | Do: ss2\_fault\_code\_logic

| |

P0783FIL = 0 ---------------| | (shift solenoid 2 failed)

(Upshift occured when 3-4 |

commanded) |

| --- ELSE ---

(Continued on the following page)

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SHIFT CONTROL, SHIFT SOLENOID FUNCTIONAL TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(Continued from the previous page)

P0781FIL > SFT\_12\_ERR ------------| |

(1-2 shifts bad) | |

| |

P0782FIL > SFT\_23\_ERR ------------|AND -| SS1MALF = 1

(2-3 shifts bad) | | Do: ss1\_fault\_code\_logic

| |

P0783FIL > SFT\_34\_ERR ------------| | SS2MALF = 1

(3-4 shifts bad) | Do: ss2\_fault\_code\_logic

|

| --- ELSE ---

|

| SS1MALF = 0

| P0751MALF = 0

| P1751MALF = 0

|

| SS2MALF = 0

| P0756MALF = 0

| P1756MALF = 0

|

| (No fault present, or

| shift errors do not

| match solenoid failure

| patterns, clear shift

| solenoid funcational

| test malfunciton flags)

SS1MALF = 1 ----------------------|

(SS1 fault currently present) |OR --| SS\_MALF\_FLG = 1

| | (Set shift solenoid malfunction

SS2MALF = 1 ----------------------| | flag, used to flash the TCIL)

(SS2 fault currently present) |

| --- ELSE ---

|

| SS\_MALF\_FLG = 0

26-77

SHIFT CONTROL, SHIFT SOLENOID FUNCTIONAL TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ss1\_fault\_code\_logic

It has been requested by TED management that illumination of the MIL for

shift solenoid functional test codes be calibratable (can set a code without

turning the MIL on). This can only be done by having two codes (one MIL, one

NON-MIL) which mean the same thing, with a calibration switch to select

between them.

SS\_MIL\_SW = 1 --------------------------| P0751MALF = 1

(MIL codes cal'ed in) | malfunction(ccm,P0751)

| (Set SS1 MIL code)

|

| --- ELSE ---

|

| P1751MALF = 1

| store\_code(P1751)

| (Set SS1 NON-MIL code)

END: ss1\_fault\_code\_logic

BEGIN: ss2\_fault\_code\_logic

It has been requested by TED management that illumination of the MIL for

shift solenoid functional test codes be calibratable (can set a code without

turning the MIL on). This can only be done by having two codes (one MIL, one

NON-MIL) which mean the same thing, with a calibration switch to select

between them.

SS\_MIL\_SW = 1 --------------------------| P0756MALF = 1

(MIL codes cal'ed in) | malfunction(ccm,P0756)

| (Set SS2 MIL code)

|

| --- ELSE ---

|

| P1756MALF = 1

| store\_code(P1756)

| (Set SS2 NON-MIL code)

END: ss2\_fault\_code\_logic

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CHAPTER 27

ELECTRONIC PRESSURE CONTROL

27-1

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

27.1 ELECTRONIC PRESSURE CONTROL GUIDE (CDAN0)

OVERVIEW

EPC pressure is regulated by a variable force solenoid which is under EEC-IV

control. The purpose of EPC pressure is to modulate the hydraulic pressure

used to apply, release, and hold the various clutches and bands in the

transmission. The higher the pressure, the more torque the transmission can

transmit. This input torque in a conventional transmission has been

approximated by either a mechanical linkage connected to the throttle plates,

or a vacuum diaphragm which sees manifold vacuum. The electronic EPC

strategy looks up engine torque from a table and varies the EPC pressure to

contain the static capacity requirement of the transmission.

In general, EPC pressure is calculated as follows:

- Static Capacity - This is the EPC required to hold the weakest friction

element due to combustion torque (TQ\_NET) and inertia torque (TQ\_IALPHA)

during a shift. Inertia torque is 0 when a shift is not taking place.

The sum of the combustion torque and inertia torque values is multiplied

by the torque converter torque ratio to determine the total torque the

transmission must transmit (tq\_stat\_cp). This in turn determines the

static TV capacity requirement (TV\_STAT).

- Dynamic TV - This is TV required to obtain acceptable shift feel and is

the powertrain developers main calibration tool. A switch is provided

(SW\_DYN) to allow the developer to either freeze RPM at a the start of a

shift, or to allow dynamic TV pressure to follow RPM during the shift

(TV\_DYN). The combustion torque always updates, even during the shift.

- AETV - Additional TV provided on quick tip-ins to counteract the lag in

EEC-IV updates to torque and to compensate for hydraulic lag times in the

VFS/TV hydraulic system.

- Total TV - (TV\_PRES) is simply the sum of static, dynamic and AETV

requirements.

Additional features -

- Cold Starts - additional TV can be requested to counteract the viscous

effect of cold transmission oil on engagements

- Rock cycling and high speed engagements - additional TV can be requested

to protect the transmission capacity during severe engagement conditions

- Tip-out from stall capacity hold - delay the release of stall TV pressure

during a quick tip-out to contain powertrain wind-up

- Stall TV - at low speed ratio and vehicle speed stall TV is computed as a

function of throttle position

- Coast boost - coast boost on a manual downshift is computed as a function

of output shaft speed.

- Start-up - additional TV can be requested once per start-up to "charge"

the TV system in extremely cold ambients.

- Engagement TV - A function of engine speed is provided to model the

engagement accumulator.

27-2

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - CDAN2

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DEFINITIONS

Registers:

- EIP\_TMR = Engagement in progress timer.

- EPC\_BLP\_TMR = Engagement EPC blip timer, sec.

- EPC\_ENG\_TMR = Engagement EPC ramp timer, sec.

- GR\_CM = Current transmission gear.

- GR\_DS\_TV = Desired gear used to compute TV pressure.

- N = Engine speed, rpm.

- NEBART = Filtered engine RPM for transmission, rpm.

- NE\_ENG\_STRT = Engine speed at start of engagement, rpm.

- NEU\_RES\_TMR = Neutral residency timer, sec.

- N\_RUN = Minimum engine speed to exit Crank mode.

- PDL = Current PRNDL position.

- PDL\_LST = PRNDL position last background pass.

- RT\_NOVS = Ratio of actual N/V to base N/V in KAM.

- SPD\_RATIO = Speed ratio across torque converter.

- TMR\_ASILT = Timer which controls anti-silting logic.

- TOT = Transmission oil temperature (degrees F).

- TV\_PRES = TV pressure, psi.

- TV\_PRES\_BAR = Filtered EPC pressure, psi.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission,

mph.

- VSCTR = Count of MPH sensor errors.

Bit Flags:

- CC\_FM\_FLG = Converter clutch failure mode flag; 0 -> normal operation, 1

-> execute converter clutch failure mode.

- DRV2NEU\_FLG = Forward prior to neutral flag.

- ETV\_TEST = ETV open/short test in progress.

- FLG\_ASILT = Anti-silting logic status; 1 -> anti-silting logic active.

- FLG\_DE\_CMGR = Indicates first pass through the delay shift for TV

routine.

27-3

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_DRV\_REV = Forward to reverse engagement flag.

- FLG\_ENG\_IN = Engagement in progress flag.

- FLG\_ENG\_LS = Engagement in progress last pass flag.

- FLG\_ENG\_TV = Engagement TV pressure flag; 0 -> do engagement logic, 1 ->

do not do engagement logic.

- FLG\_FRST\_DS = First time a shift is desired flag; 0 -> no shift desired

this BG pass, 1 -> shift desired this BG pass.

- FLG\_FRST\_TV = Start-up TV pressure flag; 0 -> do start-up TV logic, 1 ->

do not do start-up TV logic.

- FLG\_FWD\_REV = Rock cycling engagement in progress flag.

- FLG\_NEU\_DRV = Neutral to drive engagement flag.

- FLG\_NEU\_REV = Neutral to reverse engagement flag.

- FLG\_PWR = Power mode flag; 1 -> power on mode, 0 -> power off mode.

- FLG\_REV\_DRV = Reverse to drive engagement flag.

- FLG\_SFT\_IN = Shift in progress flag; 1 -> shift in progress.

- FLG\_SFT\_UP = Upshift flag; 1 -> current or last shift was an upshift.

- FLG\_TVENG\_MD = Moderate temperature for TV engagement flag.

- FLG\_VE\_DSGR = Verify desired gear first pass flag.

- MFMFLG = MAP/MAF FMEM flag.

- OTEMP\_FM\_FLG = Transmission overtemperature FMEM flag; 1 -> transmission

is overtemperature.

- PDL\_ERROR = Flag indicating a MLIP sensor failure; 1 -> failure.

- P0721MALF = Noisy OSS malfunction flag; 1 -> a noisy OSS failure has been

detected.

- REV2NEU\_FLG = Reverse prior to neutral flag.

- SFT\_FM\_FLG = Shift error failure mode flag; 0 -> no failure mode action,

1 -> failure mode action will be executed.

- TFMFLG = TP FMEM flag.

- OSFMFLG = Output shaft speed sensor FMEM flag.

Calibration Constants:

- EPCFMRV = Failure mode EPC pressure for Reverse operation, psi.

- FN12T(TOT) = TV\_PRES multiplier versus TOT for upshift to 2nd gear.

27-4

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - CDAN2

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- FN21T(TOT) = TV\_PRES multiplier versus TOT for downshift to 1st gear.

- FN23T(TOT) = TV\_PRES multiplier versus TOT for upshift to 3rd gear.

- FN32T(TOT) = TV\_PRES multiplier versus TOT for downshift to 2nd gear.

- FN34T(TOT) = TV\_PRES multiplier versus TOT for upshift to 4th gear.

- FN43T(TOT) = TV\_PRES multiplier versus TOT for downshift to 3rd gear.

- NEUTIM = Minimum time in neutral to use neutral to in gear engagement EPC

functions, sec.

- RTSTAL = Maximum SPD\_RATIO to do stall TV.

- SW\_STALTV = Software switch to do stall TV; 0 -> do normal TV, 1 ->

always use stall TV.

- TCEPC = Time constant for TV\_PRES\_BAR, sec.

- TM\_ASILT = Time for each step in anti-silting cycle.

- TM46BLP = Time after a forward to reverse engagement to use FN46B for TV

engagement pressure, sec.

- TM54BLP = Time after a neutral to forward engagement to use FN54B for TV

engagement pressure, sec.

- TM56BLP = Time after a neutral to reverse engagement to use FN56B for TV

engagement pressure, sec.

- TM64BLP = Time after a reverse to drive engagement to use FN64B for TV

engagement pressure, sec.

- TMDRVREV = Time to complete a forward to reverse engagement, sec.

- TMENGACT = Time to complete an engagement.

- TMNEUDRV = Time to complete a neutral to forward engagement, sec.

- TMNEUREV = Time to complete a neutral to reverse engagement, sec.

- TMREVDRV = Time to complete a revolution to forward engagement, sec.

- TVFMMN = Minimum TV clip when VS or PRNDL sensor has failed, psi.

- TVPMIN\_1 = Minimum TV pressure clip when GR\_DS\_TV = 1, psi.

- TVPMIN\_2 = Minimum TV pressure clip when GR\_DS\_TV = 2, psi.

- TVPMIN\_3 = Minimum TV pressure clip when GR\_DS\_TV = 3, psi.

- TVPMIN\_4 = Minimum TV pressure clip when GR\_DS\_TV = 4, psi.

- TVPMIN\_ENG = Minimum TV pressure clip during engagment, psi.

- TVPMINPT\_1 = Minimum TV pressure clip when PT and GR\_DS\_TV = 1, psi.

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ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - CDAN2

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- TVPMINPT\_2 = Minimum TV pressure clip when PT and GR\_DS\_TV = 2, psi.

- TVPMINPT\_3 = Minimum TV pressure clip when PT and GR\_DS\_TV = 3, psi.

- TVPMINPT\_4 = Minimum TV pressure clip when PT and GR\_DS\_TV = 4, psi.

- TVPMINPT\_ENG = Minimum TV pressure clip when PT during engagment, psi.

- TVPMINST\_1 = Minimum non-shifting TV\_PRES, GR\_DS\_TV -> 1.

- TVPMINST\_2 = Minimum non-shifting TV\_PRES, GR\_DS\_TV -> 2.

- TVPMINST\_3 = Minimum non-shifting TV\_PRES, GR\_DS\_TV -> 3.

- TVPMINST\_4 = Minimum non-shifting TV\_PRES, GR\_DS\_TV -> 4.

- TV\_ASILT1 = TV for stage one of anti-silting strategy.

- TV\_ASILT2 = TV for stage two of anti-silting strategy.

- TV\_ASILT3 = TV for stage three of anti-silting strategy.

- VSSTAL = Maximum vehicle speed to do stall TV, mph.

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PROCESS

STRATEGY MODULE: EPC\_GUIDE\_COM17

N > N\_RUN -------------------|

|AND -|

PDL <= 4 --------------------| |

(in fwd) |OR --| FLG\_FRST\_TV = 1

| | (Stop charging TV circuit

N > N\_RUN -------------------| | | after the 1st engagement)

|AND -|

PDL = 6 ---------------------|

(in rev)

always ----------------------------------| FLG\_ENG\_LS = FLG\_ENG\_IN

ENGAGEMENT FLAGS/TIMERS

PDL = 5 ---------------------|

(in neutral) |OR --|

| |

PDL = 7 ---------------------| |AND -| NEU\_RES\_TMR = NEUTIM

(in park) | | (load neutral timer)

| | DRV2NEU\_FLG = 1

PDL\_LST <= 4 ----------------------| | REV2NEU\_FLG = 0

(fwd last pass) | (indicate fwd prior to neu)

|

| --- ELSE ---

PDL = 5 ---------------------| |

(in neutral) |OR --| |

| | |

PDL = 7 ---------------------| |AND -| NEU\_RES\_TMR = NEUTIM

(in park) | | (load neutral timer)

| | DRV2NEU\_FLG = 0

PDL\_LST = 6 -----------------------| | REV2NEU\_FLG = 1

(rev last pass) | (indicate rev prior to neu)

|

| --- ELSE ---

|

| NO ACTION

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PDL = 6 ---------------------------|

(in rev) |

|

PDL\_LST = 5 -----------------| |

(neu last pass) |OR --| | (neutral to reverse)

| |AND -| NE\_ENG\_STRT = NEBART

PDL\_LST = 7 -----------------| | | EPC\_ENG\_TMR = TMNEUREV +

(park last pass) | | TM56BLP

| | EPC\_BLP\_TMR = TM56BLP

| | EIP\_TMR = TMENGACT

NEU\_RES\_TMR = 0 -------------| | | FLG\_DRV\_REV = 0

(in neu long enough) |OR --| | FLG\_NEU\_DRV = 0

| | FLG\_NEU\_REV = 1

DRV2NEU\_FLG = 0 -------------| | FLG\_REV\_DRV = 0

(not fwd prior to neu) |

| --- ELSE ---

|

PDL = 6 ---------------------------| | (drive to reverse)

(in rev) |AND -| NE\_ENG\_STRT = NEBART

| | EPC\_ENG\_TMR = TMDRVREV +

PDL\_LST <> 6 ----------------------| | TM46BLP

(fwd to rev or | EPC\_BLP\_TMR = TM46BLP

fwd to neu to rev with | EIP\_TMR = TMENGACT

short time in neu) | FLG\_DRV\_REV = 1

| FLG\_NEU\_DRV = 0

| FLG\_NEU\_REV = 0

| FLG\_REV\_DRV = 0

|

| --- ELSE ---

PDL <= 4 --------------------------| |

(in fwd) | |

| |

PDL\_LST = 5 -----------------| | |

(neu last pass) |OR --| | (neutral to drive)

| |AND -| NE\_ENG\_STRT = NEBART

PDL\_LST = 7 -----------------| | | EPC\_ENG\_TMR = TMNEUDRV +

(park last pass) | | TM54BLP

| | EPC\_BLP\_TMR = TM54BLP

| | EIP\_TMR = TMENGACT

NEU\_RES\_TMR = 0 -------------| | | FLG\_DRV\_REV = 0

(in neu long enough) |OR --| | FLG\_NEU\_DRV = 1

| | FLG\_NEU\_REV = 0

REV2NEU\_FLG = 0 -------------| | FLG\_REV\_DRV = 0

(not rev prior to neu) |

| --- ELSE ---

|

PDL <= 4 --------------------------| | (reverse to drive)

(in fwd) |AND -| NE\_ENG\_STRT = NEBART

| | EPC\_ENG\_TMR = TMREVDRV +

PDL\_LST > 4 -----------------------| | TM64BLP

(rev to fwd or | EPC\_BLP\_TMR = TM64BLP

rev to neu to fwd | EIP\_TMR = TMENGACT

with short time in neu) | FLG\_DRV\_REV = 0

| FLG\_NEU\_DRV = 0

| FLG\_NEU\_REV = 0

| FLG\_REV\_DRV = 1

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ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - CDAN2

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EPC\_ENG\_TMR > 0 -------------------------| FLG\_ENG\_IN = 1

| (engagement in progress)

|

| --- ELSE ---

|

| FLG\_ENG\_IN = 0

| (no engagement in progress)

FLG\_ENG\_IN = 1 --------------------|

(engagement in progress) |

|

FLG\_DRV\_REV = 1 -------------| |

(fwd to rev) | |

| |AND -| FLG\_FWD\_REV = 1

FLG\_REV\_DRV = 1 -------------| | | DRV2NEU\_FLG = 0

(rev to fwd) | | | REV2NEU\_FLG = 0

| | | (set direction change flag

FLG\_NEU\_REV = 1 -------| |OR --| | and clear "prior to neutral"

(neu to rev) |AND -| | flags)

| | |

DRV2NEU\_FLG = 1 -------| | |

(fwd prior to neu) | |

| |

FLG\_NEU\_DRV = 1 -------| | |

(neu to fwd) |AND -| |

| |

REV2NEU\_FLG = 1 -------| |

(rev prior to neu) |

| --- ELSE ---

|

FLG\_ENG\_IN = 0 --------------------------| FLG\_FWD\_REV = 0

(no engagement in progress) | (clear direction change flag)

|

| --- ELSE ---

|

| NO ACTION

always ----------------------------------| Do: EPC\_ASILT\_COM1

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FLG\_FWD\_REV = 1 -------------------|

(direction change) |

|

PDL >= 5 -------------------------|OR --| FLG\_ENG\_TV = 1

(not in forward gear) | | (perform engagement/stall TV)

| |

GR\_DS\_TV = GR\_CM ------------| | |

(no verify in progress) |AND -| |

| |

FLG\_ENG\_IN = 1 --------------| |

(engagement in progress) |

| --- ELSE ---

GR\_DS\_TV <> GR\_CM -----------------| |

(desired shift being verified) | |

| |

FLG\_FRST\_DS = 1 -------------------|OR --| FLG\_ENG\_TV = 0

(shift is desired) | | (Stop doing engagement/stall

| | TV; forward engagement is over

PDL <= 4 --------------------| | | and trans is warm or a shift

(forward gear) |AND -| | is pending)

| |

FLG\_TVENG\_MD = 0 ------------| |

(transmission warm) |

| --- ELSE ---

|

| NO ACTION

27-10

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - CDAN2

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PDL = 5 ---------------------------|

(neutral) |OR --| Do: "START-UP TV" LOGIC

| |

PDL = 7 ---------------------------| | flg\_eng\_stall = 1

(park) |

| --- ELSE ---

SW\_STALTV = 1 ---------------------| |

(forced stall TV) | |

| |

FLG\_ENG\_TV = 1 --------------------| |

(1st engagement) | |

|OR --| Do: "ENGAGEMENT/STALL TV" LOGIC

SPD\_RATIO <= RTSTAL ---------| | |

(low speed ratio) | | | flg\_eng\_stall = 1

| | |

VSBART\_RT <= VSSTAL ---------|AND -| |

(low vehicle speed) | |

| |

FLG\_SFT\_IN = 0 --------------| |

(no shift in progress) |

| --- ELSE ---

|

| Do: "NORMAL TV CALCULATION"

|

| flg\_eng\_stall = 0

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ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - CDAN2

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FLG\_SFT\_IN = 0 --------------|

|AND -|

GR\_DS\_TV = GR\_CM ------------| |

|OR --| NO ACTION

FLG\_PWR = 0 -----------------| | | (do not adjust TV\_PRES for

|AND -| | transmission oil temperature

flg\_eng\_stall = 0 -----------| | unless shifting)

|

| --- ELSE ---

|

GR\_DS\_TV = 1 ----------------------------| TV\_PRES = TV\_PRES \* FN21T(TOT)

|

| --- ELSE ---

GR\_DS\_TV = 2 ----------------------| |

|AND -| TV\_PRES = TV\_PRES \* FN12T(TOT)

FLG\_SFT\_UP = 1 --------------------| |

| --- ELSE ---

|

GR\_DS\_TV = 2 ----------------------------| TV\_PRES = TV\_PRES \* FN32T(TOT)

|

| --- ELSE ---

GR\_DS\_TV = 3 ----------------------| |

|AND -| TV\_PRES = TV\_PRES \* FN23T(TOT)

FLG\_SFT\_UP = 1 --------------------| |

| --- ELSE ---

|

GR\_DS\_TV = 3 ----------------------------| TV\_PRES = TV\_PRES \* FN43T(TOT)

|

| --- ELSE ---

|

GR\_DS\_TV = 4 ----------------------------| TV\_PRES = TV\_PRES \* FN34T(TOT)

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ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - CDAN2

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flg\_eng\_stall = 1 -----------------------| temp\_tvpminpt = TVPMINPT\_ENG

| temp\_tvpmin = TVPMIN\_ENG

|

| --- ELSE ---

|

GR\_DS\_TV = 1 ----------------------------| temp\_tvpminpt = TVPMINPT\_1

| temp\_tvpmin = TVPMIN\_1

| temp\_tvpminst = TVPMINST\_1

|

| --- ELSE ---

|

GR\_DS\_TV = 2 ----------------------------| temp\_tvpminpt = TVPMINPT\_2

| temp\_tvpmin = TVPMIN\_2

| temp\_tvpminst = TVPMINST\_2

|

| --- ELSE ---

|

GR\_DS\_TV = 3 ----------------------------| temp\_tvpminpt = TVPMINPT\_3

| temp\_tvpmin = TVPMIN\_3

| temp\_tvpminst = TVPMINST\_3

|

| --- ELSE ---

|

| temp\_tvpminpt = TVPMINPT\_4

| temp\_tvpmin = TVPMIN\_4

| temp\_tvpminst = TVPMINST\_4

FLG\_SFT\_IN = 1 --------------|

|

FLG\_VE\_DSGR = 1 -------------|

|OR --|

FLG\_DE\_CMGR = 1 -------------| |

| |AND -| TV\_PRES =

flg\_eng\_stall = 1 -----------| | | max(TV\_PRES,temp\_tvpminpt)

| |

FLG\_PWR = 1 -----------------------| |

| --- ELSE ---

FLG\_SFT\_IN = 1 --------------| |

| |

FLG\_VE\_DSGR = 1 -------------|OR --| |

| | |

FLG\_DE\_CMGR = 1 -------------| |AND -| TV\_PRES =

| | max(TV\_PRES, temp\_tvpmin)

FLG\_PWR = 0 -----------------------| |

| --- ELSE ---

flg\_eng\_stall = 1 -----------------| |

|AND -| TV\_PRES =

FLG\_PWR = 0 -----------------------| | max(TV\_PRES, temp\_tvpmin)

|

| --- ELSE ---

|

| TV\_PRES =

| max(TV\_PRES, temp\_tvpminst)

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ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - CDAN2

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TFMFLG = 1 ------------------------|

(TP failed) |

|

MFMFLG = 1 ------------------------|AND -| TV\_PRES = EPCFMRV

(MAP failed) | |

| |

PDL = 6 ---------------------------| |

(PRNDL in Reverse) |

| --- ELSE ---

TFMFLG = 1 ------------------| |

(TP failed) |AND -| |

| | |

MFMFLG = 1 ------------------| |OR --| TV\_PRES = 127.5 (Maximum)

(MAP failed) | |

| |

ETV\_TEST = 1 ----------------------| |

| --- ELSE ---

OSFMFLG = 1 -----------------------| |

(output shaft speed sensor | |

failed) | |

| |

P0721MALF = 1 ---------------------| |

;Noisy OSS malfunction detected | |

| |

SFT\_FM\_FLG = 1 --------------------| |

(shift error detected) |OR --| TV\_PRES = max(TV\_PRES,TVFMMN)

|

PDL\_ERROR = 1 ---------------------|

(MLPS failed) |

|

CC\_FM\_FLG = 1 ---------------------|

(Converter Clutch error detected) |

|

OTEMP\_FM\_FLG = 1 ------------------|

(Transmission overtemperature)

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ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - CDAN2

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FLG\_ASILT = 0 -------------| tv\_pres\_bar = TV\_PRES\_BAR

| tv\_pres\_bar = rolav(TV\_PRES,TCEPC)

| TV\_PRES\_BAR = tv\_pres\_bar

|

| --- ELSE ---

|

TMR\_ASILT < TM\_ASILT ------| TV\_PRES = TV\_ASILT1

| TV\_PRES\_BAR = TV\_ASILT1

|

| --- ELSE ---

|

TMR\_ASILT < 2 \* TM\_ASILT --| TV\_PRES = TV\_ASILT2

| TV\_PRES\_BAR = TV\_ASILT2

|

| --- ELSE ---

|

TMR\_ASILT < 3 \* TM\_ASILT --| TV\_PRES = TV\_ASILT3

| TV\_PRES\_BAR = TV\_ASILT3

|

| --- ELSE ---

|

TMR\_ASILT < 4 \* TM\_ASILT --| TV\_PRES = TV\_ASILT2

| TV\_PRES\_BAR = TV\_ASILT2

|

| --- ELSE ---

|

| TV\_PRES = TV\_ASILT1

| TV\_PRES\_BAR = TV\_ASILT1

always --------------------| Do: substitute(16,TV\_PRES\_BAR)

| (output state control override)

always --------------------| Do: "EPC VFS CONTROL AND SELF

| TEST" MODULE.

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ELECTRONIC PRESSURE CONTROL, START-UP TV LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

27.2 START-UP TV LOGIC (CDAA0)

OVERVIEW

Start up TV is used to charge the TV system during cold ambient conditions.

DEFINITIONS

INPUTS

Registers:

- RATCH = Closed throttle position, counts.

- TP = Throttle position sensor.

- TP\_REL = Relative TP = TP - RATCH, counts.

Bit Flags:

- FLG\_FRST\_TV = Start-up TV pressure flag: 0 -> do start-up TV logic; 1 ->

do not do start-up TV logic.

- FLG\_TVSTR\_CD = Flag which indicates cold temperature for start-up TV: 0

-> Don't use TVCHRG in start-up TV; 1 -> Use TVCHRG in start-up TV.

Calibration Constants:

- TVCHRG = TV charge pressure for first start-up.

OUTPUTS

Registers:

- FN616F(TP\_REL) = Stall TV pressure for forward.

- TV\_PRES = TV pressure.

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ELECTRONIC PRESSURE CONTROL, START-UP TV LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: TV\_STARTUP\_COM5

FLG\_TVSTR\_CD = 1 -|

(cold engine) |AND -| TV\_PRES = TVCHRG

| | (charge TV circuit, first start-up only)

FLG\_FRST\_TV = 0 --| |

(first start-up) | --- ELSE ---

|

| TV\_PRES = FN616F(TP\_REL)

27-17

ELECTRONIC PRESSURE CONTROL, ENGAGEMENT/STALL TV LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

27.3 ENGAGEMENT/STALL TV LOGIC (CDAA0)

OVERVIEW

Engagement/stall TV provides the greater of engagement TV or stall TV unless

a drive/reverse engagement is taking place. The engagement logic takes the

place of an engagement accumulator. Note that engagement TV is generally

lower than stall TV at closed throttle.

DEFINITIONS

INPUTS

Registers:

- NEBART = Filtered engine RPM for transmission, rpm.

- PDL = Current PRNDL position.

- TP = Instantaneous throttle position, counts.

- TP\_REL = Relative throttle position, counts.

- TPBARTV = Filtered TP for TV strategy. This filtered throttle position

is calculated using the ROLAV subroutine, but with a different time

constant then the values used in the TPBART and TPBARTC calculation.

TPBARTV is used in the TV routine to determine a tip-in condition.

During a tip-in condition in the TV routine, extra TV is added.

- TV\_PRES = TV pressure.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission,

mph.

Bit Flags:

- FLG\_ENG\_IN = Engagement in progress flag.

- FLG\_ENG\_TV = Engagement TV pressure flag; 0 -> do engagement logic, 1 ->

do not do engagement logic.

- FLG\_FWD\_REV = Rock cycling engagment in progress flag.

- FLG\_TVENG\_CD = Flag which indicates cold temperature for engagement TV; 0

-> Don't use TVEMAX in engagement TV, 1 -> Use TVEMAX in engagement TV.

- FLG\_TVENG\_MD = Flag which indicates moderate temperature for engagement

TV; 0 -> Don't use TVEMOD in engagement TV, 1 -> Use TVEMAX in engagement

TV.

Calibration Constants:

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ELECTRONIC PRESSURE CONTROL, ENGAGEMENT/STALL TV LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FN616\_SW = Switch to select FN616 usage during engagements.

- FN616F(TP\_REL) = Stall EPC for forward.

- FN616R = Stall EPC for reverse.

- NETVMN = Minimum RPM to use TVEMOD engagement TV.

- NETVMX = Minimum RPM to use TVEMAX engagement TV.

- REV\_ENG\_ADD = Reverse Engagement Adder.

- SW\_STALTV = Software switch to do stall TV; 0 -> do normal TV, 1 ->

always use stall TV.

- TOTVTP = Tip-out TP change to hold stall TV.

- TPTVMN = Minimum TP\_REL to use TVEMOD engagement TV.

- TPTVMX = Minimum TP\_REL to use TVEMAX engagement TV.

- TVEMAX = TV for worst case engagement.

- TVEMOD = TV for moderate engagement.

- VSTVMN = Minimum vehicle speed to use TVEMOD engagement TV.

- VSTVMX = Minimum vehicle speed to use TVEMAX engagement TV.

OUTPUTS

Registers:

- TV\_PRES = TV pressure.

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ELECTRONIC PRESSURE CONTROL, ENGAGEMENT/STALL TV LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EPC\_ENGMT\_STALL\_COM6

ENGAGEMENT/STALL TV LOGIC

SW\_STALTV = 0 -------------------------|

(not forcing Stall EPC) |

|

FN616\_SW = 1 --------------------------|AND -| tempreg1 = 0

(FN616 selection switch) | | (do not consider FN616

| | during engagement)

FLG\_ENG\_IN = 1 ------------------------| |

(engagement in progress) | --- ELSE ---

|

PDL = 6 -------------------------------------| tempreg1 = FN616R(TP\_REL)

| (determine reverse stall

| TV)

|

| --- ELSE ---

|

| tempreg1 = FN616F(TP\_REL)

| (determine forward stall

| TV)

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ELECTRONIC PRESSURE CONTROL, ENGAGEMENT/STALL TV LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGAGEMENT/STALL TV LOGIC (continued)

VSBART\_RT >= VSTVMX -------------|

(high vehicle speed) |AND -|

| |

FLG\_FWD\_REV = 1 -----------------| |

(fwd/rev or rev/fwd) |

|OR --| tempreg2 = TVEMAX

FLG\_ENG\_TV = 1 ------------------| | | [ + REV\_ENG\_ADD]

(engagement situation) | | | (set maximum TV

| | | engagement pressure)

TP\_REL >= TPTVMX ----------| |AND -| |

(high TP) | | |

| | |

NEBART >= NETVMX ----------|OR --| |

(high engine speed) | |

| |

FLG\_TVENG\_CD = 1 ----------| |

(cold temperature) |

| --- ELSE ---

VSTVMN < VSBART\_RT < VSTVMX -----| |

(moderate vehicle speed) |AND -| |

| | |

FLG\_FWD\_REV = 1 -----------------| | |

(fwd/rev or rev/fwd) | |

|OR --| tempreg2 = TVEMOD

FLG\_ENG\_TV = 1 ------------------| | | [ + REV\_ENG\_ADD]

(engagement situation) | | | (set moderate TV

| | | engagement pressure)

TPTVMN < TP\_REL < TPTVMX --| |AND -| |

(moderate TP) | | |

| | |

NETVMN < NEBART < NETVMX --|OR --| |

(moderate engine speed) | |

| |

FLG\_TVENG\_MD = 1 ----------| |

(moderate temperature) |

| --- ELSE ---

|

| tempreg2 = 0

Note: "[ ]" indicates optional term in tempreg2 value when TVEMAX or TVEMIN

are selected.

27-21

ELECTRONIC PRESSURE CONTROL, ENGAGEMENT/STALL TV LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGAGEMENT/STALL TV LOGIC (continued)

The following logic controls REV\_ENG\_ADD usage:

PDL = 6 -------------------------------------| include REV\_ENG\_ADD in

| tempreg2 if using

| TVEMAX or TVEMOD

|

| --- ELSE ---

|

| do not include

| REV\_ENG\_ADD

tempreg2 > tempreg1 -------------------------| tempreg1 = tempreg2

| (choose the larger of the

| stall TV pressure or

| engagement TV pressure,

| put in tempreg1)

(TPBARTV - TP) >= TOTVTP --------------|

(high tip-out rate) |AND -| No change to TV\_PRES

| | (use last pass value to

TV\_PRES > tempreg1 --------------------| | hold TV pressure on tip-out)

(last pass value has enough capacity) |

| --- ELSE ---

|

| TV\_PRES = tempreg1

| (use the higher of stall

| TV or engagement TV)

27-22

ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

27.4 NORMAL TV CALCULATION (CDAN0)

OVERVIEW

Normal EPC computes the EPC pressure required to maintain static capacity

based on engine output torque (TQ\_NET). During a shfit, inertia torque

(TQ\_IALPHA) is added to the total torque. A seperate slope and intercept is

provided for calculating the static capacity during shifting and non-shifting

operation. Dynamic EPC is called from this module.

During shift verification, cold operation (FLG\_DYN\_CD = 1), and when the

vehicle is in 4X4L, the shifting static and dynamic EPC calculations are

performed as well as the non-sfhiting static calculation. The strategy then

chooses the higher of the two pressures (shifting vs. non-shifting).

An option is added to the shifting static calculation to hold or ramp static

capacity at the end of the ratio change during an upshift (when torque

modulation ends). Calibrating the EPC scalar to 0 (EPC\_ST\_12, EPC\_ST\_23, and

EPC\_ST\_34), the strategy will hold the last pass value of the shifting static

EPC until the EPC\_RMP\_TMR expires, or the shift ends. A non-zero value for

EPC\_RMP\_TM and EPC\_ST\_RMP is required for the ramp to initiate. The ramp can

be calibrated out by setting the EPC\_RMP\_TM values to zero (EPC\_RMP\_12,

EPC\_RMP\_23, and EPC\_RMP\_34).

During heavy tip-ins, an additional pressure is added to the static to

compenstate for system delays (AETV).

DEFINITIONS

INPUTS

Registers:

- EPC\_RMP\_TM = Time over which static capacity is ramped at the end of the

ratio change, seconds.

- EPC\_RMP\_TMR = Timer which control static EPC ramp, initiated at end of

the ratio change, seconds.

- EPC\_ST\_RMP = EPC value which sets the slope of the ramp (slope =

EPC\_ST\_RMP/ramp time), psi.

- GR\_CM = Current transmission gear.

- GR\_DS\_TV = Desired gear used to compute EPC pressure.

- NEBART = Filtered engine RPM for transmission.

- RATCH = Closed throttle position, counts.

- SPD\_RATIO = Speed ratio across the torque converter.

- TP = Throttle Position, counts.

27-23

ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TPBARTV = Filtered TP for TV strategy. TPBARTV is used in the TV routine

to determine a tip-in condition. During a tip-in condition in the TV

routine, extra TV is added.

- TP\_REL = Relative Throttle Position, TP - RATCH.

- TP\_STRT\_SFT = TP\_REL at the start of a shift, counts.

- TQ\_IALPHA = I-ALPHA torque due to ratio change.

- TQ\_NET = Net torque into torque converter.

- TQ\_STAT\_CP = Static Capacity Torque of transmission.

- TR\_STRT\_SFT = Torque ratio at the start of a shift.

- TV\_DYN = TV pressure required for dynamic shift control.

- TV\_PRES = TV pressure.

- TV\_STAT = TV pressure required for static capacity.

- TV\_ST\_LST = Last pass value of TV\_ST\_SFT, psi.

- TV\_ST\_SFT = Static TV pressure while shifting.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission,

MPH.

27-24

ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- FLG\_4X4L = 4X4L flag: 0 -> not in 4X4 L; 1 -> in 4X4 L.

- FLG\_DYN\_CD = Flag which indicates that it is necessary to add dynamic TV

due to cold transmission conditions.

- FLG\_EPC\_RMP = Indicates end of ratio change, begin ramping static

capacity.

- FLG\_FRST\_CM = Flag indicating a shift was commanded this background loop.

- FLG\_SPK\_TQM = Torque modulation spark retard flag. 1 -> toruqe

modulation is in progress.

Calibration Constants:

- AETV = Anticipatory TV adder for heavy tip-ins.

- AETVTP = Minimum throttle change to include AETV in TV\_STAT.

- EPC\_RMP\_12 = Time over which to ramp static EPC at the end of the ratio

change for a 1-2 upshift, seconds.

- EPC\_RMP\_23 = Time over which to ramp static EPC at the end of the ratio

change for a 2-3 upshift, seconds.

- EPC\_RMP\_34 = Time over which to ramp static EPC at the end of the ratio

change for a 3-4 upshift, seconds.

- EPC\_ST\_12 = EPC value which sets the slope of the static EPC ramp for a

1-2 upshift (slope = EPC\_ST\_12/ramp time), seconds.

- EPC\_ST\_23 = EPC value which sets the slope of the static EPC ramp for a

2-3 upshift (slope = EPC\_ST\_23/ramp time), seconds.

- EPC\_ST\_34 = EPC value which sets the slope of the static EPC ramp for a

3-4 upshift (slope = EPC\_ST\_34/ramp time), seconds.

- FN617(SPD\_RATIO) = Torque converter torque ratio.

- SCINT1 = Static capacity TV intercept, first gear.

- SCINT2 = Static capacity TV intercept, second gear.

- SCINT3 = Static capacity TV intercept, third gear.

- SCINT4 = Static capacity TV intercept, fourth gear.

- SCSLP1 = Static capacity TV slope, first gear.

- SCSLP1SD = Static capacity TV slope, downshift to first gear.

- SCSLP2 = Static capacity TV slope, second gear.

- SCSLP2SD = Static capacity TV slope, downshift to second gear.

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ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SCSLP2SU = Static capacity TV slope, upshift to second gear.

- SCSLP3 = Static capacity TV slope, third gear.

- SCSLP3SD = Static capacity TV slope, downshift to third gear.

- SCSLP3SU = Static capacity TV slope, upshift to third gear.

- SCSLP4 = Static capacity TV slope, fourth gear.

- SCSLP4SU = Static capacity TV slope, upshift to fourth gear.

OUTPUTS

Registers:

- EPC\_RMP\_TM = See above.

- EPC\_RMP\_TMR = See above.

- EPC\_ST\_RMP = See above.

- NE\_STRT\_SFT = Engine RPM at strat of shift.

- TQ\_STAT\_CP = See above.

- TP\_STRT\_SFT = See above.

- TV\_DYN = See above.

- TV\_PRES = See above.

- VS\_STRT\_SFT = Filtered vehicle speed at start of shift, MPH.

Bit Flags:

- FLG\_EPC\_RMP = See above.

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ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EPC\_NORM\_COM1

BEGIN: MAIN

FLG\_FRST\_CM = 1 ---------------------| NE\_STRT\_SFT = NEBART

(start of shift) | VS\_STRT\_SFT = VSBART\_RT

| TR\_STRT\_SFT = FN617(SPD\_RATIO)

| TP\_STRT\_SFT = TP\_REL

| (capture engine speed, torque

| ratio and throttle position at

| start of shift)

| DO "TQ\_IALPHA CALCULATION"

Now calculate the minimum static capacity.

FLG\_SFT\_IN = 1 ----------------------| TQ\_STAT\_CP = (TQ\_NET + TQ\_IALPHA) \*

(shift in progress, | TR\_STRT\_SFT

use IALPHA term) | (calculate static torque capacity

| required)

|

| --- ELSE ---

|

FLG\_SFT\_IN = 0 ----------------------| TQ\_IALPHA = 0

(shift done, use steady torque | TQ\_STAT\_CP = TQ\_NET \* FN617(SPD\_RATIO)

requirement) | (calculate steady state input torque

| through torque converter ratio)

Calculate steady state pressure for current gear.

FLG\_SFT\_IN = 0 ----------------------| DO "NON-SHIFTING STATIC TV

| CALCULATION"

27-27

ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calculate pressure for shift using shifting slopes and Dynamic TV.

FLG\_SFT\_IN = 1 ----------------|

|

GR\_DS\_TV <> GR\_CM -------------|OR --| DO "SHIFTING STATIC TV CALCULATION"

| | DO "DYNAMIC TV CALCULATION"

FLG\_DYN\_CD = 1 ----------------|

|

FLG\_4X4L = 1 ------------------|

Select proper value for TV\_PRES.

FLG\_SFT\_IN = 0 ----------------|

|

GR\_DS\_TV = GR\_CM --| |AND -| TV\_PRES = TV\_STAT

| | |

FLG\_4X4L = 0 ------|AND -| | |

| | | |

FLG\_DYN\_CD = 0 ----| |OR --| |

| |

TV\_STAT > TV\_ST\_SFT | |

+ TV\_DYN -----| |

| --- ELSE ---

|

| TV\_PRES = TV\_ST\_SFT + TV\_DYN

| (Clip TV\_PRES to zero minimum)

Now add anticipatory TV value for a tip-in.

FLG\_SFT\_IN = 0 ----------------|

|AND -| TV\_PRES = TV\_PRES + AETV

(TP - TPBARTV) >= AETVTP ------| | (adjust TV pressure for heavy

| tip-in to compensate for all

| system delays)

END: MAIN

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ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: NON-SHIFTING STATIC TV CALCULATION

GR\_CM = 1 ---------------------------| TV\_STAT = (TQ\_STAT\_CP \* SCSLP1) +

| SCINT1

|

| --- ELSE ---

|

GR\_CM = 2 ---------------------------| TV\_STAT = (TQ\_STAT\_CP \* SCSLP2) +

| SCINT2

|

| --- ELSE ---

|

GR\_CM = 3 ---------------------------| TV\_STAT = (TQ\_STAT\_CP \* SCSLP3) +

| SCINT3

|

| --- ELSE ---

|

| TV\_STAT = (TQ\_STAT\_CP \* SCSLP4) +

| SCINT4

END: NON-SHIFTING STATIC TV CALCULATION

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ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: SHIFTING STATIC TV CALCULATION

FLG\_SPK\_TQM = 1 ---------------------| TV\_ST\_LST = TV\_ST\_SFT

| ;store last pass value of

| ;TV\_ST\_SFT during torque

| ;modulation

GR\_DS\_TV = 1 ------------------------| TV\_ST\_SFT = (TQ\_STAT\_CP \* SCSLP1SD) +

| SCINT1

| EPC\_RMP\_TM = 0

| EPC\_ST\_RMP = 0

|

| --- ELSE ---

GR\_DS\_TV = 2 ------------------| |

|AND -| TV\_ST\_SFT = (TQ\_STAT\_CP \* SCSLP2SU) +

FLG\_SFT\_UP = 1 ----------------| | SCINT2

| EPC\_RMP\_TM = EPC\_RMP\_12

| EPC\_ST\_RMP = EPC\_ST\_12

|

| --- ELSE ---

|

GR\_DS\_TV = 2 ------------------------| TV\_ST\_SFT = (TQ\_STAT\_CP \* SCSLP2SD) +

| SCINT2

| EPC\_RMP\_TM = 0

| EPC\_ST\_RMP = 0

|

| --- ELSE ---

GR\_DS\_TV = 3 ------------------| |

|AND -| TV\_ST\_SFT = (TQ\_STAT\_CP \* SCSLP3SU) +

FLG\_SFT\_UP = 1 ----------------| | SCINT3

| EPC\_RMP\_TM = EPC\_RMP\_23

| EPC\_ST\_RMP = EPC\_ST\_23

|

| --- ELSE ---

|

GR\_DS\_TV = 3 ------------------------| TV\_ST\_SFT = (TQ\_STAT\_CP \* SCSLP3SD) +

| SCINT3

| EPC\_RMP\_TM = 0

| EPC\_ST\_RMP = 0

|

| --- ELSE ---

|

| TV\_ST\_SFT = (TQ\_STAT\_CP \* SCSLP4SU) +

| SCINT4

| EPC\_RMP\_TM = EPC\_RMP\_34

| EPC\_ST\_RMP = EPC\_ST\_34

27-30

ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_FRST\_CM = 1 ---------------------| EPC\_RMP\_TMR = 0

| ;insure ramp is

| ;zeroed out

|

| --- ELSE ---

|

FLG\_EPC\_RMP = 1 ---------------------| EPC\_RMP\_TMR = EPC\_RMP\_TM

| ;initalize timer for

| ;ramping static capacity

| FLG\_EPC\_RMP = 0

EPC\_RMP\_TM = 0 ----------------|

|OR --| NO Action

EPC\_RMP\_TMR = 0 ---------------| | ;Allow TV\_ST\_SFT to pass

| ;through

|

| --- ELSE ---

|

EPC\_RMP\_TMR > 0 ---------------------| tv\_st\_tmp = TV\_ST\_LST +

| EPC\_ST\_RMP (1 - (EPC\_RMP\_TMR/

| EPC\_RMP\_TM))

| TV\_ST\_SFT = min(tv\_st\_tmp,

| TV\_ST\_SFT)

| ;clip value to TV\_ST\_SFT

END: SHIFTING STATIC TV CALCULATION

27-31

ELECTRONIC PRESSURE CONTROL, TQ\_IALPHA CALCULATION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

27.5 TQ\_IALPHA CALCULATION (CDAA0)

OVERVIEW

The I-ALPHA torque calculation determines the torque that results from a

transmission upshift or downshift.

DEFINITIONS

INPUTS

Registers:

- GEAR\_CUR = Current transmission gear.

- GEAR\_OLD = Last commanded gear.

- NE\_STRT\_SFT = Engine RPM at start of a shift.

- RT\_GR\_CUR = Current transmission gear ratio.

- RT\_GR\_OLD = Last gear transmission gear ratio.

Calibration Constants:

- TQIA12 = I-ALPHA torque constant for 1 - 2.

- TQIA21 = I-ALPHA torque constant for 2 - 1.

- TQIA23 = I-ALPHA torque constant for 2 - 3.

- TQIA32 = I-ALPHA torque constant for 3 - 2.

- TQIA34 = I-ALPHA torque constant for 3 - 4.

- TQIA43 = I-ALPHA torque constant for 4 - 3.

OUTPUTS

Registers:

- TQ\_IALPHA = I-ALPHA torque due to ratio change.

27-32

ELECTRONIC PRESSURE CONTROL, TQ\_IALPHA CALCULATION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EPC\_TQ\_IALPHA\_COM4

GEAR\_CUR = 2 --|

|AND --| TQ\_IALPHA = NE\_STRT\_SFT \* TQIA12 \*

GEAR\_OLD = 1 --| | [1 - (RT\_GR\_CUR/RT\_GR\_OLD)]

|

| --- ELSE ---

GEAR\_CUR = 1 --| |

|AND --| TQ\_IALPHA = NE\_STRT\_SFT \* TQIA21 \*

GEAR\_OLD > 1 --| | [1 - (RT\_GR\_CUR/RT\_GR\_OLD)]

|

| --- ELSE ---

GEAR\_CUR = 3 --| |

|AND --| TQ\_IALPHA = NE\_STRT\_SFT \* TQIA23 \*

GEAR\_OLD < 3 --| | [1 - (RT\_GR\_CUR/RT\_GR\_OLD)]

|

| --- ELSE ---

GEAR\_CUR = 2 --| |

|AND --| TQ\_IALPHA = NE\_STRT\_SFT \* TQIA32 \*

GEAR\_OLD > 2 --| | [1 - (RT\_GR\_CUR/RT\_GR\_OLD)]

|

| --- ELSE ---

GEAR\_CUR = 4 --| |

|AND --| TQ\_IALPHA = NE\_STRT\_SFT \* TQIA34 \*

GEAR\_OLD < 4 --| | [1 - (RT\_GR\_CUR/RT\_GR\_OLD)]

|

| --- ELSE ---

GEAR\_CUR = 3 --| |

|AND --| TQ\_IALPHA = NE\_STRT\_SFT \* TQIA43 \*

GEAR\_OLD = 4 --| | [1 - (RT\_GR\_CUR/RT\_GR\_OLD)]

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ELECTRONIC PRESSURE CONTROL, DYNAMIC EPC CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

27.6 DYNAMIC EPC CALCULATION (CDAM0)

OVERVIEW

Dynamic EPC calculates the EPC pressure required to obtain good shift feel.

DEFINITIONS

Registers:

- GEAR\_CUR = Current commanded gear.

- GR\_DS\_TV = Gear to be used for dynamic EPC calculation.

- PNWF = Performance and Normal Weighting Factor.

- TP\_REL = Relative throttle position, counts.

- TP\_STRT\_SFT = Throttle position at start of a shift, counts.

- TV\_DYN = EPC pressure required for dynamic shift control.

- TV\_RAMP = Stores added EPC value during upshifts.

- TV\_RAMP\_TMR = EPC ramp timer during upshifts.

- TVRMPTM = Stores EPC ramp timer for upshifts.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission,

mph.

- VS\_STRT\_SFT = Filtered vehicle speed at start of shift, MPH.

Bit Flags:

- FLG\_MAN42 = Identifies a Manual 4-2 pull-in.

- FLG\_AUT41 = Identifies a Automatic 4-1 pull-in.

- FLG\_AUT42 = Identifies a Automatic 4-2 pull-in.

- FLG\_FRST\_CM = First time a shift is commanded flag; 0 -> no.

- FLG\_PWR = 1 -> power on; 0 -> power off.

- FLG\_SFT\_DN = Downshift flag.

- FLG\_SFT\_IN = Shift in progress flag; 0 -> no shift in progress, 1 ->

shift in progress.

- FLG\_SFT\_UP = Upshift flag; 1 -> last/current shift is upshift.

- FLG\_SPK\_TQM = Torque Modulation spark retard flag.

27-34

ELECTRONIC PRESSURE CONTROL, DYNAMIC EPC CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_TRIG\_RMP = Triggers start of dynamic EPC ramps - set by Torque

Modulation strategy.

Calibration Constants:

- EPC\_MAN42 = Dynamic EPC adder for a Manual 4-2 pull-in, psi.

- EPC\_AUT41 = Dynamic EPC adder for a Automatic 4-1 pull-in, psi.

- EPC\_AUT423 = Dynamic EPC scalar adder for the 4-3 part of an Automatic

4-2 shift, psi.

- FN12DYTX\_VS = Dynamic EPC pressure for 1 - 2 shift, table of TP\_REL and

VSBART\_RT.

X = FNX12T(tempreg) = Normalizing function for TP\_REL.

Y = FNX12V(tempreg\_vs) = Normalizing function for VSBART\_RT.

- FN12DCP = Dynamic EPC pressure performance mode adjustment for a 1-2

shift.

- FN21DYTX\_VS = Dynamic EPC pressure for 2 - 1 shift.

X = FNX21T(tempreg) = Normalizing function for TP\_REL.

Y = FNX21V(tempreg\_vs) = Normalizing function for VSBART\_RT.

- FN21DCP = Dynamic EPC pressure performance mode adjustment for a 2-1

shift.

- FN23DCP = Dynamic EPC pressure performance mode adjustment for a 2-3

shift.

- FN23DYTX\_VS = Dynamic EPC pressure for 2 - 3 shift, table of TP\_REL and

VSBART\_RT.

X = FNX23T(tempreg) = Normalizing function for TP\_REL.

Y = FNX23V(tempreg\_vs) = Normalizing function for VSBART\_RT.

- FN32DYTX\_VS = Dynamic EPC pressure for 3 - 2 shift, table of TP\_REL and

VSBART\_RT.

X = FNX32T(tempreg) = Normalizing function for TP\_REL.

Y = FNX32V(tempreg\_vs) = Normalizing function for VSBART\_RT.

- FN32DCP = Dynamic EPC pressure performance mode adjustment for a 3-2

shift.

- FN34DCP = Dynamic EPC pressure performance mode adjustment for a 3-4

shift.

- FN34DYTX\_VS = Dynamic EPC pressure for 3 - 4 shift, table of TP\_REL and

VSBART\_RT.

X = FNX34T(tempreg) = Normalizing function for TP\_REL.

Y = FNX34V(tempreg\_vs) = Normalizing function for VSBART\_RT.

- FN422A\_EPC = Dynamic EPC adder for the 3-2 part of an Automatic 4-2

shift, psi. (function of VSBART\_RT).

- FN43DCP = Dynamic EPC pressure performance mode adjustment for a 4-3

shift.

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ELECTRONIC PRESSURE CONTROL, DYNAMIC EPC CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FN43DYTX\_VS = Dynamic EPC pressure for 4 - 3 shift, table of TP\_REL and

VSBART\_RT.

X = FNX43T(tempreg) = Normalizing function for TP\_REL.

Y = FNX43V(tempreg\_vs) = Normalizing function for VSBART\_RT.

- SW\_DYN = Software switch for dynamic EPC; 0 -> allow shift dynamics to

vary with TP, 1 -> use TP at start of shift for dynamic EPC.

- SW\_DYN\_VS = Software switch for dynamic EPC for 4-3 and 3-2 shifts; 0 ->

allow shift dynamics for vary with VS, 1 -> use VSBART\_RT at start of

shift for dynamic EPC.

- TMTVRMP\_12 = EPC ramp timer for 1-2 shift, sec.

- TMTVRMP\_23 = EPC ramp timer for 2-3 shift, sec.

- TMTVRMP\_34 = EPC ramp timer for 3-4 shift, sec.

- TVRMP\_12 = Added EPC during 1-2 shift.

- TVRMP\_23 = Added EPC during 2-3 shift.

- TVRMP\_34 = Added EPC during 3-4 shift.

- TV\_4L\_12 = 4x4l adder for 1 - 2 shift, psi.

- TV\_4L\_21 = 4x4l adder for 2 - 1 shift, psi.

- TV\_4L\_23 = 4x4l adder for 2 - 3 shift, psi.

- TV\_4L\_32 = 4x4l adder for 3 - 2 shift, psi.

- TV\_4L\_34 = 4x4l adder for 3 - 4 shift, psi.

- TV\_4L\_43 = 4x4l adder for 4 - 3 shift, psi.

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ELECTRONIC PRESSURE CONTROL, DYNAMIC EPC CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EPC\_DYNAMIC\_COM14

SW\_DYN = 1 -------|

|AND -| tempreg = TP\_STRT\_SFT

FLG\_SFT\_IN = 1 ---| | (do not allow shift dynamics to vary)

|

| --- ELSE ---

|

| tempreg = TP\_REL

| (allow shift dynamics to vary)

SW\_DYN\_VS = 1 ----|

|AND -| tempreg\_vs = VS\_STRT\_SFT

FLG\_SFT\_IN = 1 ---| | (do not allow shift dynamics to vary)

|

| --- ELSE ---

|

| tempreg\_vs = VSBART\_RT

| (allow shift dynamics to vary)

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ELECTRONIC PRESSURE CONTROL, DYNAMIC EPC CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

GR\_DS\_TV = 1 -----|

|AND -| TV\_DYN = FN21DYTX\_VS(tempreg, tempreg\_vs)

FLG\_AUT41 = 1 ----| | + EPC\_AUT41

| + [PNWF \* FN21DCP(TP\_REL)]

|

| --- ELSE ---

|

GR\_DS\_TV = 1 -----------| TV\_DYN = FN21DYTX\_VS(tempreg, tempreg\_vs) +

| [PNWF \* FN21DCP(TP\_REL)]

|

| --- ELSE ---

GR\_DS\_TV = 2 -----| |

| |

FLG\_MAN42 = 1 ----|AND -| TV\_DYN = FN32DYTX\_VS(tempreg, tempreg\_vs)

| | + EPC\_MAN42

FLG\_PWR = 1 ------| | + [PNWF \* FN32DCP(TP\_REL)]

|

| --- ELSE ---

GR\_DS\_TV = 2 -----| |

|AND -| TV\_DYN = FN12DYTX\_VS(tempreg, tempreg\_vs) +

FLG\_SFT\_UP = 1 ---| | [PNWF \* FN12DCP(TP\_REL)]

|

| --- ELSE ---

GR\_DS\_TV = 2 -----| |

|AND -| TV\_DYN = FN32DYTX\_VS(tempreg, tempreg\_vs)

FLG\_AUT41 = 1 ----| | + EPC\_AUT41

| + [PNWF \* FN32DCP(TP\_REL)]

|

| --- ELSE ---

GR\_DS\_TV = 2 -----| |

|AND -| TV\_DYN = FN32DYTX\_VS(tempreg, tempreg\_vs)

FLG\_AUT42 = 1 ----| | + FN422A\_EPC

| + [PNWF \* FN32DCP(TP\_REL)]

|

| --- ELSE ---

|

GR\_DS\_TV = 2 -----------| TV\_DYN = FN32DYTX\_VS(tempreg, tempreg\_vs) +

| [PNWF \* FN32DCP(TP\_REL)]

|

| --- ELSE ---

GR\_DS\_TV = 3 -----| |

| |

FLG\_MAN42 = 1 ----|AND -| TV\_DYN = FN43DYTX\_VS(tempreg, tempreg\_vs)

| | + EPC\_MAN42

FLG\_PWR = 1 ------| | + [PNWF \* FN43DCP(TP\_REL)]

|

| --- ELSE ---

GR\_DS\_TV = 3 -----| |

|AND -| TV\_DYN = FN23DYTX\_VS(tempreg, tempreg\_vs) +

FLG\_SFT\_UP = 1 ---| | [PNWF \* FN23DCP(TP\_REL)]

|

| --- ELSE ---

(continued on next page)

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ELECTRONIC PRESSURE CONTROL, DYNAMIC EPC CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

GR\_DS\_TV = 3 -----| |

|AND -| TV\_DYN = FN43DYTX\_VS(tempreg, tempreg\_vs)

FLG\_AUT41 = 1 ----| | + EPC\_AUT41

| + [PNWF \* FN43DCP(TP\_REL)]

|

| --- ELSE ---

GR\_DS\_TV = 3 -----| |

|AND -| TV\_DYN = FN43DYTX\_VS(tempreg, tempreg\_vs)

FLG\_AUT42 = 1 ----| | + EPC\_AUT423

| + [PNWF \* FN43DCP(TP\_REL)]

|

| --- ELSE ---

|

GR\_DS\_TV = 3 -----------| TV\_DYN = FN43DYTX\_VS(tempreg, tempreg\_vs) +

| [PNWF \* FN43DCP(TP\_REL)]

|

| --- ELSE ---

|

GR\_DS\_TV = 4 -----------| TV\_DYN = FN34DYTX\_VS(tempreg, tempreg\_vs) +

| [PNWF \* FN34DCP(TP\_REL)]

|

| --- ELSE ---

|

| TV\_DYN = 0

FLG\_FRST\_CM = 1 --------| TVRMPTM = 1

| TV\_RAMP\_TMR = 1

| TV\_RAMP = 0

| (reset TV\_RAMP value)

| FLG\_TRIG\_RMP = 1

| (trigger EPC ramps)

FLG\_TRIG\_RMP = 1 -|

|

FLG\_SFT\_UP = 1 ---|AND -| TVRMPTM = TMTVRMP\_12

| | TV\_RAMP\_TMR = TMTVRMP\_12

GR\_DS\_TV = 2 -----| | TV\_RAMP = TVRMP\_12

| | FLG\_TRIG\_RMP = 0

FLG\_SPK\_TQM = 1 --| |

|

|

| --- ELSE ---

FLG\_TRIG\_RMP = 1 -| |

| |

FLG\_SFT\_UP = 1 ---|AND -| TVRMPTM = TMTVRMP\_23

| | TV\_RAMP\_TMR = TMTVRMP\_23

GR\_DS\_TV = 3 -----| | TV\_RAMP = TVRMP\_23

| | FLG\_TRIG\_RMP = 0

FLG\_SPK\_TQM = 1 --| |

|

|

| --- ELSE ---

(continued on next page)

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ELECTRONIC PRESSURE CONTROL, DYNAMIC EPC CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

FLG\_TRIG\_RMP = 1 -| |

| |

FLG\_SFT\_UP = 1 ---|AND -| TVRMPTM = TMTVRMP\_34

| | TV\_RAMP\_TMR = TMTVRMP\_34

GR\_DS\_TV = 4 -----| | TV\_RAMP = TVRMP\_34

| | FLG\_TRIG\_RMP = 0

FLG\_SPK\_TQM = 1 --| |

FLG\_SFT\_IN = 1 ---------| TV\_DYN = TV\_DYN + TV\_RAMP \*

| [(TVRMPTM - TV\_RAMP\_TMR) / TVRMPTM]

|

| --- ELSE ---

|

| No action

Compensate for 4X4L operation:

FLG\_4X4L = 0 ------------------------------| No Action

|

| --- ELSE ---

|

GEAR\_CUR = 1 ------------------------------| TV\_DYN = TV\_DYN + TV\_4L\_21

|

| --- ELSE ---

GEAR\_CUR = 2 ------------------| |

|AND -------| TV\_DYN = TV\_DYN + TV\_4L\_12

FLG\_SFT\_UP = 1 ----------------| |

| --- ELSE ---

|

GEAR\_CUR = 2 ------------------------------| TV\_DYN = TV\_DYN + TV\_4L\_32

|

| --- ELSE ---

GEAR\_CUR = 3 ------------------| |

|AND -------| TV\_DYN = TV\_DYN + TV\_4L\_23

FLG\_SFT\_UP = 1 ----------------| |

| --- ELSE ---

|

GEAR\_CUR = 3 ------------------------------| TV\_DYN = TV\_DYN + TV\_4L\_43

|

| --- ELSE ---

|

always ------------------------------------| TV\_DYN = TV\_DYN + TV\_4L\_34

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ELECTRONIC PRESSURE CONTROL, EPC CURRENT MONITOR - CDAN2

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27.7 EPC VFS CONTROL AND SELF TEST (CDAG0)

OVERVIEW

The Electronic Pressure Control (EPC) Variable Force Solenoid (VFS) is a

current control device with a 0 to 1 amp control range. One amp produces the

lowest line pressure (handles idle torque capacity). Current to the VFS is

controlled by a custom integrated circuit which converts an 8 bit binary

value to a proportional current using the following relationship:

I ave. = requested counts/255

This 8 bit word is clocked into the IC via two low speed output lines from

the DUCE chip called data and clock.

The EPC VFS control and self test module contains all of the logic necessary

to convert a desired pressure into a required current, output this current to

the VFS, and test the EPC VFS control circuit during continuous and on-demand

self test (based on the overcurrent circuit monitor).

This module is called from the EPC\_GUIDE after TV\_PRES\_BAR (desired EPC) has

been calculated. Required current to the VFS is then calculated based on

TV\_PRES\_BAR and current vehicle operating conditions:

ON-DEMAND SELF TEST - During on demand self test TV\_COUNTS is calculated

based on desired vfs output (TV\_PRES\_BAR) except under the following

conditions:

CCM Engine Off test in progress (CCM\_EO\_ENA = 1)

TV\_COUNTS = KOEO\_TV\_CNTS unless the EPC current monitor is attempting

to distinguish between an OPEN and a SHORT circuit (ETV\_TEST = 1), in

which case TV\_COUNTS = 0.

Output cycling in progress

Upon completion of Engine Off self test, the technician can initiate

output cycling to aid diagnostics (track faults through the wiring).

During output cycling:

OSM\_EO\_ON = 1 --> TV\_COUNTS = KOEO\_TV\_CNTS

OSM\_EO\_OFF = 1 --> TV\_COUNTS = 0

NORMAL OPERATION - TV\_COUNTS is calculated based on desired vfs output

(TV\_PRES\_BAR), unless the EPC current monitor is attempting to distinguish

between an OPEN and a SHORT circuit failure (ETV\_TEST = 1), in which case

TV\_COUNTS = 0.

TV\_COUNTS will be output to the DUCE chip during the 1 millisecond repeater

if a new value has been calculated (this is due to the way the DUCE channels

are updated, and is NOT the result of the EPC VFS needing to be controlled in

foreground).

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ELECTRONIC PRESSURE CONTROL, EPC CURRENT MONITOR - CDAN2

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All EPC VFS self test is based on the EPC Overcurrent Circuit Monitor.

EPCOCM1 is a voltage representative of the current in the EPC solenoid. This

voltage is read by the EEC-IV through the A/D (see circuit diagram below).

The expected monitor voltage is a function of battery voltage and solenoid

current. Measured voltage decreases with increasing current or decreasing

battery voltage.

Vbat

|

\_\_\_|\_\_\_

| | Rpull-up = 6.81K ohms

\ \ R236 = 1 ohm

Rpull-up / /Rload (VFS) R287 = 61.9K ohms

\ \ R288 = 26.7K ohms

|\_\_\_\_\_| Rload = hardware dependent,

| R236 approx. 3-5 ohms

Vn|\_\_\_\_\_/\/\/\\_\_\_\_\_\_\_\_\_\_

| | Note: all resistance values

| | approximate.

\ |/

R287 / \_\_ Q1 |

\ | ---|

|\_\_|A/D CONV |

| |(EPCOCM1) |\

\ |\_\_ |

R288 / |

\_\_\\_\_ \_\_|\_\_

\_\_\_ \_\_\_

\_ \_

Due to the presence of the pull-up resistor, an open circuit will look like a

short to ground for all non-zero TV\_COUNTS values (non-zero TV\_COUNTS ==>

transistor Q1 will be on).

If the measured voltage is less than the allowable minimum (etv\_ocm\_min), an

"EPC Test" sequence will be initiated. This sequence commands zero TV\_COUNTS

and then rechecks the voltage to differentiate an open from a short. Through

the use of a "pull-up" circuit connected to the EPC output, at zero

TV\_COUNTS, a short will result in low voltage on EPCOCM1, while an open will

show a near-normal voltage (see analysis below). If an error is detected,

the appropriate error code (error code 1746 - EPC solenoid/driver open

circuit -or- code 1747 - EPC solenoid/driver short to ground) is set.

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ELECTRONIC PRESSURE CONTROL, EPC CURRENT MONITOR - CDAN2

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EPC Circuit Steady-State Analysis

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

| OPEN CIRCUIT | SHORT TO GROUND |

|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|

| Q1 ON (TV\_COUNTS <> 0): | Q1 ON (TV\_COUNTS <> 0): |

| | |

| VEPCOCM1 = Vn\*[R288/(R287+R288)] | VEPCOCM1 = Vn\*[R288/(R287+R288)]|

| | |

| Vbat\*R236||(R287+R288) | Vn is approximately zero |

| Vn = ---------------------------- | |

| Rpull-up + R236||(R287+R288)| VEPCOCM1 will be a small value |

| R236 = 1 ohm | |

| | | |

| | | |

| v | |

| R236||(R287+R288) will be less | |

| than 1 ohm | |

| | | |

| | | |

| v | |

| Vbat\*(approx. 1) | |

| Vn = ----------------- | |

| 6.81K + 1 | |

| | | |

| | | |

| v | |

| VEPCOCM1 will be a small value | |

| (similar to an short circuit) | |

|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|

| Q1 OFF (TV\_COUNTS = 0): | Q1 OFF (TV\_COUNTS = 0): |

| | |

| VEPCOCM1 = Vn\*[R288/(R287+R288)] | VEPCOCM1 = Vn\*[R288/(R287+R288)]|

| | |

| Vbat\*(R287+R288) | Vn is approximately zero |

| Vn = ------------------------ | |

| Rpull-up + (R287+R288) | VEPCOCM1 will be a small value |

| | | |

| | | |

| v | |

| VEPCOCM1 will be a near normal | |

| voltage for zero TV\_COUNTS, | |

| making it possible to distinguish| |

| between an open and a short. | |

|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|

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ELECTRONIC PRESSURE CONTROL, EPC CURRENT MONITOR - CDAN2

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DEFINITIONS

INPUTS

Registers:

- EPC\_DLY\_TMR = EPC test delay timer.

- EPCOCM1 = EPC VFS overcurrent circuit monitor, counts.

- P1747FIL = EPC short circuit failure fault filter.

- P1746FIL = EPC open circuit failure fault filter.

- SPD\_RATIO = Speed ratio across torque converter (output/input).

- TOT = Transmission oil temperature (degrees F).

- TQ\_NET = Net torque into torque converter.

- TSTRAT = Transmission strategy switch; The TSTRAT software switch

controls which transmission control strategy is executed:

0 -> No transmission control (Manual trans., AOD, ATX, C6, C3, etc.)

1 -> SIL (Shift indicator light)

2 -> A4LD with 3-4 shift control and converter clutch control

3 -> AXOD

4 -> C64E (E4OD)

5 -> A4LDE

6 -> FAX-4

7 -> AOD-E (AOD-I)

8 -> 4EAT

9 -> CD4E

- TV\_COUNTS = Required counts value to produce desired EPC VFS output

pressure.

- TV\_COUNT\_LST = TV pressure counts last update.

- TV\_PRES\_BAR = Filtered desired EPC, calculated in the EPC GUIDE.

- VBAT = Battery voltage.

Bit Flags:

- CCM\_EO\_ENA = Comprehensive component monitor engine off test enable flag;

1 -> KOEO CCM tests are enabled.

- CCM\_TST\_ENA = Comprehensive component monitor test enable flag; 1 -> CCM

tests are enabled.

- ETV\_TEST = ETV open/short test in progress.

- OSM\_EO\_OFF = Output State Monitor KOEO test actuator for OFF state flag;

1 -> turn actuator off and monitor the output.

- OSM\_EO\_ON = Output State Monitor KOEO test actuator for ON state flag; 1

-> turn actuator on and monitor the output.

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ELECTRONIC PRESSURE CONTROL, EPC CURRENT MONITOR - CDAN2

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Calibration Constants:

- EPC\_CM\_ENA = Calibration switch to enable EPC current monitor test.

- EPC\_DLY\_TIM = EPC test transient delay time.

- ETV\_BIAS = EPCOCM1 voltage at 10V VBAT and 0 TV\_COUNTS.

- ETV\_GAIN = EPCOCM1 voltage gain/one count TV\_COUNTS.

- ETV\_GAIN\_BAT = EPCOCM1 count gain/one volt VBAT.

- FN617 = Torque converter torque ratio.

- FN620 = EPC VFS transfer function, used to converted desired pressure

(TV\_PRES\_BAR) into counts.

- FN622 = Temperature dependent VFS transfer function modifier.

- FN622A = Temperature dependent VFS transfer function multiplier.

- KOEO\_TV\_CNTS = Commanded value of TV\_COUNTS during KOEO self test.

- OFMTQMAX\_CL = Torque below which normal fire is requested during ETV

overcurrent.

- OFMTQMAX\_SH = Torque above which alternate fire is requested during ETV

overcurrent.

- P1747LVL = EPC short circuit failure fault threshold.

- P1747UP = EPC short circuit failure upcount.

- P1746LVL = EPC open circuit failure fault threshold.

- P1746UP = EPC open circuit failure upcount.

- TVCDLT = Maximum change in TV counts to consider ETV as steady state.

- VBAT\_MIN = Minimum battery voltage to allow EPC test entry.

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ELECTRONIC PRESSURE CONTROL, EPC CURRENT MONITOR - CDAN2

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OUTPUTS

Registers:

- P1747FIL = See above.

- P1746FIL = See above.

- EPC\_DLY\_TMR = See above.

- ETV\_OCM\_MN\_D = \*DISPLAY ONLY\* expected ETV current.

- TV\_COUNTS = See above.

- TV\_COUNT\_LST = See above.

Bit Flags:

- ETV\_TEST = See above.

- OFMFLG = ETV solenoid failure flag.

- OFM\_FMEM = ETV overcurrent based alternate fire request flag; 1 ->

Alternate fire requested, 0 -> Normal fire.

- PxxxMALF = OBDII malfunction flag for fault XXX; 1 -> Fault XXX currently

exits.

- PxxxMON = OBDII monitor flag for fault XXX; 1 -> Fault XXX has been

monitored this power-up.

OTHER

- epc\_codes = SET OF {P1746, P1747} the set of OBDII fault codes that

relate to the EPC VFS.

- clear\_malf(Pxxx) = Clears malfunction flag specified by Pxxx.

- ccm\_malfunction{Pxxx} = Logic process, imported from MIL control module;

Pxxx indicates a fault code.

- store\_code(Pxxx) = Stores fault code specified by Pxxx.

- P1746 = Fault code; EPC VFS open circuit.

- P1747 = Fault code; EPC VFS short to ground.

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ELECTRONIC PRESSURE CONTROL, EPC CURRENT MONITOR - CDAN2

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PROCESS

STRATEGY MODULE: EPC\_VFS\_OBDII\_COM11

This logic calculates TV\_COUNTS based on desired vfs output (TV\_PRES\_BAR) and

current vehicle operating conditions (see module overview for a brief

description):

TSTRAT <= 3 ----------------------------| Exit module

(Manual/non-electric transmission) |

| --- ELSE ---

|

| TV\_COUNT\_LST = TV\_COUNTS

| (save previous value of TV\_COUNTS)

OSM\_EO\_ON = 1 --------------|

(Cycle output on |

requested) |OR --|

| |

CCM\_EO\_ENA = 1 -------------| |

(Engine Off CCM in |AND -| TV\_COUNTS = KOEO\_TV\_CNTS

progress) | |

| |

ETV\_TEST = 0 ---------------------| |

(EPC open/short test not |

in progress) |

| --- ELSE ---

OSM\_EO\_OFF = 1 -------------------| |

(Cycle output off | |

requested) |OR --| TV\_COUNTS = 0

| |

ETV\_TEST = 1 ---------------------| |

(EPC open/short test in |

progress) |

| --- ELSE ---

|

| tv\_comp = TV\_PRES\_BAR \* FN622A(TOT)

| TV\_COUNTS = max [FN620(tv\_comp) +

| FN622(TOT),0]

unconditionally ------------------------| output(TV\_COUNTS)

| (Output TV\_COUNTS

| to the EPC VFS)

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ELECTRONIC PRESSURE CONTROL, EPC CURRENT MONITOR - CDAN2

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This logic delays epc test entry (when enabled) for a calibratable amount of

time when transients (large changes in desired current) occur.

CCM\_EO\_ENA = 0 -------------|

(Engine Off CCM disabled) |AND -|

| |

CCM\_TST\_ENA = 0 ------------| |

(Continuous CCM disabled) |

|

EPC\_CM\_ENA = 0 -------------------|OR --| EPC\_DLY\_TMR = 0

(Test cal'ed out) | |

| | EXIT MODULE

ABS(TV\_COUNT\_LST - | | (Conditions not met

TV\_COUNTS) > TVCDLT -------| | to monitor EPC circuit,

(Transient occurred) | | zero transient delay

| | timer and exit module)

VBAT < VBAT\_MIN ------------------| |

(Battery voltage too low to monitor |

EPC VFS circuit) |

| --- ELSE ---

|

EPC\_DLY\_TMR >= EPC\_DLY\_TIM -------------| Do: calculate\_min\_epcocm1

(Transient delay is over) | Do: epc\_current\_monitor

|

| --- ELSE ---

|

| EXIT

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ELECTRONIC PRESSURE CONTROL, EPC CURRENT MONITOR - CDAN2

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BEGIN: calculate\_min\_epcocm1

Calculate the minimum allowed value of EPCOCM1 based on the current vehicle

operating conditions.

always ----------------| etv\_ocm\_min = [ETV\_BIAS - (ETV\_GAIN\*TV\_COUNTS)] +

| [(VBAT - 10.0) \* ETV\_GAIN\_BAT]

| (clip to zero)

| ETV\_OCM\_MN\_D = etv\_ocm\_min

| (save for display)

END: calculate\_min\_epcocm1

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ELECTRONIC PRESSURE CONTROL, EPC CURRENT MONITOR - CDAN2

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BEGIN: epc\_current\_monitor

EPCOCM1 < etv\_ocm\_min ------------|

(EPCOCM1 below allowed minimum) |AND -| (initiate open/short test)

| | OFMFLG = 0

ETV\_TEST = 0 ---------------------| | ETV\_TEST = 1

(epc test sequence is not in progress) | tq\_ofm = 0

|

| --- ELSE ---

EPCOCM1 < etv\_ocm\_min ------------| |

(EPCOCM1 low - short circuit) |AND -| (over current/short

| | circuit)

ETV\_TEST = 1 ---------------------| | P1747FIL = P1747FIL + P1747UP

(epc test sequence is in progress) | OFMFLG = 1

| tq\_ofm = TQ\_NET \*

| FN617(SPD\_RATIO)

| (torque into the gear set)

| Do: epc\_monitor\_logic

|

| --- ELSE ---

EPCOCM1 >= etv\_ocm\_min -----------| |

(EPCOCM1 high - open circuit) |AND -| (under current/open

| | circuit)

ETV\_TEST = 1 ---------------------| | P1746FIL = P1746FIL + P1746UP

(epc test sequence is in progress) | OFMFLG = 0

| ETV\_TEST = 0

| tq\_ofm = 0

| Do: epc\_monitor\_logic

|

| --- ELSE ---

|

| (no error)

| P1747FIL = P1747FIL - 1

| P1746FIL = P1746FIL - 1

| OFMFLG = 0

| ETV\_TEST = 0

| tq\_ofm = 0

|

| Do: epc\_monitor\_logic

tq\_ofm >= OFMTQMAX\_SH ------------|S Q -| OFM\_FMEM

| | (torque limit exceeded

tq\_ofm < OFMTQMAX\_CL -------------|C | alternate fire)

END: epc\_current\_monitor

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ELECTRONIC PRESSURE CONTROL, EPC CURRENT MONITOR - CDAN2

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BEGIN: epc\_monitor\_logic

This logic sets the epc circuit test monitor and malfunction flags based on

the current circuit status.

P1746FIL >= P1746LVL -------------------| store\_code(P1746)

| (epc open circuit

| malfunction present)

|

| --- ELSE ---

|

P1746FIL = 0 ---------------------------| clear\_malf(P1746)

| (no epc open circuit

| malfunction presnet)

P1747FIL >= P1747LVL -------------------| P1747MON = 1

| malfunction(ccm,P1747)

| (epc short to ground

| malfunction present)

|

| --- ELSE ---

|

P1747FIL = 0 ---------------------------| P1747MON = 1

| clear\_malf(P1747)

| (epc circuit has been

| monitored for a short

| circuit, no malfunction

| currently present)

END: epc\_monitor\_logic

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ELECTRONIC PRESSURE CONTROL, TRANSMISSION OVERTEMPERATURE TEST - CDAN2

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27.8 TRANSMISSION OVERTEMPERATURE TEST (CDAN0)

27.8.1 PROCEDURE Transmission\_overtemp\_test

BEGIN transmission\_overtemp\_test

FUNCTIONAL REQUIREMENTS

At very high temperatures, the torque capacity of the transmission is

decreased, which can impact its durabilty. When a high transmission oil

temperature is reached, the malfunction flag is set (P1783MALF) and failure

mode action is initiated. The failure mode flag (OTEMP\_FM\_FLG) will remain

set until the transmission drops below the overtemperature exit

(OTEMP\_EXIT\_S) value.

LOGICAL REQUIREMENTS

Logic Diagram

This structure diagram shows calling relations between logic charts in this

process.

LEVEL ENTITY CALLED

1 Chart transmission\_overtemp\_test\_0

2 Function clear-malf

2 Function store\_code

EXTERNAL INTERFACE

Inputs:

- CCM\_TST\_ENA

- FFG\_TOT

- OTEMP\_EXIT\_S

- OTEMP\_TIM

- P1783

- TOT

- TOT\_OTEMP\_S

- TSTRAT

Outputs:

No parameters are applicable.

PARAMETER DECLARATIONS

Registers:

- TOT = TRANSMISSION OIL TEMPERATURE (DEGREES F)

Resolution: 0.12500000 Units: -- Init. Value: 60

Min. Value: -4096.0000 Max. Value: 4095.87500 Reg. Type: RAM

Logic Chart transmission\_overtemp\_test\_0

STRATEGY FILE: EPC\_OTEMP\_TEST\_OBDII\_COM1/GEN=13

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ELECTRONIC PRESSURE CONTROL, TRANSMISSION OVERTEMPERATURE TEST - CDAN2

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TSTRAT <= 3 ---------------------------| Exit module

;Manual / non - electric transmission |

|

| --- ELSE ---

|

CCM\_TST\_ENA = 0 -----------------| | OTEMP\_TMR := 0

;CCM testing disabled | | ;Conditions to run the test not

| | ;met, or TOT is below the overtemp

FFG\_TOT = 1 ---------------------|OR --| ;value - > zero the error timer

;TOT unreliable | |

| |

TOT <= TOT\_OTEMP\_S --------| | |

;NOT overtemperature |AND -| |

| |

OTEMP\_FM\_FLG = 0 ----------| |

;NOT in otemp fmem |

|

| --- ELSE ---

|

TOT <= OTEMP\_EXIT\_S -------------------| DO: clear\_malf(P1783)

;In fmem AND TOT low enough to exit | ;transmission temperature is okay,

| ;clear the malfunction flag

|

| OTEMP\_FM\_FLG := 0

| ;exit FMEM

|

| --- ELSE ---

|

OTEMP\_TMR > OTEMP\_TIM -----------------| DO: store\_code(P1783)

;Error present long enough |

| OTEMP\_FM\_FLG := 1

| ;malfunction detected, set flag

| ;and enter FMEM)

|

END: transmission\_overtemp\_test

STRATEGY FILE: EPC\_OTEMP\_TEST\_OBDII\_COM1/GEN=13

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TRANSMISSION INPUT CONVERSIONS, ANTI-SILTING ENABLING LOGIC - CDAN2

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27.8.2 ANTI-SILTING ENABLING LOGIC (CDAN0)

DEFINITIONS

Registers:

- PDL = PRNDL position - from A to D conversion.

- TMR\_ASILT = Anti-silting timer.

- VSCTR = Counter which tracks unrealistic changes in vehicle speed.

- VS = Unfiltered vehicle speed.

Bit Flags:

- BIFLG = Brake input flag.

- FLG\_ASILT = Anti-silting strategy enabled; 1 -> anti-silting strategy

enabled.

- FLG\_ASILT\_LS = Anti-silting strategy enabled last pass; 1 -> anti-silting

strategy enabled last pass.

- FLG\_ENG\_IN = Engagement in progress status; 1 -> engagement in progress.

- FLG\_ENG\_LS = Engagement in progress status last pass; 1 -> engagement in

progress last pass.

- FLG\_FWD\_REV = Direction change flag; 1 -> direction changed.

- FLG\_TP\_CT = Closed throttle flag; 1 -> at closed throttle.

- FLG\_TR\_ENG = Transmission engagement status; 1 -> transmission fully

engaged.

- TFMFLG = Throttle position sensor failed; 1 -> TP sensor failed.

- VSFMFLG = Vehicle speed sensor failed; 1 -> Vehicle speed sensor failed.

Calibration Constants:

- ASILT\_BR\_SW = Calibration switch to enable anti-silting when vehicle is

at rest with the brake on; 1 -> anti-silting logic on.

- TM\_ASILT = Length of time for each stage of anti-silting cycle.

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TRANSMISSION INPUT CONVERSIONS, ANTI-SILTING ENABLING LOGIC - CDAN2

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PROCESS

STRATEGY MODULE: EPC\_ASILT\_COM1

always ---------------------------------| FLG\_ASILT\_LS = FLG\_ASILT

PDL <= 4 -----------------|

|OR --|

PDL = 6 ------------------| |

|

FLG\_FWD\_REV = 0 ----------------|AND -| FLG\_TR\_ENG = 1

| |

FLG\_ENG\_IN = 0 -----------------| |

| |

FLG\_ENG\_LS = 1 -----------------| |

| --- ELSE ---

|

PDL = 5 ------------------------| |

| |

FLG\_FWD\_REV = 1 ----------------|OR --| FLG\_TR\_ENG = 0

|

PDL = 7 ------------------------|

TFMFLG = 0 -----------------------|

|

VSFMFLG = 0 ----------------------|

|

FLG\_TR\_ENG = 1 -------------------|

|

VSCTR = 0 ------------------------|

|AND -| FLG\_ASILT = 1

FLG\_TP\_CT = 1 --------------------| |

| |

VS = 0 ---------------------------| |

| |

BIFLG = 1 ------------------------| |

| |

ASILT\_BR\_SW = 1 ------------------| |

| --- ELSE ---

|

| FLG\_ASILT = 0

FLG\_ASILT\_LS = 0 -----------|

|AND -|

FLG\_ASILT = 1 --------------| |OR --| TMR\_ASILT = 0

| | (reset anti-silting timer)

TMR\_ASILT > 5 \* TM\_ASILT ---------|

27-55

TRANSMISSION INPUT CONVERSIONS, ANTI-SILTING ENABLING LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

27-56

CHAPTER 28

CONVERTER CLUTCH CONTROL

28-1

CONVERTER CLUTCH CONTROL, BYPASS CLUTCH CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.1 BYPASS CLUTCH CONTROL (CDAM0)

OVERVIEW

The modulated bypass clutch control module is the main calling routine for

modulated bypass clutch strategy. This module provides the order in which

all other modules are called.

DEFINITIONS

Calibration Constants:

- SWBCTST = Modulated Bypass Clutch control test switch.

PROCESS

STRATEGY MODULE: CCC\_BYP\_CLTCH\_CTL\_COM6

SWBCTST > 0 -----------| Do: CCC\_BYP\_CLTCH\_TESTS\_COMx

| EXIT MODULATED BYPASS CONVERTER CLUTCH CONTROL

|

| --- ELSE ---

|

| Do: CCC\_FMEM\_COM3

| Do: CCC\_HOT\_LCK\_COMx

| Do: CCC\_SCHLD\_LCK\_UNLCK\_COMx

| Do: CCC\_UNCOND\_UNLK\_COMx

| Do: CCC\_MOD\_COMx

| Do: CCC\_SCHLD\_BYP\_SLIP\_COMx

| Do: CCC\_BYP\_SLIP\_CALC\_COMx

| Do: CCC\_TCAP\_DETR\_COMx

| Do: CCC\_TCAP\_CONV\_COMX

28-2

CONVERTER CLUTCH CONTROL, HOT LOCKUP LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.2 HOT LOCKUP LOGIC (CDAA0)

OVERVIEW

The hot lockup logic uses ECT or TOT to set an overtemperature lockup mode

flag. The intent of the overtemperature lockup mode is to reduce the amount

of transmission generated heat by hardlocking the torque converter, thereby,

increasing its efficiency. Since driveability decreases substantially in

this mode, it is used only when absolutely required, typically when TOT is

greater than 275 deg. F.

DEFINITIONS

INPUTS

Registers:

- ECT = Engine Coolant Temperature, deg. F.

- TOT = Transmission Oil Temperature, deg. F.

Calibration Constants:

- LUHECT\_CL = ECT below which overtemp lockup mode can be disabled.

- LUHECT\_SH = ECT above which overtemp lockup mode always enabled.

- LUHTOT\_CL = TOT below which overtemp lockup mode can be disabled.

- LUHTOT\_SH = TOT above which overtemp lockup mode always enabled.

OUTPUTS

Bit Flags:

- FLG\_OT\_LK = Transmission overtemp lockup mode flag; 1 -> overtemperature

mode.

PROCESS

STRATEGY MODULE: CCC\_HOT\_LCK\_COM1

ECT >= LUHECT\_SH ------------|

|OR --| FLG\_OT\_LK = 1

TOT >= LUHTOT\_SH ------------| | (overtemp lockup mode)

|

| --- ELSE ---

ECT < LUHECT\_CL -------------| |

|AND -| FLG\_OT\_LK = 0

TOT < LUHTOT\_CL -------------|

28-3

CONVERTER CLUTCH CONTROL, SCHEDULED BYPASS CLUTCH SLIP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.3 SCHEDULED BYPASS CLUTCH SLIP (CDAN0)

OVERVIEW

The Scheduled Bypass Clutch Slip module determines the amount of slip

(SLIP\_TARGET) requested by the calibrator based on tables of vehicle speed

and throttle position. Unique tables are provided for 2nd, 3rd and 4th

gears. There are three unique altitude adjustment tables as well. In

addition, an overtemp lockup mode table provides the ability to hardlock to

increase converter efficiency in cases of extreme heat. No 1st gear tables

are provided since it was felt that no one would schedule slip in 1st gear.

The slip tables can have values between 0 and 1,020 rpm with 4 rpm

resolution. Slip greater than 1,020 rpm can be commanded by setting MAXSLIP1

greater than 1,020. The final value of target slip also determines the

control mode.

A slip target between 0 and 4 rpm is normally considered hardlock mode, that

is, essentially no slip is allowed. The controller will increase duty cycle

to achieve no slip. Hardlock mode is not recommended for transmissions

without a damper. Hardlock mode can be calibrated out by setting SLPHRD to

0.

When the PRNDL is in the D position ( overdrive lock-out mode), hardlock is

commaned above a throttle position break-point (TP3LCK). This is to insure

transmission durability when towing trailers.

A slip target between 4 and 500 rpm is normally considered engage mode, that

is, the controller controls slip in a closed loop manner to the desired

value.

DEFINITIONS

Registers:

- ACT = Air charge temperature, degree F.

- ECT = Coolant temp, degree F.

- GR\_CM = Current transmission gear.

- GR\_DS\_TV = Commanded gear for TV.

- PDL = PRNDL position - from A to D conversion.

- SLIP\_TARGET = Target slip value from tables, rpm.

- TM\_VER\_SFT = Time to verify automatic desired shift.

- TOT = Transmission Oil Temperature (Degrees Fahrenheit).

- TP\_REL = Relative Throttle Position, counts.

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CONVERTER CLUTCH CONTROL, SCHEDULED BYPASS CLUTCH SLIP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- FLG\_AC\_CTL = Flag indicating when to use A/C comp. slip target; 1 -> use

target.

- FLG\_CLUP = Flag indicating closed loop/bcsdc freeze region for upshifts.

- FLG\_CRV\_LK = Scheduled curve lockup flag.

- FLG\_DIS\_CSM = Disable continuous slip mode flag; 0 -> continuous slip

enabled, 1 -> continuous slip disabled.

- FLG\_DNS\_CTL = Downshift slip modulation flag.

- FLG\_ENG\_LK = Modulated bypass clutch engage mode flag; 1 -> in engage

mode.

- FLG\_FMM\_LK = Failure Mode Management lock-up flag; 1 -> lock converter

due to FMEM action.

- FLG\_HRD\_EN = Base table slip\_target value indicates HARDLOCK mode.

- FLG\_HRD\_LK = Modulated bypass clutch hardlock mode flag; 1 -> in hardlock

mode.

- FLG\_HRD\_LST = Last pass value of FLG\_HRD\_LK used to detect transitions.

- FLG\_HT\_MOD = Flag indicating high temperature slip modulation allowed; 1

-> modulation allowed, 0 -> not allowed.

- FLG\_OPEN = MLUS is in open mode; no capacity when set.

- FLG\_OPEN\_LST = Last pass value of FLG\_OPEN used to detect transitions.

- FLG\_OT\_LK = Transmission overtemperature lockup mode flag.

- FLG\_TP3\_LCK = Flag indicating TP\_REL is in hardlock zone for 3rd gear,

PDL = 3.

- FLG\_UNC\_UNLK = Converter clutch unconditional unlock flag.

- FLG\_UNLK\_DS = Converter unlock in progress flag.

- SFT\_ERR\_FLG = Flag indicating that one shift has failed.

Calibration Constants:

- ACSLIP = Desired slip target for AC Clutch engagement.

- FNDN2SSLP\_0 = Slip adder prior to commanding a downshift to 1st or 2nd

gear.

- FNDN3SSLP\_0 = Slip adder prior to commanding a downshift to 3rd gear.

- MAXSLIP1 = Maximum attainable slip target value, rpm.

- MODACT\_CL = ACT below which slip modulation is not allowed.

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CONVERTER CLUTCH CONTROL, SCHEDULED BYPASS CLUTCH SLIP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- MODACT\_SH = ACT above which slip modulation is allowed.

- MODECT\_CL = ECT below which slip modulation is not allowed.

- MODECT\_SH = ECT above which slip modulation is allowed.

- MODTOT\_CL = TOT below which slip modulation is not allowed.

- SLIP\_DES\_MIN = SLIP\_TARGET while verifying shift.

- SLIP\_HRD\_SL = SLIP\_TARGET to set hardlock.

- SLIP\_HRD\_CH = SLIP\_TARGET to clear hardlock.

- TP3LCK = TP\_REL above which hardlock is commanded in 3rd gear, PDL = 3.

- TP3LCK\_HYS = Hysteresis term for PDL = 3, 3rd gear hardlock condition.

PROCESS

STRATEGY MODULE: CCC\_SCHLD\_BYP\_SLIP\_COM5

FLG\_DIS\_CSM = 1 ---------------|

(continous slip mode disabled)|

|

FLG\_UNC\_UNLK = 1 --------------|

|OR --| FLG\_HT\_MOD = 0

ACT < MODACT\_CL ---------------| | (exit high temp. modulation

| | region)

ECT < MODECT\_CL ---------------| |

| |

TOT < MODTOT\_CL ---------------| |

| --- ELSE ---

ACT >= MODACT\_SH --------------| |

|AND -| FLG\_HT\_MOD = 1

ECT >= MODECT\_SH --------------| | (enter high temp. modulation

| region)

TP\_REL >= TP3LCK --------------|S Q -| FLG\_TP3\_LCK

| | (Allow hardlock in 3rd gear

TP\_REL < TP3LCK - TP3LCK\_HYS --| | when PDL = 3)

28-6

CONVERTER CLUTCH CONTROL, SCHEDULED BYPASS CLUTCH SLIP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_CRV\_LK = 1 ----------------|

|

SFT\_ERR\_FLG = 1 ---------| |

(hardlock after shift | |

solenoid functional | |

test detects one bad | |

shift) | |

| |

FLG\_FMM\_LK = 1 ----------| |

(lock requested due to | |

FMEM action) | |

| |AND -| slip\_target = 0

FLG\_OT\_LK = 1 -----------| | |

| | |

FLG\_HT\_MOD = 0 ----------|OR --| |

(no high temperature | |

modulation) | |

| |

PDL = 3 -----------| | |

| | |

GR\_CM = 3 ---------|AND -| |

| |

FLG\_TP3\_LCK = 1 ---| |

(command hardlock when TP\_REL |

is above TP3LCK and PDL = 3) |

| --- ELSE ---

FLG\_CRV\_LK = 1 ----------------| |

|AND -| slip\_target1 = FN[GR\_CM]SSLP

GR\_CM <> 1 --------------------| |

| --- ELSE ---

|

| slip\_target1 = MAXSLIP1

slip\_target1 <= SLIP\_HRD\_SL ---------| FLG\_HRD\_EN = 1

|

| --- ELSE ---

|

slip\_target1 >= SLIP\_HRD\_CH ---------| FLG\_HRD\_EN = 0

always ------------------------------| FLG\_OPEN\_LST = FLG\_OPEN

| FLG\_HRD\_LST = FLG\_HRD\_LK

28-7

CONVERTER CLUTCH CONTROL, SCHEDULED BYPASS CLUTCH SLIP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_CRV\_LK = 0 ----------------------| FLG\_OPEN = 1

| FLG\_ENG\_LK = 0

| FLG\_HRD\_LK = 0

| slip\_target2 = MAXSLIP1

|

| --- ELSE ---

FLG\_HRD\_EN = 1 ----------------| |

| |

TM\_VER\_SFT = 0 ----------------| |

| |

FLG\_UNLK\_DS = 0 ---------------|AND -| FLG\_OPEN = 0

| | FLG\_ENG\_LK = 0

FLG\_CLUP = 0 ------------------| | FLG\_HRD\_LK = 1

| | slip\_target2 = 0

FLG\_DNS\_CTL = 0 ---------------| |

| |

FLG\_AC\_CTL = 0 ----------------| |

| --- ELSE ---

TM\_VER\_SFT > 0 ----------------| |

| |

FLG\_UNLK\_DS = 1 ---------------|OR --| FLG\_OPEN = 0

| | FLG\_ENG\_LK = 1

FLG\_CLUP = 1 ------------------| | FLG\_HRD\_LK = 0

| slip\_target2 =

| max(slip\_target1,SLIP\_DES\_MIN)

|

| --- ELSE ---

|

FLG\_AC\_CTL = 1 ----------------------| FLG\_OPEN = 0

| FLG\_ENG\_LK = 1

| FLG\_HRD\_LK = 0

| slip\_target2 =

| max(ACSLIP,slip\_target1)

|

| --- ELSE ---

|

| FLG\_OPEN = 0

| FLG\_ENG\_LK = 1

| FLG\_HRD\_LK = 0

| slip\_target2 = slip\_target1

28-8

CONVERTER CLUTCH CONTROL, SCHEDULED BYPASS CLUTCH SLIP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_UNLK\_DS = 1 ---------------|

|AND -| slip\_target3 = slip\_target2 +

GR\_DS\_TV <= 2 -----------------| | FNDN2SSLP\_0

| (4-3 downshift slip control)

|

| --- ELSE ---

|

FLG\_UNLK\_DS = 1 ---------------------| slip\_target3 = slip\_target2 +

| FNDN3SSLP\_0

| (downshift slip control)

|

| --- ELSE ---

|

| slip\_target3 = slip\_target2

always ------------------------------| SLIP\_TARGET = min(slip\_target3,

| MAXSLIP1)

28-9

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.4 UNCONDITIONAL UNLOCK LOGIC (CDAN0)

OVERVIEW

The Unconditional Unlock Logic module is designed to unlock the converter

clutch without regard to the schedule or any other shift control function

taking place, hence the name, unconditional. Typical unconditional unlocks

are: closed throttle, high tip in or tip out rates, brake, cold engine, high

altitude or time since start of an unlocked shift. If any of the above

conditions are present, the timer TM\_LK\_DLY is loaded with a unique value

that must expire before normal converter clutch is allowed. If multiple

conditions are present, the longest delay time is used. All unconditional

unlocks result in 0% duty cycle to the bypass clutch.

Overtemp lock up mode eliminates some unconditional unlocks in an attempt to

keep the converter hardlocked as much as possible. This does, however,

degrade driveability.

DEFINITIONS

Registers:

- BP = Barometric pressure.

- CS\_SFT\_MULT = Cold start shift multiplier.

- ECT = Engine coolant temperature.

- GR\_CM = Current transmission gear.

- GR\_OLD = Last commanded gear.

- NEBART = Filtered engine speed, RPM.

- PDL = Current PRNDL position.

- TM\_LK\_DLY = Timer for converter clutch unconditional unlock.

- TM\_UN\_CT = Timer for closed throttle converter clutch relock.

- TP\_RATE = Throttle position rate.

- TP\_REL = Relative throttle position; TP - RATCH.

- UNLKDLY\_TMR = Timer used to delay closed throttle unconditional unlock

(msec)

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS, MPH.

Bit Flags:

- BIFLG = Brake applied flag; 0 -> brake not applied, 1 -> brake applied.

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CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- BIFLG\_LST = Last pass value of BIFLG.

- CC\_FM\_FLG = Converter clutch failure mode flag; 0 -> normal converter

clutch operation, 1 -> converter clutch fmem action in progress.

- FLG\_CT\_LST = Last pass value of FLG\_TP\_CT.

- FLG\_FRST\_CM = First time a shift is commanded flag; 0 -> no shift

commanded this background pass, 1 -> shift commanded this background

pass.

- FLG\_HIGH\_ALT = Flag indicating vehicle is at high altitude.

- FLG\_LK\_CM = Converter clutch lock-up commanded flag; 0 -> de-energize

solenoid, unlock converter clutch, 1 -> energize solenoid, lock converter

clutch.

- FLG\_MLUS\_FM = Excessive converter clutch slip error unconditional unlock

flag; 0 -> no excessive clutch slip unlock, 1 -> excessive clutch slip

unlock.

- FLG\_OT\_LK = Transmission overtemp lockup mode flag; 1 -> overtemperature

mode.

- FLG\_SFT\_IN = Shift in progress flag; 1 -> shift in progress.

- FLG\_TP\_CT = Flag indicating closed throttle break point; 0 -> above

closed throttle break point, 1 -> below closed throttle break point.

- FLG\_UN\_ALT = High altitude unconditional unlock flag; 0 -> not at high

altitude, 1 -> high altitude.

- FLG\_UN\_BRK = Brake applied unconditional unlock flag; 0 -> brake not

applied, 1 -> brake applied.

- FLG\_UN\_CT = Closed throttle unconditional unlock flag; 0 -> not closed

throttle, 1 -> closed throttle.

- FLG\_UN\_MDN = Manual downshift sequence unconditional unlock flag; 0 -> no

manual downshift unlock, 1 -> manual downshift unlock.

- FLG\_UN\_PRN = PRNDL position unconditional unlock flag; 0 -> no PRNDL

position unconditional unlock, 1 -> PRNDL in park, reverse, neutral, or

manual one.

- FLG\_UN\_SPD = Low engine/vehicle speed or low speed ratio unconditional

unlock flag; 0 -> no low speed related unlock, 1 -> low speed unlock.

- FLG\_UN\_TEMP = Cold temperature unconditional unlock flag; 0 -> no cold

- FLG\_UN\_TRA = Throttle rate accel unconditional unlock flag; 0 -> not high

positive throttle rate, 1 -> high positive throttle rate.

- FLG\_UN\_TRD = Throttle rate decel unconditional unlock flag; 0 -> not high

negative throttle rate, 1 -> high negative throttle rate.

- FLG\_UN\_ULSF = Unlocked shift unconditional unlock flag; 0 -> locked up

prior to start of shift, 1 -> unlocked prior to start of shift.

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CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_UNC\_UNLK = Converter clutch unconditional unlock flag; 0 -> normally

scheduled MLUS modulation, 1 -> unconditional unlock.

- OFMFLG = ETV overcurrent monitor failure flag; 0 -> ETV O.K., 1 -> ETV

failure mode.

- OSFMFLG = Output Shaft Sensor FMEM flag; 1 -> OSS fmem in progress.

- TRAC\_ULFLG = Flag forcing transmission unlock; 1 -> unlock.

- MLUS\_FM\_FLG = Flag used to allow FMEM action without storage of a service

code.

- SFT\_ERR\_FLG = Flag indicating that one shift has failed.

Calibration Constants:

- BPUNMH = Hysteresis for BPUNMN.

- BPUNMN = Minimum BP to unlock converter clutch.

- BRKRLCKTM = Time to remain unlocked after transition from break off to

break on.

- CTDLY = Closed throttle relock delay.

- D21DLY = Unlocked 2 -> 1 shift relock delay.

- D32DLY = Unlocked 3 -> 2 shift relock delay.

- D43DLY = Unlocked 4 -> 3 shift relock delay.

- ETLUMX = Minimum ECT to enable converter clutch lock-up, deg F.

- LUDLY = High altitude/cold engine relock delay.

- MLPS\_2 = IPDL value the MLPS is in the second to last position; 2 =

Manual 2 mode has been selected, TCS is present, 3 = Drive mode/Overdrive

cancel mode has been selected, no TCS present.

- NELUMN = Minimum NEBART to unconditionally unlock converter, RPM.

- OTCTDLY = Overtemp closed throttle relock delay, sec.

- PDL\_UNLK = PDLs which force Unconditional Unlock; bit (PDL - 1) set

forces Unlock.

- PRNDLY = PRNDL relock delay.

- SRLUMN = Maximum SPD\_RATIO to unconditionally unlock converter, unitless.

- SRLUMN0T = maximum speed ratio to unconditionally unlock when FLG\_OT\_LK =

1

- TMCTDY = Minimum time before relock at closed throttle.

- TPUNBRK = Maximum relative TP for brake applied unlock.

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CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TPUNCH = Hysteresis for TPUNCT.

- TPUNCT = Maximum relative TP for closed throttle unlock.

- TPUNTR = Relative TP breakpoint for high and low unlock throttle rate.

- TRADLY = High throttle rate, accel, relock delay.

- TRDDLY = High throttle rate, decel, relock delay.

- TRUHAC = Throttle rate unlock, high TP, accel.

- TRUHDC = Throttle rate unlock, high TP, decel.

- TRULAC = Throttle rate unlock, low TP, accel.

- TRULDC = Throttle rate unlock, low TP, decel.

- UNLKDLYTM = Time to remain locked upon reaching closed throttle break

point.

- U12DLY = Unlocked 1 -> 2 shift relock delay.

- U23DLY = Unlocked 2 -> 3 shift relock delay.

- U34DLY = Unlocked 3 -> 4 shift relock delay.

- VSCTDY = Minimum vehicle speed for closed throttle relock.

- VSLUMN = Maximum VSBRT\_RT to unconditionally unlock converter, mph.

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CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_UNCOND\_UNLK\_COM10

always ----------------------------------| FLG\_CT\_LST = FLG\_TP\_CT

TP\_REL < TPUNCT -------------------|S Q -| FLG\_TP\_CT

|

TP\_REL >= TPUNCT + TPUNCH ---------|C

FLG\_CT\_LST = 0 --------------------|

|AND -| UNLKDLY\_TMR = UNLKDLYTM

FLG\_TP\_CT = 1 ---------------------| | (load unlock delay timer)

(transition to closed throttle)

FLG\_TP\_CT = 1 ---------------------|

|AND -| FLG\_UN\_CT = 1

UNLKDLY\_TMR = 0 -------------------| | (command closed throttle

(at closed throttle for a | unlock)

calibratible time) |

| --- ELSE ---

FLG\_TP\_CT = 0 ---------------------| |

(not at closed throttle) |AND -| FLG\_UN\_CT = 0

| | (reset closed throttle

FLG\_UN\_CT = 1 ---------------------| | unlock flag)

|

| --- ELSE ---

|

| NO ACTION

TP\_RATE >= TRUHAC -----|

|AND -|

TP\_REL >= TPUNTR ------| |

|OR --|

TP\_RATE >= TRULAC -----| | |

|AND -| |AND -| FLG\_UN\_TRA = 1

TP\_REL < TPUNTR -------| | | (high tip-in rate)

| |

FLG\_OT\_LK = 0 ---------------------| |

| --- ELSE ---

|

| FLG\_UN\_TRA = 0

28-14

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TP\_RATE <= TRUHDC -----|

|AND -|

TP\_REL >= TPUNTR ------| |

|OR --|

TP\_RATE <= TRULDC -----| | |

|AND -| |AND -| FLG\_UN\_TRD = 1

TP\_REL < TPUNTR -------| | | (high tip-in rate)

| |

FLG\_OT\_LK = 0 ---------------------| |

| --- ELSE ---

|

| FLG\_UN\_TRD = 0

BIFLG\_LST = 0 ---------------------|

|

BIFLG = 1 -------------------------|AND -| FLG\_UN\_BRK = 1

| | (brake applied)

TP\_REL <= TPUNBRK -----------------| |

(vehicle speed maintained - |

4-way flasher not on) | --- ELSE ---

|

| FLG\_UN\_BRK = 0

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CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

bit (PDL - 1) of PDL\_UNLK = 1 -----------| FLG\_UN\_PRN = 1

|

| --- ELSE ---

|

| FLG\_UN\_PRN = 0

ECT <= ETLUMX ---------------------|

|OR --| FLG\_UN\_TEMP = 1

CS\_SFT\_MULT <> 1.0 ----------------| | (cold engine)

|

| --- ELSE ---

|

| FLG\_UN\_TEMP = 0

PDL = 3 ---------------------------|

|

GR\_CM = 4 -------------------------|AND -| FLG\_UN\_MDN = 1

| | (hydraulic 4-3 downshift)

MLPS\_2 <> 2 -----------------------| |

(TCS input NOT present) |

| --- ELSE ---

|

| FLG\_UN\_MDN = 0

BP <= BPUNMN ----------------------|S Q -| FLG\_HIGH\_ALT

| | (vehicle at high altitude)

BP > BPUNMN + BPUNMH --------------|C

FLG\_HIGH\_ALT = 1 ------------------|

|AND -| FLG\_UN\_ALT = 1

FLG\_OT\_LK = 0 ---------------------| | (high altitude)

|

| --- ELSE ---

|

| FLG\_UN\_ALT = 0

FLG\_FRST\_CM = 1 -------------------|

(shift commanded) |AND -| FLG\_UN\_ULSF = 1

| | (minimum unlock time after

FLG\_UNC\_UNLK = 1 ------------------| | start of unlocked shift)

(unconditional unlock) |

| --- ELSE ---

|

| FLG\_UN\_ULSF = 0

28-16

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

NEBART < NELUMN -------------------|

|

VSBART\_RT < VSLUMN ----------------|OR --| FLG\_UN\_SPD = 1

| | (low engine/vehicle speed

SPD\_RATIO < SRLUMN ----------| | | or low speed ratio

| | |

FLG\_OT\_LK = 0 ---------------| | |

|AND -| |

FLG\_SFT\_IN = 0 --------------| | |

| | |

OSFMFLG = 0 -----------------| | |

| | |

SFT\_ERR\_FLG = 0 -------------| | |

| |

SPD\_RATIO < SRLUMNOT --------| | |

| | |

FLG\_OT\_LK = 1 ---------------| | |

|AND -| |

FLG\_SFT\_IN = 0 --------------| |

| |

OSFMFLG = 0 -----------------| |

| |

SFT\_ERR\_FLG = 0 -------------| |

| --- ELSE ---

|

| FLG\_UN\_SPD = 0

FLG\_UN\_CT = 1 ---------------------------| Allow TM\_UN\_CT to count up

(closed throttle) |

| --- ELSE ---

|

| TM\_UN\_CT = 0

MLUS\_FM\_FLG = 1 -------------------|

(exessive slip due to |

overtemp) |OR --| FLG\_MLUS\_FM = 1

| | (excessive converter

CC\_FM\_FLG = 1 ---------------------| | clutch slip)

(converter clutch FMEM in progress) |

|

| --- ELSE ---

|

| FLG\_MLUS\_FM = 0

| (no excessive converter

| clutch slip)

28-17

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_UN\_CT = 1 ---------------------|

(closed throttle) |

|AND -| TM\_LK\_DLY = OTCTDLY

TM\_LK\_DLY < OTCTDLY ---------------| |

| |

FLG\_OT\_LK = 1 ---------------------| |

| --- ELSE ---

FLG\_UN\_CT = 1 ---------------------| |

(closed throttle) |AND -| TM\_LK\_DLY = CTDLY

|

TM\_LK\_DLY < CTDLY -----------------|

FLG\_UN\_TRA = 1 --------------------|

(high tip-in rate) |AND -| TM\_LK\_DLY = TRADLY

|

TM\_LK\_DLY < TRADLY ----------------|

FLG\_UN\_TRD = 1 --------------------|

(high tip-out rate) |AND -| TM\_LK\_DLY = TRDDLY

|

TM\_LK\_DLY < TRDDLY ----------------|

FLG\_UN\_BRK = 1 --------------------|

(brake applied) |

|AND -| TM\_LK\_DLY = BRKRLCKTM

TM\_LK\_DLY < BRKRLCKTM -------------|

(BRKRLCKTM must be calibrated long

enough to prevent engine stall on

a panic stop)

FLG\_UN\_PRN = 1 --------------------|

(park, rev, neut) |AND -| TM\_LK\_DLY = PRNDLY

|

TM\_LK\_DLY < PRNDLY ----------------|

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CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OFMFLG = 1 ------------------|

(ETV sol. shorted) |

|

FLG\_UN\_SPD = 1 --------------|

(low engine/vehicle speed |

or low speed ratio) |

|

FLG\_UN\_TEMP = 1 -------------|

(cold temperature) |

|

FLG\_UN\_MDN = 1 --------------|

(manual downshift) |OR --|

| |

FLG\_UN\_ALT = 1 --------------| |

(high altitude) | |

| |AND -| TM\_LK\_DLY = LUDLY

TRAC\_ULFLG = 1 --------------| |

(traction control request) | |

| |

FLG\_MLUS\_FM = 1 -------------| |

(slip) |

|

TM\_LK\_DLY < LUDLY -----------------|

28-19

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_UN\_ULSF = 1 -------------------|

|

GR\_CM = 2 -------------------------|AND -| TM\_LK\_DLY = U12DLY

| |

GR\_OLD = 1 ------------------------| |

| --- ELSE ---

FLG\_UN\_ULSF = 1 -------------------| |

| |

GR\_CM = 1 -------------------------|AND -| TM\_LK\_DLY = D21DLY

| |

GR\_OLD > 1 ------------------------| |

| --- ELSE ---

FLG\_UN\_ULSF = 1 -------------------| |

| |

GR\_CM = 3 -------------------------|AND -| TM\_LK\_DLY = U23DLY

| |

GR\_OLD < 3 ------------------------| |

| --- ELSE ---

FLG\_UN\_ULSF = 1 -------------------| |

| |

GR\_CM = 2 -------------------------|AND -| TM\_LK\_DLY = D32DLY

| |

GR\_OLD > 2 ------------------------| |

| --- ELSE ---

FLG\_UN\_ULSF = 1 -------------------| |

| |

GR\_CM = 4 -------------------------|AND -| TM\_LK\_DLY = U34DLY

| |

GR\_OLD < 4 ------------------------| |

| --- ELSE ---

FLG\_UN\_ULSF = 1 -------------------| |

| |

GR\_CM = 3 -------------------------|AND -| TM\_LK\_DLY = D43DLY

|

GR\_OLD = 4 ------------------------|

28-20

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_UN\_CT = 1 ---------------|

|AND -|

TM\_UN\_CT <= TMCTDY ----------| |

(closed throttle short time) |

|

TM\_UN\_CT > TMCTDY -----------| |

(closed throt. long enough) | |

|AND -|

VSBART\_RT < VSCTDY ----------| |

(low speed) |

|

FLG\_UN\_TRA = 1 --------------------|

(high tip-in) |

|

FLG\_UN\_TRD = 1 --------------------|

(high tip-out) |

|

FLG\_UN\_ULSF = 1 -------------------|

(unlocked shift) |

|OR --| FLG\_UNC\_UNLK = 1

FLG\_UN\_BRK = 1 --------------------| | (unconditionally unlock

(brake applied) | | converter clutch)

| |

FLG\_UN\_PRN = 1 --------------------| |

(park, rev, neut) | |

| |

FLG\_UN\_TEMP = 1 -------------------| |

(cold temperature) | |

| |

FLG\_UN\_MDN = 1 --------------------| |

(manual downshift) | |

| |

FLG\_UN\_ALT = 1 --------------------| |

(high altitude) | |

| |

TRAC\_ULFLG = 1 --------------------| |

(traction control request) | |

| |

FLG\_UN\_SPD = 1 --------------------| |

(low engine/vehicle speed | |

or low speed ratio) | |

| |

OFMFLG = 1 ------------------------| |

(ETV solenoid shorted) | |

| |

FLG\_MLUS\_FM = 1 -------------------| |

(slip) |

| --- ELSE ---

|

TM\_LK\_DLY = 0 ---------------------------| FLG\_UNC\_UNLK = 0

| (allow modulation

| if scheduled)

|

| --- ELSE ---

|

| no change to FLG\_UNC\_UNLK

28-21

CONVERTER CLUTCH CONTROL, SHIFT MODULATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.5 SHIFT MODULATION LOGIC (CDAN0)

OVERVIEW

The Shift Modulation logic controls the length of time after a shift is

commanded that additional bypass clutch modulation takes place to control

converter slip on shifts.

DEFINITIONS

Registers:

- DELTA\_RATIO = Delta Shift Ratio change since command of shift.

- IGR\_DS = Unverified desired gear.

- GR\_CM = Commanded gear for shift solenoids.

- GR\_CM\_LST = Commanded gear last past.

- PDL = Filtered MLPS position.

- PDL\_LST = Filtered MLPS position last pass.

- TM\_SFT\_CTL = Timer for closed/open loop PID control - for upshifts.

- TM\_SFT\_EXIT = Time remaining to complete shift exit.

- TM\_SFT\_SLP = Timer to control SLIP\_TARGET during shift, sec.

- TM\_VER\_SFT = Time to verify automatic desired shift.

Bit Flags:

- FLG\_CLUP = Flag indicating closed loop/BCSDC freeze region for upshifts.

- FLG\_CLUP\_LST = Last pass value of FLG\_CLUP.

- FLG\_DLY\_SOSC = Flag used to delay millisecond "start of shift" check

until SR\_PP\_LIM is calculated once; 1 -> allow millisecond check.

- FLG\_DNS\_CTL = Downshift slip modulation flag; 1 -> Modifying SLIP\_TARGET

during downshift.

- FLG\_DNS\_EXIT = In downshift exit mode.

- FLG\_FRST\_CM = First time a shift is commanded flag; 1 -> shift commanded

this background pass; 0 -> no shift commanded this background pass.

- FLG\_NV\_SHFT = First pass flag indicating desired shift failed

verification.

- FLG\_OLUP = Flag indicating open loop control region for upshifts.

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CONVERTER CLUTCH CONTROL, SHIFT MODULATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_OLUP\_LST = Value of FLG\_OLUP from previous background loop.

- FLG\_OPN\_BS = Flag indicating converter open when upshift started; 1 ->

open before upshift.

- FLG\_SFT\_DN = Downshift flag; 1 -> Last/current shift is downshift.

- FLG\_SFT\_STRT = Set when waiting to detect start of shift once its been

commanded.

- FLG\_SFT\_UP = Upshift flag; 1 -> Last/current shift is upshift.

- FLG\_UNC\_UNLK = Converter clutch unconditional unlock flag.

- FLG\_OPEN = MLUS is in open mode, no capacity when set.

- FLG\_UCTL\_LST = Last pass value of FLG\_UPS\_CTL.

- FLG\_UPS\_CTL = Upshift slip modulation flag; 1 -> Modifying SLIP\_TARGET

during upshift.

- FLG\_UPS\_EXIT = In upshift exit mode.

- SFT\_ERR\_FLG = Flag indicating that one shift has failed.

Calibration Constants:

- DSRDE1 = Delta Shift Ratio on Downshift to 1st to indicate shift

complete.

- DSRDE2 = Delta Shift Ratio on Downshift to 2nd to indicate shift

complete.

- DSRDE3 = Delta Shift Ratio on Downshift to 3rd to indicate shift

complete.

- DSRUE2 = Delta Shift Ratio on Upshift to 2nd to indicate shift complete.

- DSRUE3 = Delta Shift Ratio on Upshift to 3rd to indicate shift complete.

- DSRUE4 = Delta Shift Ratio on Upshift to 4th to indicate shift complete.

- PCUPSCMPT = Fraction of upshift at which it is considered complete.

- TMCLUP2 = Closed loop pid period during upshift to 2nd.

- TMCLUP3 = Closed loop pid period during upshift to 3rd.

- TMCLUP4 = Closed loop pid period during upshift to 4th.

- TMD1SLP = 1st Downshift SLIP\_TARGET hold duration.

- TMD2SLP = 2nd Downshift SLIP\_TARGET hold duration.

- TMD3SLP = 3rd Downshift SLIP\_TARGET hold duration.

- TMD4SLP = 4th Downshift SLIP\_TARGET hold duration.

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CONVERTER CLUTCH CONTROL, SHIFT MODULATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TMDNSEXIT = Exit downshift duration.

- TMOLUP2 = Open loop pid period during an upshift to 2nd.

- TMOLUP3 = Open loop pid period during an upshift to 3rd.

- TMOLUP4 = Open loop pid period during an upshift to 4th.

- TMSFTSLPMAX = Watchdog time for TM\_SFT\_SLP.

- TMUPSEXIT = Exit upshift duration.

28-24

CONVERTER CLUTCH CONTROL, SHIFT MODULATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_MOD\_COM2

The following logic ignores shifting control once the shift solenoid

functional test detects one bad shift. This allows the shifts to occur

with out the torque converter clutch causing a change in engine speed.

SFT\_ERR\_FLG = 1 -------------------|

|AND -| FLG\_OLUP = 0

FLG\_SFT\_UP = 1 --------------| | | FLG\_CLUP = 0

|OR --| | FLG\_UPS\_CTL = 0

IGR\_DS > GR\_CM --------------| | FLG\_DNS\_CTL = 0

| FLG\_SFT\_STRT = 0

| FLG\_UPS\_EXIT = 0

| FLG\_DNS\_EXIT = 0

| EXIT MODULE

FLG\_FRST\_CM = 1 -------------------|

|AND -| FLG\_SFT\_STRT = 1

FLG\_SFT\_UP = 1 --------------------| |

| --- ELSE

|

FLG\_FRST\_CM = 1 -------------------------| FLG\_SFT\_STRT = 0

FLG\_FRST\_CM = 1 -------------------------| TM\_SFT\_SLP = TMSFTSLPMAX

| (set slip control timer)

FLG\_UNC\_UNLK = 1 ------------------|

|OR --| TM\_SFT\_CTL = 0

FLG\_NV\_SHFT = 1 -------------------| | FLG\_CLUP = 0

| FLG\_OLUP = 0

always ----------------------------------| FLG\_OLUP\_LST = FLG\_OLUP

| FLG\_CLUP\_LST = FLG\_CLUP

| FLG\_UCTL\_LST = FLG\_UPS\_CTL

28-25

CONVERTER CLUTCH CONTROL, SHIFT MODULATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

IGR\_DS > GR\_CM --------------|

|OR --|

PDL <> PDL\_LST --------| | |

|AND -| |

GR\_CM > GR\_CM\_LST -----| |AND -| TM\_SFT\_CTL = TMCLUP[GR\_CM]

| | FLG\_CLUP = 1

FLG\_CLUP = 0 ----------------------| | FLG\_OLUP = 0

| | FLG\_UPS\_CTL = 0

FLG\_OPEN = 1 ----------------------| | FLG\_UPS\_EXIT = 0

| FLG\_OPN\_BS = 1

|

| --- ELSE ---

IGR\_DS > GR\_CM --------------| |

|OR --| |

PDL <> PDL\_LST --------| | | |

|AND -| |AND -| TM\_SFT\_CTL = TMCLUP[GR\_CM]

GR\_CM > GR\_CM\_LST -----| | | FLG\_CLUP = 1

| | FLG\_OLUP = 0

FLG\_CLUP = 0 ----------------------| | FLG\_UPS\_CTL = 0

| FLG\_UPS\_EXIT = 0

| FLG\_OPN\_BS = 0

|

| --- ELSE ---

(continued on next page)

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CONVERTER CLUTCH CONTROL, SHIFT MODULATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

FLG\_CLUP = 1 ----------------------| |

| |

FLG\_SFT\_STRT = 0 ------------------|AND -| TM\_SFT\_CTL = TMOLUP[GR\_CM]

| | FLG\_CLUP = 0

TM\_VER\_SFT = 0 --------------------| | FLG\_OLUP = 1

| FLG\_UPS\_CTL = 1

| FLG\_UPS\_EXIT = 0

| FLG\_DLY\_SOSC = 0

|

| --- ELSE ---

TM\_SFT\_CTL = 0 --------------------| |

| |

FLG\_CLUP = 1 ----------------------|AND -| FLG\_UPS\_CTL = 1

| | FLG\_UPS\_EXIT = 0

TM\_VER\_SFT = 0 --------------------| |

| --- ELSE ---

DELTA\_RATIO > DSRUE[GR\_CM] --------| |

| |

TM\_SFT\_CTL = 0 --------------| | |

|AND -| |

FLG\_OLUP = 1 ----------------| |OR --| TM\_SFT\_CTL = 0

| | FLG\_CLUP = 0

TM\_SFT\_SLP = 0 --------------| | | FLG\_OLUP = 0

| | | FLG\_UPS\_CTL = 0

TM\_VER\_SFT = 0 --------------|AND -| | FLG\_UPS\_EXIT = 1

| | TM\_SFT\_EXIT = TMUPSEXIT

FLG\_UPS\_CTL = 1 -------| | | FLG\_SFT\_STRT = 0

|OR --| | FLG\_OPN\_BS = 0

FLG\_CLUP = 1 ----------| | FLG\_DLY\_SOSC = 0

|

| --- ELSE ---

FLG\_SFT\_UP = 1 --------------------| |

|AND -| FLG\_UPS\_EXIT = 1

TM\_SFT\_EXIT > 0 -------------------| |

| --- ELSE ---

|

| FLG\_UPS\_EXIT = 0

FLG\_SFT\_DN = 1 --------------------|

|

DELTA\_RATIO > DSRDE[GR\_CM] --------|AND -| TM\_SFT\_SLP = TMD[GR\_CM]SLP

|

TM\_SFT\_SLP > TMD[GR\_CM]SLP --------|

28-27

CONVERTER CLUTCH CONTROL, SHIFT MODULATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_SFT\_DN = 1 --------------------|

|AND -| FLG\_DNS\_CTL = 1

TM\_SFT\_SLP > 0 --------------------| | FLG\_DNS\_EXIT = 0

|

| --- ELSE ---

FLG\_SFT\_DN = 1 --------------------| |

| |

FLG\_DNS\_CTL = 1 -------------------|AND -| FLG\_DNS\_CTL = 0

| | FLG\_DNS\_EXIT = 1

FLG\_DNS\_EXIT = 0 ------------------| | TM\_SFT\_EXIT = TMDNSEXIT

|

| --- ELSE ---

FLG\_SFT\_DN = 1 --------------------| |

|AND -| FLG\_DNS\_CTL = 0

TM\_SFT\_EXIT > 0 -------------------| | FLG\_DNS\_EXIT = 1

|

| --- ELSE ---

|

| FLG\_DNS\_CTL = 0

| FLG\_DNS\_EXIT = 0

28-28

CONVERTER CLUTCH CONTROL, BYPASS CLUTCH CONTROL TESTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

28.6 BYPASS CLUTCH CONTROL TESTS (CDAK0)

OVERVIEW

This module provides different test modes to develop the calibration for the

Bypass Converter Clutch control. Setting SWBCTST to a value greater than

zero, allows selection of a particular test mode.

NOTE: Any test in which teh open loop torque capacity equation based off the

converter model is used, will not be valid during a shift due to lack of

turbine speed information.

DEFINITIONS

INPUTS

Registers:

- TCAP\_INTR1 = Interim requested torque capacity, ft-lbs.

Calibration Constants:

- SLIP\_DES\_S = Desired value of slip, signed.

- SLIP\_TARGET = Target converter slip value.

- SWBCTST = Modulated Bypass Clutch Control test switch.

- TSTBCSDC = Fixed test value for BCSDC.

- TSTSLIP = Fixed test value for SLIP\_DES\_S.

- TSTTCAP1 = Fixed test value for TCAP\_REQ1.

OUTPUTS

Registers:

- BCSDC = Modulated Byplass Clutch duty cycle.

- SLIP\_TCAP = Total desired slip to be used for torque capacity

calculation.

- TCAP\_REQ1 = Requested Bypass Clutch Torque Capacity, ft-lbs.

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CONVERTER CLUTCH CONTROL, BYPASS CLUTCH CONTROL TESTS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_BYP\_CLTCH\_TESTS\_COM2

SWBCTST = 1 ----------------------------| BCSDC = TSTBCSDC

(fixed duty cycle test) |

| --- ELSE ---

|

SWBCTST = 2 ----------------------------| SLIP\_TCAP = TSTSLIP

(fixed desired slip test; | Do: CCC\_TCAP\_CALC\_COMx

open loop control only | TCAP\_REQ1 = TCAP\_INTR1

- do not use during shifts) | Do: CCC\_TCAP\_CONV\_COMx

|

| --- ELSE ---

|

SWBCTST = 3 ----------------------------| SLIP\_DES\_S = TSTSLIP

(fixed desired slip test; | SLIP\_TARGET = TSTSLIP

open loop and PID control | Do: CCC\_BYP\_SLIP\_CALC\_COMx

- do not use during shifts) | Do: CCC\_PID\_SLIP\_CTL\_COMx

| Do: CCC\_TCAP\_CALC\_COMx

| TCAP\_REQ1 = TCAP\_INTR1

| Do: CCC\_TCAP\_CONV\_COMx

|

| --- ELSE ---

|

SWBCTST = 4 ----------------------------| TCAP\_REQ1 = TSTTCAP1

(fixed torque capacity test) | Do: CCC\_TCAP\_CONV\_COMx

28-30

CONVERTER CLUTCH CONTROL, SLIP CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.7 SLIP CALCULATION (CDAM0)

OVERVIEW

The Slip Calculation module calulates the desired slip (SLIP\_DES\_S).

This module also calculates slip error which is the difference between the

desired slip (SLIP\_DES\_S) and the value of actual slip (SLIP\_ACT). The

result is stored in ERR\_T0. Unique filterd value of ERR\_T0 are provided for

PID slip control.

DEFINITIONS

Registers:

- ERR\_T0 = Current slip error = SLIP\_DES\_S - SLIP\_ACT, rpm.

- ERR\_T0\_FD = Filtered value of ERR\_T0 for derivative PID slip control.

- ERR\_T0\_FI = Filtered value of ERR\_T0 for integral PID slip control.

- ERR\_T0\_FP = Filtered value of ERR\_T0 for proportional PID slip control.

- ERR\_T1 = Last pass value of ERR\_T0\_FD.

- GR\_CM = Commanded gear for shift solenoids.

- IGR\_DS = Unverified desired gear.

- NEBART = Filtered engine RPM for transmission, rpm.

- NOBART = Filtered transmission output shaft speed.

- NTBART = Filtered value of turbine speed.

- RT\_GR\_OLD = Last gear transmission gear ratio.

- SLIP\_ACT = Actual value of slip (signed), rpm.

- SLIP\_DES = Desired value of slip, unsigned.

- SLIP\_DES\_LST = Last pass value of SLIP\_DES.

- SLIP\_DES\_S = Desired value of slip, signed.

- SLIP\_TARGET = Target slip value from tables.

- SLP\_DES\_LST = Previous value of SLIP\_DES\_S.

- TM\_VER\_SFT = Time to verify automatic desired shift.

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CONVERTER CLUTCH CONTROL, SLIP CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- FLG\_CLUP = flag indicating closed loop/TCAP\_REQ freeze region for

upshifts.

- FLG\_CRV\_LK = Scheduled curve lockup flag.

- FLG\_DB\_REG = Flag indicating slip is within Deadband Region; 1 -> Slip

within Deadband Region.

- FLG\_DNS\_CTL = Downshift slip modulation flag; 1 -> performing downshift

modulation.

- FLG\_DNS\_EXIT = In Downshift exit mode.

- FLG\_UNLK\_DS = Converter unlock in progress flag.

- FLG\_UPS\_EXIT = In Upshift exit mode.

Calibration Constants:

- ERR\_DB\_CH = |ERR\_T0| threshold indicating slip is not in Deadband Region.

- ERR\_DB\_SL = |ERR\_T0| threshold indicating slip is in Deadband Region.

- GRRAT2 = Second gear ratio.

- SLIP\_STEP = Minimum RPM difference between SLIP\_DES\_S and SLIP\_TRG\_S to

allow desired slip to step to target.

- MAXSLIP1 = Maximum attainable slip target value, rpm.

- TCDNS = Time constant for SLIP\_DES\_S during a downshift.

- TCERRD = Time constant for ERR\_T0\_FD.

- TCERRI = Time constant for ERR\_T0\_FI.

- TCERRP = Time constant for ERR\_T0\_FP.

- TCLCK = Time constant for SLIP\_DES\_S during lockups and modulation.

- TCLCKL = Time constant for SLIP\_DES\_S durring low TP\_REL lockups.

- TCULCK = Time constant for SLIP\_DES\_S during an unlock.

- TCUPS = Time constant for SLIP\_DES\_S during an upshift.

- TPBRKTCSLP = TP\_REL break point below which to use TCLCKL.

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CONVERTER CLUTCH CONTROL, SLIP CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_BYP\_SLIP\_CALC\_COM5

At power-up initialize the following parameter:

initially ------------------------------| SLIP\_DES\_S = MAXSLIP1

always ---------------------------------| SLP\_DES\_LST = SLIP\_DES\_S

| SLIP\_DES\_LST = SLIP\_DES

| slip\_des = SLIP\_DES\_S

FLG\_CLUP = 1 ---------------------|

|OR --| tcslip = TCUPS

FLG\_UPS\_EXIT = 1 -----------------| | (use upshift time constant)

|

| --- ELSE ---

TM\_VER\_SFT > 0 -------------| |

|AND -| |

IGR\_DS < GR\_CM -------------| | |

| |

FLG\_DNS\_CTL = 1 ------------------|OR --| tcslip = TCDNS

| | (use downshift time constant)

FLG\_DNS\_EXIT = 1 -----------------| |

| |

FLG\_UNLK\_DS = 1 ------------------| |

| --- ELSE ---

|

FLG\_CRV\_LK = 1 -------------------| |

|AND--| tcslip = TCLCKL

TP\_REL < TPBRKTCSLP --------------| | (use low tp lockup time constant)

|

| --- ELSE ---

|

FLG\_CRV\_LK = 1 -------------------------| tcslip = TCLCK

| (use lockup time constant)

|

| --- ELSE ---

|

| tcslip = TCULCK

| (use unlock time constant)

always ---------------------------------| slip\_des =

ROLAV(SLIP\_TARGET,tcslip)

|SLIP\_TARGET - slip\_des| < SLIP\_STEP ---| SLIP\_DES\_S = SLIP\_TARGET

|

| --- ELSE ---

|

| SLIP\_DES\_S = slip\_des

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CONVERTER CLUTCH CONTROL, SLIP CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SLIP\_DES\_S >= 0 ------------------------| SLIP\_DES = SLIP\_DES\_S

|

| --- ELSE ---

|

| SLIP\_DES = 0

FLG\_CLUP = 1 ---------------------|

|AND -| SLIP\_ACT =

TM\_VER\_SFT = 0 -------------------| | (NEBART - NOBART \* RT\_GR\_OLD)

|

| --- ELSE ---

GR\_CM = 3 ------------------------| |

|AND -| SLIP\_ACT =

PDL = 2 --------------------------| | (NEBART - NOBART \* GRRAT2)

|

| --- ELSE ---

|

| SLIP\_ACT = (NEBART - NTBART)

always ---------------------------------| SLIP\_ABS = abs(SLIP\_ACT)

| ERR\_T1 = ERR\_T0\_FD

| ERR\_T0 = SLIP\_DES\_S - SLIP\_ACT

| ERR\_T0\_FP = ROLAV(ERR\_T0,TCERRP)

| ERR\_T0\_FI = ROLAV(ERR\_T0,TCERRI)

| ERR\_T0\_FD = ROLAV(ERR\_T0,TCERRD)

|ERR\_T0| < ERR\_DB\_SL -------------|S Q -| FLG\_DB\_REG

| | (slip error within deadband

|ERR\_T0| >= ERR\_DB\_CH ------------|C | region)

28-34

CONVERTER CLUTCH CONTROL, SCHEDULED LOCK/UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.8 SCHEDULED LOCK/UNLOCK LOGIC (CDAN0)

OVERVIEW

This logic schedules converter clutch applies and releases on the basis of

sea level and altitude or engine output torque loss lock and unlock curves.

DEFINITIONS

Registers:

- COMP\_FCTR = Compensation factor for altitude or engine output torque

loss.

- GR\_CM = Commanded gear for shift solenoids.

- PNWF = Performance and normal weighting factor.

- RATCH = Closed throttle position, counts.

- RT\_NOVS = Ratio of actual N/V to base N/V in KAM.

- SLIP\_ACT = Actual value of slip (signed).

- SPD\_RATIO = Speed ratio across the torque converter.

- TMR\_NO\_LK = Timer to delay lockup after SLIP\_ACT > SLIPNOLK.

- TP\_REL\_H = Relative TP (TP - RATCH); high byte only.

- TQ\_NET = Net torque into torque converter.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission,

mph.

Bit Flags:

- FLG\_CRV\_DS = Scheduled lockup desired from curve flag.

- FLG\_CRV\_LK = Scheduled curve lock-up flag; 0 -> no scheduled lock-up, 1

-> scheduled lock-up.

- FLG\_CRV\_LST = Last pass value of FLG\_CRV\_DS.

- FLG\_FMM\_LK = Failure Mode Management lock-up flag; 1 -> lock converter

due to FMEM action.

- FLG\_OT\_LK = Transmission overtemp lock-up mode: 1 -> overtemperature

mode.

- FLG\_SFT\_IN = Shift in progress flag.

- FLG\_SFT\_UP = Upshift flag.

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CONVERTER CLUTCH CONTROL, SCHEDULED LOCK/UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_UNC\_UNLK = Converter clutch unconditional unlock flag; 0 -> no

unconditional unlock, 1 -> unconditional unlock.

- SFT\_ERR\_FLG = Flag indicating that one shift has failed.

Calibration Constants:

- FN2LCOMP(TP\_REL\_H) = Delta vehicle speed for 2nd gear lockup for altitude

or engine output torque loss.

- FN2LH(TP\_REL\_H) = Vehicle speed for 2nd gear overtemp lockup.

- FN2LS(TP\_REL\_H) = Vehicle speed for 2nd gear lockup at sea level.

- FN2LPWF(TP\_REL\_H) = Delta vehicle speed for 2nd gear lockup in

performance mode.

- FN2UCOMP(TP\_REL\_H) = Delta Vehicle speed for 2nd gear unlock for altitude

or engine output torque loss.

- FN2UH(TP\_REL\_H) = Vehicle speed for 2nd gear overtemp unlock.

- FN2US(TP\_REL\_H) = Vehicle speed for 2nd gear unlock at sea level.

- FN2UPWF(TP\_REL\_H) = Delta vehicle speed for 2nd gear unlock in

performance mode.

- FN3LCOMP(TP\_REL\_H) = Delta vehicle speed for 3rd gear lockup for altitude

or engine output torque loss.

- FN3LH(TP\_REL\_H) = Vehicle speed for 3rd gear overtemp lockup.

- FN3LPWF(TP\_REL\_H) = Delta vehicle speed for 3rd gear lockup in

performance mode.

- FN3LS(TP\_REL\_H) = Vehicle speed for 3rd gear lockup at sea level.

- FN3UCOMP(TP\_REL\_H) = Delta Vehicle speed for 3rd gear unlock for altitude

or engine output torque loss.

- FN3UH(TP\_REL\_H) = Vehicle speed for 3rd gear overtemp unlock.

- FN3UPWF(TP\_REL\_H) = Delta vehicle speed for 3rd gear unlock in

performance mode.

- FN3US(TP\_REL\_H) = Vehicle speed for 3rd gear unlock at sea level.

- FN4LCOMP(TP\_REL\_H) = Delta vehicle speed for 4th gear lockup for altitude

or engine output torque loss.

- FN4LH(TP\_REL\_H) = Vehicle speed for 4th gear overtemp lockup.

- FN4LPWF(TP\_REL\_H) = Delta vehicle speed for 4th gear lockup in

performance mode.

- FN4LS(TP\_REL\_H) = Vehicle speed for 4th gear lockup at sea level.

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CONVERTER CLUTCH CONTROL, SCHEDULED LOCK/UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FN4UCOMP(TP\_REL\_H) = Delta Vehicle speed for 4th gear unlock for altitude

or engine output torque loss.

- FN4UH(TP\_REL\_H) = Vehicle speed for 4th gear overtemp unlock.

- FN4UPWF(TP\_REL\_H) = Delta vehicle speed for 4th gear unlock in

performance mode.

- FN4US(TP\_REL\_H) = Vehicle speed for 4th gear unlock at sea level.

- FN\_SRLK(TQ\_NET) = Function to determine minimum speed ratio to lock

comverter based on TQ\_NET.

- SLPNOLK = SLIP\_ACT below which converter is not allowed to go from open

to modulated.

- SRLKOT = minimum speed ratio to lock converter when trans. is

overtemperature.

- TMNOLKDLY = Time after SLIP\_ACT > SLPNOLK to delay lock up.

28-37

CONVERTER CLUTCH CONTROL, SCHEDULED LOCK/UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_SCHLD\_LCK\_UNLCK\_COM16

always -----------------------------------| FLG\_CRV\_LST = FLG\_CRV\_DS

GR\_CM <> 1 -------------------------|

|AND -| vs\_lk = FN[GR\_CM]LS +

FLG\_OT\_LK = 0 ----------------------| | COMP\_FCTR \* FN[GR\_CM]LCOMP +

| PNWF \* FN[GR\_CM]LPWF

|

| vs\_unlk = FN[GR\_CM]US +

| COMP\_FCTR \* FN[GR\_CM]UCOMP +

| PNWF \* FN[GR\_CM]UPWF

|

| --- ELSE ---

GR\_CM <> 1 -------------------------| |

|AND -| vs\_lk = FN[GR\_CM]LH

FLG\_OT\_LK = 1 ----------------------| |

| vs\_unlk = FN[GR\_CM]UH

GR\_CM <> 1 -------------------|

|

FLG\_OT\_LK = 0 ----------------|AND -|

| |

SPD\_RATIO >= FN\_SRLK(TQ\_NET) -| |

|OR --| ratio\_ok = 1

GR\_CM <> 1 -------------------| | |

| | |

FLG\_OT\_LK = 1 ----------------|AND -| |

| | |

SPD\_RATIO >= SRLKOT ----------| | |

| |

FLG\_SFT\_IN = 1 ---------------------| |

(shifting disregard speed ratio) |

| --- ELSE ---

|

| ratio\_ok = 0

28-38

CONVERTER CLUTCH CONTROL, SCHEDULED LOCK/UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SFT\_ERR\_FLG = 1 --------------------|

|

FLG\_SFT\_UP = 1 ---------------------|AND -| No change to

| | FLG\_CRV\_DS

FLG\_SFT\_IN = 1 ---------------------| |

(Do not allow converter |

to lock or unlock durring | --- ELSE ---

a shift after shift |

solenoid functional |

test detects one bad |

shift) |

|

GR\_CM = 1 --------------------------------| FLG\_CRV\_DS = 0

|

| --- ELSE ---

ratio\_ok = 1 -----------------| |

|AND -| |

VSBART\_RT > vs\_lk ------------| |OR --| FLG\_CRV\_DS = 1

| |

FLG\_FMM\_LK = 1 ---------------------| |

| --- ELSE ---

|

VSBART\_RT < vs\_unlk ----------------------| FLG\_CRV\_DS = 0

|

| --- ELSE ---

|

| No change to

| FLG\_CRV\_DS

SLIP\_ACT < SLPNOLK -----------------------| TMR\_NO\_LK = TMNOLKDLY

28-39

CONVERTER CLUTCH CONTROL, SCHEDULED LOCK/UNLOCK LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_UNC\_UNLK = 1 -----------------|

|OR ----| FLG\_CRV\_LK = 0

FLG\_CRV\_LK = 0 -------------| | | (unconditional unlock,

|AND -| | ignore desired state)

SLIP\_ACT < SLPNOLK ---| | |

|OR --| |

TMR\_NO\_LK > 0 --------| |

(not allow lockup durring |

negative slip ) |

| --- ELSE ---

SFT\_ERR\_FLG = 1 --------------------| |

| |

FLG\_SFT\_UP = 1 ---------------------|AND -| No change to

| | FLG\_CRV\_LK

FLG\_SFT\_IN = 1 ---------------------| |

(Do not allow converter |

to lock or unlock durring |

a shift after shift |

solenoid functional |

test detects one bad |

shift) |

|

| --- ELSE ---

|

| FLG\_CRV\_LK = FLG\_CRV\_DS

| (allow desired state to

| pass through)

28-40

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.9 MLUS CONTROL AND SELF TEST (CDAN0)

OVERVIEW

This module computes the Torque Converter Clutch modulated bypass clutch

solenoid pulsewidth (based on BCSDC), outputs the pulsewidth to the DUCE chip

(in units of DUCE ticks), monitors the fault status of the solenoid circuit,

and performs rationality checks on converter clutch operation.

NOTE: The terms Modulated Lock-Up Solenoid (MLUS) and Torque Converter

Clutch Solenoid (TCC) are used interchangeably in this module. TCC is the

"new" term for the solenoid and is being phased in where appropriate.

The High Impedance Torque Converter Clutch solenoid (TCC-H) is a duty cycle

controlled device. The driver turns the solenoid "ON" for a percentage of

each control period based on the requested duty cycle. Duty cycle is output

to a DUCE chip, which then controls the Universal Power Output Driver (UPOD).

The UPOD driver controls the TCC and returns a "fault status" (TCC\_H\_FAULT)

for the TCC circuit. The fault status can be decoded as follows:

TCC\_H\_FAULT = 0 --> no fault present.

TCC\_H\_FAULT = 1 --> a fault has been detected.

Note: The fault status lags the commanded state by 1 background - ie is for

the last commanded duty cycle.

Also, to be able to fully diagnose all faults the solenoid must be tested at

OFF (0% duty cycle) and fully ON (100% duty cycle). Monitoring TCC\_H\_FAULT

at mid-range duty cycles will not cause false error detections, but could

result in a failure being missed.

Due to this restriction, the solenoid will only be tested at 0% and 100% duty

cycle.

In addition to the output state monitor, there will be two rationality checks

performed on the mlus/converter clutch system during continuous operation:

1. mlus\_tst - verifies that the converter clutch is applied when commanded

on by comparing actual slip to target slip. If excessive slip is

detected when hardlock duty cycle is commanded, error code P0741 will be

set.

2. catchnet - monitors the converter clutch system for instability (surge)

during soft lock operation. If converter clutch surge is detected, error

code P1741 will be set.

28-41

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- BCSDC = Modulated bypass clutch duty cycle.

- BCSDC\_OUT = Modulate bypass clutch duty cycle output to the DUCE.

- BRK\_AWAY\_CNT = The number of converter clutch break aways detected.

- ERR\_T0 = Current slip error (SLIP\_DES\_S - SLIP\_ACT).

- LUS\_PW\_DTKS = Modulated bypass clutch lockup solenoid duty cycle

pulsewidth in duce\_ticks.

- LUS\_PW\_DUCE = DUCE hardware register.

- MLUS\_DLY\_TMR = MLUS test delay and verification timer, delays testing

during initial MLUS controller transients, and determines the durtation

of high slip for error verification.

- MLUS\_ERR\_CNT = Modulated bypass clutch lockup solenoid error fault

filter.

- MLUS\_NT\_TMR = Modulated bypass clutch lockup solenoid normal temperature

delay timer.

- MLUS\_OT\_CNT = Modulated bypass clutch lockup solenoid hot fault filter.

- MLUS\_OT\_TMR = Modulated bypass clutch lockup solenoid overtemperature

timer.

- NTBART = Filtered transmission turbine speed.

- P0741CNT = Fault 0741 warm up cycle counter.

- SLIP\_DES = Desired value of slip.

- SLIP\_DES\_LST = Previous value of SLIP\_DES.

- SLP\_TDLY\_TMR = Converter clutch continuous slip test transient delay

timer.

- TCC\_CTL\_TMR = TCC control timer, used in TCC functional test to determine

when the system is under control - defines a "good" lock-up event.

- TCC\_H\_FAULT = High impedance TCC fault status; 0 -> no fault present.

- TCC\_OSM\_TMR = Modulated bypass clutch lockup solenoid output state

monitor timer.

- TMSLBRK = Time since last converter clutch break away.

- TM\_BRK\_AWAY = Time at which the current break away occurred.

- TM\_BRK\_PREV = Time at which the previous break away occurred.

28-42

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TM\_BRK\_ZONE = Total time ERR\_T0 has been in the break away zone.

- TOT = Transmission operating temperature.

- TP\_REL = Relative TP (TP - RATCH).

- TP\_REL\_ENT = Value of TP\_REL at the entry of continuous slip test mode.

28-43

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TSTRAT = Transmission strategy switch; The TSTRAT software switch

controls which transmission control strategy is executed:

0 -> No transmission control (Manual trans., AOD, ATX, C6, C3, etc.)

1 -> SIL (Shift indicator light)

2 -> A4LD with 3-4 shift control and converter clutch control

3 -> AXOD

4 -> C64E (E4OD)

5 -> A4LDE

6 -> FAX-4

7 -> AOD-E (AOD-I)

8 -> 4EAT

9 -> CD4E

- TQ\_NET = Net torque into torque converter.

- TQ\_NET\_ENT = Value of TQ\_NET at the entry of continuous slip test mode.

- VBAT = Battery voltage.

- VSBART = Filtered vehicle speed for Transmission in MPH.

Bit Flags:

- ACCFLG = A/C clutch status; 0 -> disengaged, 1 -> engaged.

- AC\_STATE\_ENT = AC clutch state at the entry of converter clutch soft lock

test mode.

- CCM\_TST\_ENA = Comprehensive component monitor test enable flag; 1 -> ccm

tests are enabled.

- CC\_FM\_FLG = Converter clutch failure mode flag; 0 -> normal operation, 1

-> execute converter clutch failure mode.

- FLG\_CRV\_DS = Desired state of converter clutch based on schedule curves.

- FLG\_CRV\_LST = Last pass value of FLG\_CRV\_DES.

- FLG\_DIS\_CSM = Disable continuous slip mode flag; 0 -> continuous slip

enabled, 1 -> continuous slip disabled.

- FLG\_HIGH\_SLP = MLUS test high slip flag; 0 -> slip is ok, 1 -> excessive

slip detected during hardlock.

- FLG\_HT\_MOD = Flag indicating high temperature slip modulation allowed; 1

-> modulation allowed, 0 -> not allowed.

- FLG\_OPEN = MLUS is in open mode, no capacity when set.

- FLG\_OPEN\_LST = Last pass value of FLG\_OPEN

- FLG\_OT\_LK = Trans. overtemperature lockup mode flag.

- FLG\_PID\_CTL = Mod. byp. clutch pid control flag.

- FLG\_SFT\_IN = Shift in progress flag.

28-44

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_TST\_BRK = continuous slip test entry flag; 0 -> do not test, 1 ->

test for break away.

- FLG\_VER\_BRK = Verify converter clutch break away flag; 0 -> no

verification in progress, 1 -> verification in progress.

- MLUS\_FM\_FLG = Flag used to allow FMEM action without storage of a service

code.

- MLUS\_HF\_FLG = Flag used to signal half fuel once the converter clutch has

failed.

- PxxxFAULT = OBDII fault flag for code xxx.

- PxxxMALF = OBDII malfunction flag for fault XXX; 1 -> malfunction xxx

currently exits.

- PxxxMON = OBDII fault monitor flag.

- OSM\_EO\_OFF = KOEO OSM Off test requested by OBDII sequencer; 1 -> Command

output off and monitor circuit for off state.

- OSM\_EO\_ON = KOEO OSM On test requested by OBDII sequencer; 1 -> Command

output on and monitor circuit for on state.

- SUBST\_REQ15 = Substitution requested flag for channel 15.

- TCC\_CTL\_FLG = Flag indicating a "good" converter clutch lock-up has

occurred; 1 -> the last TCC lock-up was a "good" event.

- TCC\_MON\_OFF = TCC monitor off flag; 1 -> Off state has been observed to

function this power-up.

- TCC\_MON\_ON = TCC monitor on flag ; 1 -> On state has been observed to

function this power-up.

Calibration Constants:

- BCSDC\_HRD = BCSDC when converter is hardlocked.

- BRK\_AWAY\_LVL = Number of break aways at which continuous slip will be

disabled.

- CC\_FM\_LVL = Number of warm up cycles that converter clutch failure mode

action will be executed after error detection.

- CNET\_TP\_MIN = Minimum throttle position to allow catchnet test entry.

- ECSM\_LVL = Number of warm up cycles continuous slip mode will be disabled

before allowing continuous slip mode again.

- ENA\_CSLP\_TST = continuous slip test calibration switch; 0 -> test

disabled, 1 -> test enabled.

- ERR\_BRK\_AWAY = Value of ERR\_T0 (with no transients) that means the

converter clutch has broken away.

28-45

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- ERR\_TST\_BRK = Max value of ERR\_T0 to allow continuous slip test mode to

be initiated.

- LUS\_PRD\_DT = DUCE LUS period in duce\_ticks.

- MAX\_SLIP\_DIF = maximum desired slip change (SLIP\_DES) allowed before test

transient delay takes effect.

- MX\_SLIP\_ERR = maximum ERR\_T0 (MLUS PID controller input error) indicating

effective control.

- MLUS\_ERR\_LVL = mlus fault threshold for excessive slip error (fault code

0741).

- MLUS\_MX\_TOT = TOT high temp limit to test MLUS, max value of TOT for

which a detected converter clutch error will be defined as a fault and

not due to transmission overtemperature.

- MLUS\_NT\_DLY = Time allowed between lockup attempts at normal temperature.

- MLUS\_OT\_DLY = Time allowed between lockup attempts at high temperature.

- MLUS\_OT\_VAL = Maximum counts of attempting Converter Clutch locks under

hot conditions before fmem action.

- MLUS\_TDLY\_TM = MLUS test initial transient delay time.

- MLUS\_TST\_ENA = continuous MLUS test enable switch; 1 -> enable.

- MLUS\_UPCNT = mlus excessive slip error upcount.

- MX\_HISLP\_TM = Maximum time slip can be high without being defined as an

error.

- MX\_OTSLP\_TM = Maximum time slip can be high during transmission overtemp

mode without being defined as an error.

- MX\_TMSLBRK = Max time between break aways for which the break away count

will be updated.

- SLIP\_DIF\_MX = Max change in slip desired under which a break away will be

recognized.

- SLP\_TDLY\_TIM = Slip transient delay time.

- SW\_0741\_NMIL = Switch to allow setting a NON-MIL code for a P0741 fault.

- SW\_1744\_MIL = Switch to allow setting a MIL code for a P1744 fault.

- TCC\_CTL\_SLIP = Maximum amount of TCC slip error (abs[desired - actual])

to allow the current lock-up event to be called "good".

- TCC\_CTL\_TIM = Amount of time TCC slip must be under control to call the

current lock-up event "good".

- TOT\_DES\_HF = Temperature to desire half fuel under fmem for converter

clutch.

28-46

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TOT\_DES\_FF = Temperature to desire full fuel under fmem for converter

clutch.

- TCC\_DC\_OFF = Duty cycle below which the TCC solenoid electrically Off

state will be tested.

- TCC\_DC\_ON = Duty cycle above which the TCC solenoid electrically On state

will be tested.

- TCC\_ERR\_TIM = Maximum amount of time the mlus output state monitor can

read the wrong state without an error code (0743) being set.

- TCC\_ON\_TSTSW = Calibration switch used to enable/disable turing TCC

solenoid On at start-up to test the On state.

- TP\_DIF\_MX = Max change in TP\_REL under which a break away will be

recognized.

- TQ\_DIF\_MX = Max change in TQ\_NET under which a break away will be

recognized.

- TSSMIN = Minimum turbine speed to assume sensor output is present.

- VBAT\_CCM\_MIN = Minimum battery voltage to allow TCC OSM test entry.

- VS\_DES\_FF = Vehicle speed to desire full fuel under fmem for converter

clutch.

- VS\_DES\_HF = Vehicle speed to desire half fuel under fmem for converter

clutch.

- VER\_BRK\_TIM = Min time ERR\_T0 must remain in break away zone to be

counted as a break away.

OTHER

- mlus\_codes = SET OF {P0741, P0743, P1741} the set of OBDII fault codes

that relate to the mlus.

- malfunction{ccm,Pxxx} = Logic process, imported from MIL control module;

Pxxx indicates a fault code.

- P0741 = Fault code, exessive slip detected across the converter clutch.

- P0743 = Fault code, mlus circuit failure detected (KOEO or CCM).

- P1741 = Fault code, converter clutch instability (surge) detected by the

catchnet strategy.

- store\_code(Pxxx) = Logic process, used when NON-MIL faults are detected.

PROCESS

STRATEGY MODULE: CCC\_MLUS\_OBDII\_COM5

28-47

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Once per background the following logic is executed:

TSTRAT <= 3 ----------------------|

(Manual/non-electric |

transmission) |AND -| Do: OSC\_RESPONSE(15,10h)

| | ;send general reject

SUBST\_REQ15 = 1 ------------------| | Exit module

|

| --- ELSE ---

|

TSTRAT <= 3 ----------------------------| Exit module

(Manual/non-electric transmission) |

| --- ELSE ---

|

| Do: bcsdc\_out\_calc

| Do: bcsdc\_duce\_pw

| Do: tcc\_h\_osm

| Do: mlus\_tst

| Do: catchnet

| Exit module

28-48

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: bcsdc\_output

This logic determines the duty cycle to be output to the MLUS as follows:

Normal operation - the duty cycle determined by the converter clutch

control strategy will be output to the duce.

Engine Off on-demand self test - the MLUS will be commanded ON

(TCC\_DC\_ON) or OFF (TCC\_DC\_OFF) based on the OSM\_EO\_ON/OFF flags

(controlled by the Engine Off OBD-II Sequencer).

unconditionally ------------------------| BCSDC\_LST = BCSDC\_OUT

| (record last value of duty cycle)

OSM\_EO\_OFF = 1 -------------------------| bcsdc\_out = TCC\_DC\_OFF

| (Engine Off, OSM off test

| in progress, command MLUS

| OFF)

|

| --- ELSE ---

OSM\_EO\_ON = 1 --------------------| |

| |

FLG\_FRST\_TV = 0 ------------| |OR --| bcsdc\_out = TCC\_DC\_ON

(no engagement yet) | | | (Engine Off, OSM on test

| | | in progress; or no engagement

TCC\_MON\_ON = 0 -------------|AND -| | yet, command MLUS ON to test

(On state not monitored) | | the ON state)

| |

TCC\_ON\_TSTSW = 1 -----------| |

(TCC On test cal'ed in) |

| --- ELSE ---

|

| bcsdc\_out = BCSDC

| (Normal operation, output

| duty cycle determined by

| MLUS control strategy)

unconditionally ------------------------| Do: substitute(15,bcsdc\_out)

| BCSDC\_OUT = bcsdc\_out

| (perform output state control

| override)

END: bscdc\_output

28-49

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: bcsdc\_duce\_pw

This routine computes the modulated bypass clutch solenoid pulsewidth for the

DUCE chip in units of duce\_ticks.

always ---------------------------------| LUS\_PW\_DTKS = BCSDC\_OUT \*

| LUS\_PRD\_DT

| (clip to 65535 duce\_ticks)

|

| LUS\_PW\_DUCE = LUS\_PW\_DTKS

|

| TCC\_H\_FAULT = fault status from

| TCC-H UPOD channel.

END: bcsdc\_duce\_pw

28-50

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: tcc\_h\_osm

The Torque Converter Clutch High impedance Solenoid (TCC-H) Circuit is tested

using feedback from the drive, same logic used for engine off and continuous

self test:

OSM\_EO\_OFF = 0 -------------|

|

OSM\_EO\_ON = 0 --------------|AND -|

| |

CCM\_TST\_ENA = 0 ------------| |

(All CCM monitoring disabled) |

|

BCSDC\_OUT <> BCSDC\_LST -----------|

(Duty cycle changed) |OR --| TCC\_OSM\_TMR = 0

| | (Comprehensive component

VBAT < VBAT\_CCM\_MIN --------------| | monitor disabled or TCC

(Battry voltage too low) | | operating in mid-range or

| | duty cycle changed - wait

BCSDC\_OUT > TCC\_DC\_OFF -----| | | one background for fault

(TCC is not Off) |AND -| | status to update)

| |

BCSDC\_OUT < TCC\_DC\_ON ------| |

(TCC not fully On) |

| --- ELSE ---

BCSDC\_OUT = TCC\_DC\_ON ------------| |

(TCC fully On) |AND -| TCC\_MON\_ON = 1

| | clear\_malf(P0743)

TCC\_H\_FAULT = 0 ------------------| | TCC\_OSM\_TMR = 0

(No fault present) | (no error - zero error timer)

|

| --- ELSE ---

BCSDC\_OUT = TCC\_DC\_OFF -----------| |

(TCC fully Off) |AND -| TCC\_MON\_OFF = 1

| | clear\_malf(P0743)

TCC\_H\_FAULT = 0 ------------------| | TCC\_OSM\_TMR = 0

(No fault present) | (no error - zero error timer))

|

| --- ELSE ---

|

TCC\_OSM\_TMR > TCC\_ERR\_TIM --------------| malfunction(ccm,P0743)

(error present long enough) | (error detected, set

| malfunction flag)

P0743MALF = 1 ------------------------|

(TCC circuit failure detected) |

|

TCC\_MON\_ON = 1 -----------| |OR --| P0743MON = 1

(TCC On state monitored) |OR --| | | (TCC circuit monitored

| | | | for the current power-up)

TCC\_ON\_SW = 0 ------------| | |

(Do not count on state |AND -|

as part of a trip) |

|

TCC\_MON\_OFF = 1 ----------------|

(TCC Off state monitored)

END: tcc\_h\_osm

28-51

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: mlus\_tst

The MLUS is a duty cycled solenoid that controls the converter clutch and is

controlled by the EEC MLUS strategy. The MLUS is either hardlocked,

softlocked (running continuous slip), or in the unlocked state. When the

system is attempting to control slip to a desired value (hardlock or

softlock), this test delays testing of the system via MLUS\_DLY\_TMR until any

initial transients have settled. Once the transient delay time is over, the

test monitors slip to determine if the converter clutch is operating

correctly.

High slip when hard lock or soft lock is commanded can result in two types of

errors:

a) Error due to a converter clutch problem - unconditionally unlock the

converter clutch and fault filter code 0741.

b) Error due to transmission overtemperature - unconditionally unlock the

converter clutch.

Once a converter clutch error has been detected, the action taken depends on

the transmission temperature status:

1) If the error is due to normal temperature conditions, the converter will

try to relock after a relatively LONG delay time has expired. The converter

will also try to relock if a transition from unlock desired to lock desired

(based on the schedules) is detected. Multiple lockup attempts will only

occur for a calibrated number of times before a fault code is set. Once a

fault code is set, the transmission will not be allowed to relock the

converter clutch.

2) If the converter clutch error is caused due to high temperature, the

converter will try to relock after a set period of time. After a calibrated

number of failures, the converter will no longer try to relock in overtemp

mode. No code is set for an overtemp failure.

Note: Once the mlus error code (0741) is set, the converter clutch failure

mode action (unconditional unlock of converter clutch, clipping EPC

to TVFMMN as a minimum, flashing the TCIL) will be executed for a

calibratable number of warm up cycles.

Also, the only way that the fault fiter for code 0741 can be

downcounted is if a transition from locked to unlocked is commanded and

no error has been detected. (downcount once for a "good" converter

clutch event)

28-52

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

failure mode exit logic:

Once a converter clutch fault code has been stored, converter clutch fmem

action is controlled by CC\_FM\_FLG. This flag will remain set for a

calibratable number of warm up cycles; during which the converter clutch will

be unconditionallly unlocked, EPC will be clipped to TVFMMN as a minimum, and

the TCIL will flash (if enabled).

Once CC\_FM\_FLG is set or the max number of TCC failures for overtemp have

occured, the engine will go to half fuel IF vehicle speed and temperature

exceed calibrated values.

P0741FAULT = 1 -------------------|

|

P0741CNT < CC\_FM\_LVL -------------|

(Execute failure mode action |AND -|

for a calibratible number | |

of warm-up cycles) | |

| |

SW\_1744\_MIL = 0 ------------------| |OR --| CC\_FM\_FLG = 1

(do not light MIL for this fault) | | (Execute converter clutch)

| | failure mode action)

| |

P1744MALF = 1 --------------------------| |

| --- ELSE ---

|

| CC\_FM\_FLG = 0

For a normal temperature detected error, the flag causing the uncond. unlock

(MLUS\_FM\_FLG) is cleared after MLUS\_NT\_DLY timer is downcounted or the next

time the converter clutch lock-unlock schedule is crossed. For an overtemp.

detected failure, the flag causing the unconditional unlock (MLUS\_FM\_FLG) is

cleared after MLUS\_OT\_DLY timer is downcounted. The converter will continue

to try to relock when the timer downcounts until the number of attempts

exceeds a calibrated amount.

MLUS\_FM\_FLG = 1 ------------------------|

|

FLG\_CRV\_DS = 1 -------------------------|

|AND -| MLUS\_FM\_FLG = 0

| | (Conditions met

MLUS\_NT\_TMR = 0 ------| | | to exit mlus fmem)

|OR --| |

FLG\_CRV\_LST = 0 ------| | |

|AND -| |

TOT <= MLUS\_MX\_TOT ---------| | |

|OR --|

MLUS\_OT\_CNT < MLUS\_OT\_VAL --| |

| |

MLUS\_OT\_TMR = 0 ------------|AND -|

|

TOT > MLUS\_MX\_TOT ----------|

28-53

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MLUS feedback controller test delay logic: the MLUS test may be disabled by

calibrating MLUS\_TST\_ENA to 0. Tesing of the MLUS feedback controller is

delayed via the MLUS\_DLY\_TMR, which is cleared under the following

conditions:

P0743MALF = 1 --------------------|

(MLUS electrically |

malfunctioning) |

|

CCM\_TST\_ENA = 0 ------------------|

(CCM disabled) |

|

MLUS\_TST\_ENA = 0 -----------------|OR --| MLUS\_DLY\_TMR := 0

(test cal'd out) | | FLG\_HIGH\_SLP = 0

| | TCC\_CTL\_TMR = 0

FLG\_SFT\_IN = 1 -------------------| |

(shift in progress) | |

| |

NTBART < TSSMIN ------------------| |

(Turbine speed unavailable) | |

| |

|SLIP\_DES\_LST - SLIP\_DES| | |

> MAX\_SLIP\_DIF --| |

(large change in desired slip) |

| --- ELSE ---

|ERR\_T0| > TCC\_CTL\_SLIP ----------| |

;Slip is not under control |OR --| TCC\_CTL\_TMR = 0

| | ;TCC does not have

FLG\_OPEN = 1 ---------------------| | slip under control

;TCC commanded open | OR TCC is open, zero

| TCC under control timer.

|

| --- ELSE ---

|

TCC\_CTL\_TMR >= TCC\_CTL\_TIM -------------| TCC\_CTL\_FLG = 1

;TCC slip under control long enough | ;TCC under control

| for this lock event.

28-54

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

test logic:

|ERR\_T0| <= MX\_SLIP\_ERR ----------|

|AND -| FLG\_HIGH\_SLP = 0

FLG\_OPEN = 0 ---------------------| | (Slip is within limits,

(Converter clutch is commanded on) | clear the high slip flag)

|

| --- ELSE ---

FLG\_HIGH\_SLP = 1 -----------------| |

| |

MLUS\_DLY\_TMR > MX\_HISLP\_TM -------|AND -| MLUS\_FM\_FLG = 1

| | FLG\_HIGH\_SLP = 0

TOT <= MLUS\_MX\_TOT ---------------| | MLUS\_NT\_TMR = MLUS\_NT\_DLY

| MLUS\_ERR\_CNT = MLUS\_ERR\_CNT

| + MLUS\_UPCNT

| Do: mlus\_monitor\_logic

| (high slip has lasted long

| enough to be defined as an

| error, do fault filtering,

| unconditionally unlock the

| converter clutch)

|

| --- ELSE ---

FLG\_HIGH\_SLP = 1 -----------------| |

| |

MLUS\_DLY\_TMR > MX\_OTSLP\_TM -------|AND -| MLUS\_FM\_FLG = 1

| | FLG\_HIGH\_SLP = 0

TOT > MLUS\_MX\_TOT ----------------| | MLUS\_OT\_TMR = MLUS\_OT\_DLY

| MLUS\_OT\_CNT = MLUS\_OT\_CNT

| + MLUS\_UPCNT

| (high slip due to

| overtemperature unconditionally

| unlock the converter clutch)

|

| --- ELSE ---

FLG\_HIGH\_SLP = 0 -----------------| |

| |

BCSDC >= BCSDC\_HRD ---------------| |

|AND -| FLG\_HIGH\_SLP = 1

MLUS\_DLY\_TMR > MLUS\_TDLY\_TM ------| | MLUS\_DLY\_TMR = 0

| | (high slip detected, reset mlus

|ERR\_T0| > MX\_SLIP\_ERR -----------| | timer to allow verification of

| the error)

| TCC\_CTL\_FLG = 0

| ;Zero the "good" event flag

| if a slip error is detected.

|

| --- ELSE ---

(continued on next page)

28-55

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

MLUS\_FM\_FLG = 0 ------------------| |

| |

TCC\_CTL\_FLG = 1 ------------------| |

|AND -| TCC\_CTL\_FLG = 0

FLG\_OPEN = 1 ---------------------| | ;Only count event once.

| | MLUS\_ERR\_CNT = MLUS\_ERR\_CNT - 1

FLG\_OPEN\_LST = 0 -----------------| | Do: mlus\_monitor\_logic

| (Transition from locked to

| unlocked commanded, no error

| detected, and TCC was under

| control, downcount the fault

| fiter once for a good event)

Under conditions where the converter clutch fails, it is desired to force the

engine to go to half fuel to deter any more damage to the transmission.

VSBART > VS\_DES\_HF ---------------------|

(vs high enough to desire half\_fuel |

|AND -| MLUS\_HF\_FLG =1

TOT > TOT\_DES\_HF -----------------------| | (Set flag for half\_fuel)

(temp high enough to desire half\_fuel) | |

| |

CC\_FM\_FLG = 1 --------------------| | |

(fault code set for CC) | | |

|OR --| |

MLUS\_OT\_CNT >= MLUS\_OT\_VAL -------| |

(trans too hot to lock CC) |

|

VSBART < VS\_DES\_FF ---------------------| |

|OR --| MLUS\_HF\_FLG = 0

TOT < TOT\_DES\_FF -----------------------|

END: mlus\_tst

28-56

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: mlus\_monitor\_logic

SW\_0741\_NMIL = 1 -----------------|

(allow a NON-MIL code for a |

P0741 fault) |

|AND -| P0741MALF = 1

MLUS\_ERR\_CNT >= MLUS\_ERR\_LVL -----| | P0741MON = 1

| | store\_code(P0741)

FLG\_SS\_MON = 1 -------------------| | (mlus falut detected)

(Shift validation monitoring |

complete) |

| --- ELSE ---

FLG\_SS\_MON = 0 -------------------| |

|OR --| P0741MALF = 0

MLUS\_ERR\_CNT = 0 -----------------| | P0741MON = 1

| (mlus monitored or cannot

| perform accurate test)

SW\_1744\_MIL = 1 ------------------|

(allow a MIL code for |

this fault) |

|AND -| malfunction (CCM,P1744)

MLUS\_ERR\_CNT >= MLUS\_ERR\_LVL -----| | P1744MALF = 1

| | P1744MON = 1

FLG\_SS\_MON = 1 -------------------| |

(Shift validation monitoring |

complete) |

| --- ELSE ---

FLG\_SS\_MON = 0 -------------------| |

|OR --| P1744MALF = 0

MLUS\_ERR\_CNT = 0 -----------------| | (mlus monitored or cannot

| perform accurate test)

| P1744MON = 1

END: mlus\_monitor\_logic

28-57

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: catchnet

Catchnet is designed to dertermine if the converter clutch is going out of

control (breaks away) during soft lock operation. In the event that a break

away is detected, a counter is incremented. If a calibratable number of

break aways have been detected soft lock mode will be disabled (for a

calibratable number of warm up cycles), and hard lock will be commanded

whenever soft lock is asked for by the strategy.

The modulated bypass clutch soft lock test has three modes (ENTRY, TEST, and

VERIFY).

1. ENTRY MODE (FLG\_TST\_BRK = 0, FLG\_VER\_BRK = 0):

during this mode the test looks for slip to enter a control region

(SLIP\_ABS - SLIP\_DES < ERR\_TST\_BRK) to determine if the test mode can be

entered. Upon entering soft lock mode, after a transient, or after a

break away, slip must enter the control region before the test mode will

be entered.

2. TEST MODE (FLG\_TST\_BRK = 1, FLG\_VER\_BRK = 0):

Once slip is within the control region, this mode checks that slip stays

within the expected operating region (SLIP\_ABS - SLIP\_DES < ERR\_BRK\_AWAY)

as long as there has been no transient to account for the change in slip

(the test will return to entry mode if a transient occurs). If the

converter clutch does break away (SLIP\_ABS - SLIP\_DES > ERR\_BRK\_AWAY),

the verify mode is entered.

3. VERIFY MODE (FLG\_TST\_BRK = 0, FLG\_VER\_BRK = 1):

In this mode the time slip enters the break away zone is stored, and the

test then looks for slip to remain in the break away region for a

calibratable amount of time to verify that a break away has occurred

(prevent noise from being counted as a break away). If the break away is

verified this mode looks at the time between break aways to determine if

the frequency of break aways is within the expected range. if the time

between break aways is within range, the break away counter is

incremented; otherwise the counter is reset to zero. The test records

when the break away occurred (saves the time the break away occurred at

for the frequency check the next time a break away is verified), and then

returns to entry mode, waiting slip to enter the control region before

testing it again (only count a break away once).

Once a calibratable nunber of break aways have occurred, soft lock mode will

be disabled until a calibratable number of warm up cycles have occurred.

If too much time has pas since the last break away, the break away counter

will be set to zero.

28-58

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Disabled continuous slip mode exit logic:

P1741CNT >= ECSM\_LVL -------------|

|OR --| FLG\_DIS\_CSM = 0

P1741FAULT = 0 -------------------| |

| (enough warm up cycles have

| passed to re-enable continous

| slip mode, or the fault code

| has been cleared)

Test logic:

Update transient determination conditions if slip is within the control

region:

|ERR\_T0| < ERR\_TST\_BRK -----------|

(Slip within the control region) |AND -| TP\_REL\_ENT = TP\_REL

| | (TP has decreased, save

TP\_REL < TP\_REL\_ENT --------------| | the min. value observed

| in the control region used

| to detect transients)

|ERR\_T0| < ERR\_TST\_BRK -----------|

(Slip within the control region) |AND -| TQ\_NET\_ENT = TQ\_NET

| | (TQ has decreased, save

TQ\_NET < TQ\_NET\_ENT --------------| | the min. value observed

| in the control region, used

| to detect transients)

28-59

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CCM\_TST\_ENA = 0 ------------------|

(CCM disabled) |

|

FLG\_HT\_MOD = 0 -------------------|

(not in continuous slip mode) |

|

FLG\_OT\_LK = 1 --------------------|

(in hot lockup mode) |

|

ENA\_CSLP\_TST = 0 -----------------|

(test disabled) |

|

FLG\_PID\_CTL = 0 ------------------|

(not in PID control) |

|

|SLIP\_DES - SLIP\_DES\_LST| > |

SLIP\_DIF\_MX --|OR --| SLP\_TDLY\_TMR = SLP\_TDLY\_TIM

(Change in desired slip) | | BRK\_AWAY\_CNT = 0

| | TQ\_NET\_ENT = TQ\_NET

FLG\_SFT\_IN = 1 -------------------| | TP\_REL\_ENT = TP\_REL

(Shift in progress) | | AC\_STATE\_ENT = ACCFLG

| | FLG\_TST\_BRK = 0

TQ\_NET - TQ\_NET\_ENT > TQ\_DIF\_MX --| | FLG\_VER\_BRK = 0

(Torque has increased enough | | (Test entry conditions have not

to cause an increase in slip) | | been met, or a transient has

| | occurred, set delay timer and

TP\_REL - TP\_REL\_ENT > TP\_DIF\_MX --| | place the test in entry mode)

(TP has increased enough to | |

cause an increase in slip) | | EXIT catchnet

|

TP\_REL < CNET\_TP\_MIN -------------|

(TP below min value to allow |

test entry) |

|

ACCFLG <> AC\_STATE\_ENT -----------|

(AC has changed states)

28-60

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SLP\_TDLY\_TMR = 0 -----------------|

(transient delay over) |

|

FLG\_TST\_BRK = 0 ------------------|AND -| FLG\_TST\_BRK = 1

(not in test mode) | | FLG\_VER\_BRK = 0

| | (slip has entered the

|ERR\_T0| < ERR\_TST\_BRK -----------| | control region, store

(slip is within the test entry region) | transient determination

| parameters and initiate

| test mode)

|

| --- ELSE ---

FLG\_TST\_BRK = 1 ------------------| |

(in test mode) |AND -| FLG\_TST\_BRK = 0

| | FLG\_VER\_BRK = 1

|ERR\_T0| > ERR\_BRK\_AWAY ----------| | TM\_BRK\_AWAY = current time in

(slip is in the break away zone) | milliseconds

| TM\_BRK\_ZONE = 0

| (possible break away detected,

| initiate verify mode and store

| the time at which the break

| away occurred)

|

| --- ELSE ---

FLG\_VER\_BRK = 1 ------------------| |

(in verify mode) |AND -| TM\_BRK\_ZONE = current time in

| | milliseconds - TM\_BRK\_AWAY

|ERR\_T0| > ERR\_BRK\_AWAY ----------| | (slip is still in the break away

(slip is in the break away zone) | zone, calculate total time in

| the zone)

|

| --- ELSE ---

|

FLG\_VER\_BRK = 1 ------------------------| FLG\_TST\_BRK = 1

(in verify mode) | FLG\_VER\_BRK = 0

| (slip is no longer in the break

| away zone return to test mode)

28-61

CONVERTER CLUTCH CONTROL, MLUS CONTROL AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BRK\_AWAY\_CNT > 0 -----------------------| TMSLBRK = current time in

| milliseconds - TM\_BRK\_PREV

| (calculate time since

| last break away)

|

| --- ELSE ---

|

| TMSLBRK = 0

| (break away count is zero,

| set time since last break

| away to zero)

NOTE TO SOFTWARE: Please protect for clock roll-overs in the calculation

of TMSLBRK.

FLG\_VER\_BRK = 1 ------------------|

(in verify mode) |

|

TM\_BRK\_ZONE > VER\_BRK\_TIM --------|AND -| FLG\_VER\_BRK = 0

(enough time to verify break | | BRK\_AWAY\_CNT =

away has passed) | | BRK\_AWAY\_CNT + 1

| | TM\_BRK\_PREV = TM\_BRK\_AWAY

TMSLBRK <= MX\_TMSLBRK ------------| | TM\_BRK\_ZONE = 0

(time since last break away is | (break away detected,

within limit) | frequency of break away

| is within expected range)

|

| --- ELSE ---

|

TMSLBRK > MX\_TMSLBRK -------------------| BRK\_AWAY\_CNT = 0

BRK\_AWAY\_CNT > BRK\_AWAY\_LVL ------------| FLG\_DIS\_CSM = 1

| (disable continuous slip

| mode, allow only hardlock

| mode)

|

| store\_code(P1741)

END: catchnet

28-62

CONVERTER CLUTCH CONTROL, FAILURE MODE MANAGEMENT LOCK-UP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.10 FAILURE MODE MANAGEMENT LOCK-UP (CDAA0)

OVERVIEW

This module determines converter clutch lock-ups during a TP Sensor or a

Output Shaft Speed Sensor failure. If the Output Shaft speed sensor fails,

locks are based on a function of NEBART and TP\_REL. If the TP Sensor fails,

locks are based on SPD\_RATIO.

Once an FMEM lock-up is requested, locks continue to be based on this module,

until the next power-up.

Unlocks occur as a result of Unconditional unlocks only.

DEFINITIONS

INPUTS

Registers:

- GR\_CM = Commanded gear.

- NEBART = Filter engine speed, RPM.

- SPD\_RATIO = Speed Ratio across the torque converter.

Bit Flags:

- FLG\_FMM\_LK = Failure Mode Management lock-up flag; 1 -> lock converter

due to FMEM action.

- FLG\_FMM\_CC = Flag used to insure once FMEM lock-up is activated, it is

not de-activated until next power-up; 0 -> Failure mode lock-up is not in

use this power-up, 1 -> Failure mode lock-up is in use this power-up.

- FLG\_UNC\_UNLK = Converter clutch unconditional unlock flag; 0 -> no

unconditional unlock, 1 -> unconditional unlock.

- OSFMFLG = Ouput shaft speed sensor FMEM flag; 0 -> no OSS failure, 1 ->

OSS failure, operating in FMEM mode.

- TFMFLG = TP FMEM flag; 0 -> no TP failure, 1 -> TP failure, operating in

FMEM mode.

28-63

CONVERTER CLUTCH CONTROL, FAILURE MODE MANAGEMENT LOCK-UP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- FN689L(TP\_REL) = Engine Speed to lock converter when TP sensor is still

available, for Failure Mode Management, RPM.

- NELK\_FM = Engine Speed to lock converter when TP sensor has failed, for

Failure Mode Management, RPM.

- SRLK\_FM = Speed Ratio to lock converter for Failure Mode Management.

OUTPUTS

Bit Flags:

- FLG\_FMM\_LK = Failure Mode Management lock-up flag; 1 -> lock converter

due to FMEM action.

- FLG\_FMM\_CC = Flag used to insure once FMEM lock-up is activated, it is

not de-activated until next power-up; 0 -> Failure mode lock-up is not in

use this power-up, 1 -> Failure mode lock-up is in use this power-up.

28-64

CONVERTER CLUTCH CONTROL, FAILURE MODE MANAGEMENT LOCK-UP - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_FMEM\_COM3

FLG\_FMM\_LK = 1 -----------------------------------|

(Failure Mode Lock Requested) |AND -| FLG\_FMM\_LK = 0

| | (Reset FMEM

FLG\_UNC\_UNLK = 1 ---------------------------------| | lock-up flag)

(Unconditional Unlock Requested)

GR\_CM <= 2 ---------------------------------------------| EXIT module

|

| --- ELSE ---

|

OSFMFLG = 1 --------------------------------| |

(OSS failure) | |

| |

TFMFLG = 0 ---------------------| |AND -| |

(TP Sensor OK) |AND -| | | |

| | | | |

NEBART > FN689L(TP\_REL) --------| | | | |

(Engine Speed above failure |OR --| | |

mode minimum) | |OR --| FLG\_FMM\_LK = 1

| | | FLG\_FMM\_CC = 1

TFMFLG = 1 ---------------------| | | | (Continue with

(TP Sensor failure) |AND -| | | FMEM Lock-up

| | | until next

NEBART > NELK\_FM ---------------| | | power-up)

(Engine Speed above failure | |

mode minimum) | |

| |

TFMFLG = 1 ---------------------------| | |

(TP Sensor Failure) |OR --| | |

| | | |

FLG\_FMM\_CC = 1 -----------------------| |AND -| |

(FMEM lock-up activated this power-up) | |

| |

SPD\_RATIO > SRLK\_FM ------------------------| |

(Speed Ratio above failure mode minimum) |

| --- ELSE ---

|

| No Action

28-65

CONVERTER CLUTCH CONTROL, TORQUE CAPACITY DETERMINATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.11 TORQUE CAPACITY DETERMINATION LOGIC (CDAN0)

OVERVIEW

This module determines the appropriate Torque Capacity Calculation to be

executed: "shifting" or "non-shifting" (normal).

DEFINITIONS

Registers:

- TCAP\_INTR1 = Interim requested torque capacity, ft-lbs.

- TCAP\_REQ1 = Final requested torque capacity, ft-lbs

Bit Flags:

- FLG\_CLUP = Flag indicating closed loop/TCAP\_REQ1 freeze region for

upshifts.

- FLG\_DNS\_CTL = Downshift slip modulation flag; 1 -> Modifying TCAP\_REQ1

during a downshift.

- FLG\_HRD\_JMP = Flag indicating a jump to hardlock based on high TP and SR

is requested.

- FLG\_HRD\_MODE = Flag indicating converter clutch is physically hardlocked.

- FLG\_OLUP = Flag indicating open loop control region for upshifts.

- FLG\_RMP\_OPEN = Ramp from hard lock to slip control mode.

- FLG\_SFTTOPID = Flag indicating last background pass was shifting tcap\_req

calculation.

- FLG\_STROKE = STROKE mode enabled.

- FLG\_STR\_LST = Last pass value of flg\_stroke.

- FLG\_UPS\_CTL = Upshift slip modulation flag; 1 -> Modifying TCAP\_REQ1

during an upshift.

- FLG\_UPS\_JMP = Flag indicating jump to hardlock mode request - after

upshift.

Calibration Constants:

- TCAP\_PSTR1 = "Pre-stroke" torque capacity, ft-lbs.

28-66

CONVERTER CLUTCH CONTROL, TORQUE CAPACITY DETERMINATION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_TCAP\_DETR\_COM2

always ---------------------------------| FLG\_STR\_LST = FLG\_STROKE

FLG\_CLUP = 1 ---------------------|

|

FLG\_OLUP = 1 ---------------------|

|OR --| FLG\_SFTTOPID = 0

FLG\_UPS\_CTL = 1 ------------------| | FLG\_HRD\_MODE = 0

| | FLG\_HRD\_JMP = 0

FLG\_DNS\_CTL = 1 ------------------| | FLG\_UPS\_JMP = 0

| FLG\_RMP\_OPEN = 0

|

| Do: CCC\_TCAP\_SHFT\_CALC\_COMx

| (perform shifting Torque

| capacity calculation)

|

| FLG\_SFTTOPID = 1

|

| --- ELSE ---

|

| Do: CCC\_TCAP\_NORM\_CALC\_COMx

| (perform non-shifting Torque

| capacity calculation)

| FLG\_SFTTOPID = 0

SW\_EN\_PSTR = 1 -------------------|

|AND -| TCAP\_REQ1 =

FLG\_CRV\_DS = 1 -------------------| | max(TCAP\_INTR1,TCAP\_PSTR1)

(in lock region; apply pre-stroke) |

| --- ELSE ---

|

| TCAP\_REQ1 = TCAP\_INTR1

28-67

CONVERTER CLUTCH CONTROL, SHIFTING TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.12 SHIFTING TORQUE CAPACITY CALCULATION (CDAM0)

OVERVIEW

The Shifting Torque Capacity calculation determines the appropirate value of

the interim requested Torque Capacity (TCAP\_INTR1) during upshifts or

downshifts. Special Torque Capacity calculations outside of the open loop

equation are necessary due to the lack of turbine speed information during a

shift. Outside of shift control the open loop equation for Torque Capacity

is used.

If not shift is in progress then the "Normal Torque Capacity Control" module

is executed.

DEFINITIONS

Registers:

- DELTA\_RATIO = Delta shift ratio change since command of shift.

- DT12S\_AVG = Filtered pip delta for transmission, clock ticks.

- GR\_CM = Commanded gear for shift solenoids.

- NEBART = Filtered engine RPM for transmission.

- NOBART = Filtered output shaft speed in RPM.

- RT\_GR\_CUR = Current transmission gear ratio, dimensionless.

- SPD\_RATIO = Speed ratio across torque converter (output / input).

- SPD\_RT\_STRT = Speed ratio across torque converter at start of shift.

- SR\_PP\_LIM = Power on upshift speed ratio, pip-to-pip limit.

- STCF = Seconds-to-ticks coinversion factor.

- STROKE\_TMR = STROKE mode timer, seconds.

- TCAP\_INTR1 = Interim requested Torque Capacity, ft-lbs.

- TCAP\_REQ1 = Final requested torque capacity, ft-lbs.

- TCAP\_SFT\_ST1 = Torque Capacity at start of the shift.

- TQ\_BAR = Filtered TQ\_NET.

Bit Flags:

- FLG\_DLY\_SOSC = Flag used to delay millisecond "start of shift" check

until SR\_PP\_LIM is calculated once; 1 -> allow millisecond check.

28-68

CONVERTER CLUTCH CONTROL, SHIFTING TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_CLUP = Flag indicating closed loop/BCSDC freeze region for upshifts.

- FLG\_CRV\_LK = Scheduled curve lock-up flag; 0 -> no scheduled lock-up.

- FLG\_DNS\_CTL = Downshift slip modulation flag.

- FLG\_OPN\_BS = Flag indicating converter open at start of upshift; 1 ->

open.

- FLG\_PID\_CTL = Modulated Bypass Clutch PID control flag; 1 -> Modulated

Bypass Clutch in PID control.

- FLG\_STROKE = STROKE mode enabled, BCSDC is held at FNEMGDC1.

- FLG\_TCAPNXT = Set when start of shift detected - causes execution of

CCC\_SHFT\_TCAP\_CALC\_COMx as next background task.

- FLG\_UCTL\_LST = Last pass value of FLG\_UPS\_CTL.

- FLG\_UPS\_CTL = Upshift modulation flag.

- FLG\_FRST\_CM = First time a shift is commanded flag; 0 -> no shift

commanded.

- FLG\_SFT\_STRT = Set when waiting to detect start of shift once its been

commanded.

Calibration Constants:

- DSRU2 = Delta Shift Ratio on Upshift to 2nd to indicate shift started.

- DSRU3 = Delta Shift Ratio on Upshift to 3rd to indicate shift started.

- DSRU4 = Delta Shift Ratio on Upshift to 4th to indicate start of shift.

- FNDNSSFT32 = TCAP\_REQ1 on 3-2 shifts.

- FNDNSSFT43 = TCAP\_REQ1 on 4-3 shifts.

- FNUPSSFT23 = TCAP\_REQ1 on 2-3 shifts.

- FNUPSSFT34 = TCAP\_REQ1 on 3-4 shifts.

- PUL\_PER\_REV = Pulses per revolution number of pips per engine revolution

for E4OD\_GAS 1/2 the number of fuel pump.

- SW\_SUPD = Switch to activate 2nd update of information for c.c. upshift

control; 1 -> update at end of closed loop control.

- TCAPSTR = TCAP\_REQ used for STROKE mode Capacity.

- TCAPSTRMULT = Scalar multiplier of TQ\_BAR to determin stroke torque

capacity.

28-69

CONVERTER CLUTCH CONTROL, SHIFTING TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_TCAP\_SHFT\_CALC\_COM1

(Performed every background loop)

FLG\_FRST\_CM = 1 -------------|

|

FLG\_UPS\_CTL = 1 -------| |OR --| SPD\_RATIO = NOBART \* RT\_GR\_CUR / NEBART

| | | SPD\_RT\_STRT = SPD\_RATIO

FLG\_UCTL\_LST = 0 ------|AND -| | TCAP\_SFT\_ST1 = TCAP\_REQ1

|

SW\_SUPD = 1 -----------|

FLG\_SFT\_STRT = 1 ------------------| SR\_PP\_LIM = (SPD\_RT\_STRT + DSRU[GR\_CM])

| \* 60 \* STCF / (NOBART \* RT\_GR\_CUR \*

| PUL\_PER\_REV)

| FLG\_DLY\_SOSC = 1

| (NOTE to software: Insure update of

| FLG\_DLY\_SOSC follows update of

| SR\_PP\_LIM)

(Performed every 1 mS)

FLG\_SFT\_STRT = 1 ------------|

|

DT12S\_AVG > SR\_PP\_LIM -------|AND -| FLG\_SFT\_STRT = 0

| | FLG\_TCAPNXT = 1

FLG\_DLY\_SOSC = 1 ------------| | FLG\_UPS\_CTL = 1

| FLG\_DLY\_SOSC = 0

| TCAP\_SFT\_ST1 = TCAP\_REQ1

28-70

CONVERTER CLUTCH CONTROL, SHIFTING TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(Performed in Background Manager BEFORE every Background TASK)

FLG\_TCAPNXT = 1 -------------------| Do: Calculate TQ\_net as the

| next background task

| Do: Calculate TCAP\_INTR1 as

| the next background task

| FLG\_TCAPNXT = 0

(Performed once per background loop OR when called as next TASK from

background manager)

Calculate TCAP\_INTR1:

FLG\_UPS\_CTL = 1 -------------------| DELTA\_RATIO = max( SPD\_RATIO -

| SPD\_RT\_STRT, 0)

|

| --- ELSE ---

|

FLG\_DNS\_CTL = 1 -------------------| DELTA\_RATIO = max( SPD\_RT\_STRT -

| SPD\_RATIO, 0)

|

| --- ELSE ---

|

| DELTA\_RATIO = 0

28-71

CONVERTER CLUTCH CONTROL, SHIFTING TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_TCAPNXT = 1 -------------|

|

FLG\_OPN\_BS = 1 --------------|AND -| TCAP\_SFT\_ST1 = TCAPSTR +

| | TQ\_BAR \* TCAPSTRMULT

FLG\_CRV\_LK = 1 --------------| | FLG\_PID\_CTL = 0

|

| --- ELSE ---

FLG\_CRV\_LK = 0 --------------| |

( Includes unconditional | |

unlock ) |OR --| TCAP\_INTR1 = -1

| | FLG\_PID\_CTL = 0

FLG\_OPN\_BS = 1 --------| | | FLG\_STROKE = 0

|AND -| | STROKE\_TMR = 0

FLG\_CLUP = 1 ----------| |

| --- ELSE ---

FLG\_UPS\_CTL = 1 -------------| |

|AND -| No Change

FLG\_SFT\_STRT = 1 ------------| | FLG\_PID\_CTL = 0

|

| --- ELSE ---

FLG\_UPS\_CTL = 1 -------------| |

|AND -| TCAP\_INTR1 = TCAP\_SFT\_ST1 \*

GR\_CM <= 3 ------------------| | FNUPSSFT23(DELTA\_RATIO)

| FLG\_PID\_CTL = 0

|

| --- ELSE ---

FLG\_UPS\_CTL = 1 -------------| |

|AND -| TCAP\_INTR1 = TCAP\_SFT\_ST1

GR\_CM = 4 -------------------| | FNUPSSFT34(DELTA\_RATIO)

| FLG\_PID\_CTL = 0

|

| --- ELSE ---

FLG\_DNS\_CTL = 1 -------------| |

|AND -| TCAP\_INTR1 = TCAP\_SFT\_ST1

GR\_CM = 3 -------------------| | FNDNSSFT43(DELTA\_RATIO)

| FLG\_PID\_CTL = 0

|

| --- ELSE ---

FLG\_DNS\_CTL = 1 -------------| |

|AND -| TCAP\_INTR1 = TCAP\_SFT\_ST1

GR\_CM <= 2 ------------------| | FNDNSSFT32(DELTA\_RATIO)

| FLG\_PID\_CTL = 0

|

| --- ELSE ---

|

FLG\_CLUP = 1 ----------------------| Do: CCC\_PID\_SLIP\_CTL\_COMx

| (perform PID slip control)

| Do: CCC\_TCAP\_CALC\_COMx

| (calculate torque capacity

| using the converter model)

|

| --- ELSE ---

|

| no action

28-72

CONVERTER CLUTCH CONTROL, NORMAL TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.13 NORMAL TORQUE CAPACITY CALCULATION (CDAM0)

OVERVIEW

This module determines the Torque Capacity required at the converter clutch

when not shifting.

DEFINITIONS

Registers:

- BG\_TMR = Background loop timer.

- RMP\_OPEN\_TMR = Timer used to limit time in ramp open mode.

- SLP\_ABS\_CNT = Count of background loops where SLIP\_ABS < SLP\_ABS\_HRD.

- SLIP\_ACT = Actual value of slip, signed.

- SLIP\_DES\_S = Desired value of slip, signed.

- SLIP\_TARGET = Target value of slip from tables.

- SLIP\_TCAP = Total desired slip to be used for torque capacity

calculation.

- SPD\_RATIO = Speed ratio across torque converter (Output / Input).

- STROKE\_SLP = SLIP\_ABS at start of STROKE mode.

- STROKE\_TMR = STROKE mode timer.

- TCAP\_INTR1 = Interim requested torque capacity, ft-lbs.

- TCAP\_REQ1 = Final requested torque capacity, ft-lbs.

- TC\_HRD\_OFF = Torque capacity offset when in hardlock mode, ft-lbs.

- TM\_OFF\_DLY = Converter hardlock torque capacity offset delay timer, secs.

- TP\_REL = Relative TP (TP - RATCH).

- TQ\_BAR = Filtered TQ\_NET.

- TQ\_BAR\_LST = Last pass value of TQ\_BAR, ft-lbs.

Bit Flags:

- FLG\_CLUP = Flag indicating closed loop/BCSDC freeze region for upshifts.

- FLG\_CRV\_LK = Scheduled curve lockup flag.

- FLG\_FMM\_LK = Failure Mode Management Lock-up flag; 1 -> lock converter

due to FMEM action

28-73

CONVERTER CLUTCH CONTROL, NORMAL TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_HRD\_JMP = Flag indicating a jump to hardlock based on high TP and SR

is requested.

- FLG\_HRD\_LK = Modulated bypass clutch hardlock mode flag; 1 -> In hardlock

mode.

- FLG\_HRD\_MODE = Flag indicating converter clutch is physically hardlocked.

- FLG\_NEG\_CAP = Flag indication that a negative torque capacity has been

commanded; 1 -> negative capacity commanded.

- FLG\_OLUP = Flag indicating open loop control region for upshifts.

- FLG\_OLUP\_LST = Last pass value of FLG\_OLUP used to detect transitions.

- FLG\_OT\_LK = Transmission overtemperature lockup mode flag.

- FLG\_OPEN = MULS is in open mode; no capacity when set.

- FLG\_OPEN\_LST = Last pass value fo FLG\_OPEN used to detect transitions.

- FLG\_PID\_CTL = Modulated bypass clutch control flag; 1 -> Modulated bypass

clutch in PID control.

- FLG\_RMP\_OPEN = Ramp from hard lock to slip control mode.

- FLG\_STROKE = STROKE mode enabled, BCSDC is held at FNEMGDC1.

- FLG\_UNC\_UNLK = Converter Clutch uncondtional unlock flag; 0 -> normally

scheduled MLUS modulation, 1 -> unconditional unlock.

- FLG\_UPS\_JMP = Flag indicating jump to hardlock mode request - after

upshift.

Calibration Constants:

- MXRMPOPENTM = Maximum time to be in ramp open mode.

- OPNRMPOFF = Constant torque capacity to reset tcap\_req when going form

hardlock to slip control.

- OPNRMPOFFL = Constant torque capacity to reset tcap\_req when going from

hardlock to slip\_control for unlocks.

- OPNRMPMULT = Multiplier of TQ\_BAR to reset tcap\_req when going from

hardlock to slip control.

- OPNRMPMULTL = Multiplier of TQ\_BAR to reset tcap\_req when going from

hardlock to slip\_control for unlocks.

- SLP\_ABS\_HRD = SLIP\_ABS at which BCSDC jumps to BCSDC\_HRD is allowed.

- SLP\_ABS\_LVL = Value of SLP\_ABS\_CNT at and above which BCSDC is allowed to

jump to BCSDC\_HRD.

- SLP\_HRD\_OFF = Converter slip threshold during hardlock to enable update

of hardlock torque capacity offset, rpm.

28-74

CONVERTER CLUTCH CONTROL, NORMAL TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SLPRMPOPN = Slip above which ramp open mode is exited.

- SR\_HL = Speed ratio across torque converter at which a jump to hardlock

mode is initiated.

- SR\_HL\_OT = Speed ratio across torque converter at which a jump to

hardlock mode is initiated in overtemp mode.

- STROKE\_DRP = STROKE mode SLIP\_ABS drop to exit mode.

- STROKE\_TM = STROKE mode default duration.

- TCAPOFF = Value by which hardlock torque capacity offset is incremented

when converter is slipping, ft-lbs.

- TCAP\_HLK = Scalar multiplier of TQ\_BAR to determine hardlock mode.

- TCAPSTR = TCAP\_REQ used for STROKE mode Capacity.

- TCAPSTRMULT = Scalar multiplier of TQ\_BAR to determin stroke torque

capacity.

- TCOFFDLY1 = Torque transient delay time to disable update of hardlock

torque capacity offset, secs.

- TCOFFDLY2 = Minimum time delay between updates of the hardlock torque

capacity offset, secs.

- TCRMP1 = TCAP\_REQ1 hardlock ramp rate; rate at which TCAP\_REQ1 is ramped

to the hardlock torque capacity.

- TCRMP2 = TCAP\_REQ1 hardlock ramp rate; rate at which TCAP\_REQ1 is ramped

to the hardlock torque capacity.

- TCRMP3 = TCAP\_REQ1 hardlock ramp rate; rate at which TCAP\_REQ1 is ramped

to the hardlock torque capacity.

- TCRMP10 = tcap\_req1 ramp open ramp rate; for a/c hits and softlock.

- TCRMP10L = tcap\_req1 ramp open ramp rate; for unlocks.

- TP\_HL = Relative TP at which a jump to hardlock mode is initiated.

- TQHRDDIF = Maximum torque change to allow update of hardlock torque

capacity offset, ft-lbs.

28-75

CONVERTER CLUTCH CONTROL, NORMAL TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_TCAP\_NORM\_CALC\_COM1

|SLIP\_ACT| < SLP\_ABS\_HRD -----|

|AND -| SLP\_ABS\_CNT =

FLG\_PID\_CTL = 1 --------------| | min(SLP\_ABS\_CNT+1,255)

|

| --- ELSE ---

|

| SLP\_ABS\_CNT = 0

SLP\_ABS\_CNT >= SLP\_ABS\_LVL ---------| slp\_abs\_enb = 1

|

| --- ELSE ---

|

| slp\_abs\_enb = 0

28-76

CONVERTER CLUTCH CONTROL, NORMAL TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TCAP\_REQ1 <= 0 ---------------------| FLG\_NEG\_CAP = 1

(torque capacity negtive)

FLG\_OPEN = 0 -----------------|

|

FLG\_OPEN\_LST = 1 -------------|

|

FLG\_NEG\_CAP = 1 --------------|AND -| FLG\_NEG\_CAP = 0

| | STROKE\_TMR = STROKE\_TM

FLG\_CLUP = 0 -----------------| | STROKE\_SLP = SLIP\_ACT

| | (transition from OPEN mode with

FLG\_OLUP = 0 -----------------| | TCAP\_REQ1 at OPEN value - Load STROKE

| timer and grab value of SLIP\_ACT)

|

| --- ELSE ---

FLG\_OPEN = 1 -----------------| |

|OR --| STROKE\_TMR = 0

STROKE\_SLP - SLIP\_ACT | | (either STROKE canceled because

> STROKE\_DRP ----| | OPEN requested, or SLIP\_ACT drop

| seen - clear delay timer)

STROKE\_TMR > 0 ---------------------| FLG\_STROKE = 1

| (STROKE mode enabled)

|

| --- ELSE ---

|

| FLG\_STROKE = 0

| (STROKE mode disabled)

TP\_REL > TP\_HL ---------|

|AND -|

SPD\_RATIO > SR\_HL ------| |

|OR --| hrd\_jmp\_enb = 1

TP\_REL > TP\_HL ---------| | |

| | |

FLG\_OT\_LK = 1 ----------|AND -| |

| |

SPD\_RATIO > SR\_HL\_OT ---| |

| --- ELSE ---

|

| hrd\_jmp\_enb = 0

28-77

CONVERTER CLUTCH CONTROL, NORMAL TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The following logic checks if the converter is slipping during hardlock

mode, and increments the Hardlock offset (TC\_HRD\_OFF = TCHRDINT at powerup.)

TM\_OFF\_DLY > 0 -------------------|

(delay timer not expired) |OR --| no action

| |

FLG\_HRD\_LK = 0 -------------------| |

(not requesting hardlock) |

| --- ELSE ---

|

TQ\_BAR - TQ\_BAR\_LST > TQHRDDIF ---------| TM\_OFF\_DLY = TCOFFDLY1

(torque transient occured) |

| --- ELSE ---

FLG\_HRD\_MODE = 1 -----------| |

|OR --| |

FLG\_HRD\_JMP = 1 ------------| |AND -| TM\_OFF\_DLY = TCOFFDLY2

| | TC\_HRD\_OFF = TC\_HRD\_OFF +

SLIP\_ACT >= SLP\_HRD\_OFF ----------| | TCAPOFF

(converter slipping in hardlock)

FLG\_CRV\_LK = 0 -----------------------| opnrmpmult = OPNRMPMULTL

(unlock) | opnrmpoff = OPNRMPOFFL

| tcrmp10 = TCRMP10L

|

| --- ELSE ---

|

(a/c hits and softlock) | opnrmpmult = OPNRMPMULT

| opnrmpoff = OPNRMPOFF

| tcrmp10 = TCRMP10

28-78

CONVERTER CLUTCH CONTROL, NORMAL TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_STROKE = 1 ------------------------------| TCAP\_INTR1 = TCAPSTR +

| TQ\_BAR \* TCAPSTRMULT

| FLG\_PID\_CTL = 0

| FLG\_HRD\_MODE = 0

| FLG\_HRD\_JMP = 0

| FLG\_UPS\_JMP = 0

| FLG\_RMP\_OPEN = 0

|

| --- ELSE ---

FLG\_UNC\_UNLK = 1 ----------------------| |

| |

FLG\_OPEN = 1 --------------------| |OR --| TCAP\_INTR1 = -1

| | | FLG\_PID\_CTL = 0

SLIP\_DES\_S = SLIP\_TARGET --| |AND -| | FLG\_HRD\_MODE = 0

|OR --| | FLG\_HRD\_JMP = 0

SLIP\_TCAP >= SLIP\_TARGET --| | FLG\_UPS\_JMP = 0

| FLG\_RMP\_OPEN = 0

|

| --- ELSE ---

FLG\_FMM\_LK = 1 ------------------------| |

|OR --| tcap\_intr = TCAP\_REQ1 +

FLG\_HRD\_LK = 1 ------------------| | | (TCRMP1 \* BG\_TMR)

|AND -| | TCAP\_INTR1 = min(tcap\_intr,

slp\_abs\_enb = 1 -----------| | | (TQ\_BAR \* TCAP\_HLK) +

|OR --| | TC\_HRD\_OFF)

FLG\_HRD\_MODE = 1 ----------| | FLG\_PID\_CTL = 0

| FLG\_HRD\_MODE = 1

| FLG\_HRD\_JMP = 0

| FLG\_UPS\_JMP = 0

| FLG\_RMP\_OPEN = 0

|

| --- ELSE ---

FLG\_HRD\_LK = 1 ------------------------| |

|AND -| tcap\_intr = TCAP\_REQ1 +

hrd\_jmp\_enb = 1 -----------------| | | (TCRMP2 \* BG\_TMR)

|OR --| | TCAP\_INTR1 = min(tcap\_intr,

FLG\_HRD\_JMP = 1 -----------------| | (TQ\_BAR \* TCAP\_HLK) +

| TC\_HRD\_OFF)

| FLG\_PID\_CTL = 0

| FLG\_HRD\_MODE = 0

| FLG\_HRD\_JMP = 1

| FLG\_UPS\_JMP = 0

| FLG\_RMP\_OPEN = 0

|

| --- ELSE ---

|

(continued on next page)

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CONVERTER CLUTCH CONTROL, NORMAL TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

FLG\_HRD\_LK = 1 ------------------| |

| |

FLG\_OLUP = 0 --------------------|AND -| |

| | |

FLG\_OLUP\_LST = 1 ----------------| |OR --| tcap\_intr = TCAP\_REQ1 +

| | (TCRMP3 \* BG\_TMR)

FLG\_HRD\_LK = 1 ------------------| | | TCAP\_INTR1 = min(tcap\_intr,

|AND -| | (TQ\_BAR \* TCAP\_HLK) +

FLG\_UPS\_JMP = 1 -----------------| | TC\_HRD\_OFF)

| FLG\_PID\_CTL = 0

| FLG\_HRD\_MODE = 0

| FLG\_HRD\_JMP = 0

| FLG\_UPS\_JMP = 1

| FLG\_RMP\_OPEN = 0

|

| --- ELSE ---

FLG\_HRD\_MODE = 1 ----------------------| |

| |

FLG\_HRD\_JMP = 1 -----------------------|OR --| TCAP\_INTR1 = (opnrmpmult \*

| | TQ\_BAR) + opnrmpoff

FLG\_UPS\_JMP = 1 -----------------------| | RMP\_OPEN\_TMR = 0

(FLG\_HRD\_LK = 0) | FLG\_PID\_CTL = 0

| FLG\_HRD\_MODE = 0

| FLG\_HRD\_JMP = 0

| FLG\_UPS\_JMP = 0

| FLG\_RMP\_OPEN = 1

|

| --- ELSE ---

FLG\_RMP\_OPEN = 1 ----------------------| |

| |

SLIP\_ACT < SLPRMPOPN ------------------| |

|AND -| TCAP\_INTR1 = TCAP\_REQ1 -

TCAP\_REQ1 > 0.03125 -------------------| | (tcrmp10 \* BG\_TMR)

| |

RMP\_OPEN\_TMR < MXRMPOPENTM ------------| |

| --- ELSE ---

|

| FLG\_HRD\_MODE = 0

| FLG\_HRD\_JMP = 0

| FLG\_UPS\_JMP = 0

| Do: CCC\_PID\_SLIP\_CTL\_COMx

| (perform PID slip control)

| Do: CCC\_TCAP\_CALC\_COMx

| (calculate torque capacity

| using the converter model)

| FLG\_RMP\_OPEN = 0

28-80

CONVERTER CLUTCH CONTROL, TORQUE CAPACITY CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.14 TORQUE CAPACITY CALCULATION (CDAK0)

OVERVIEW

This module calculates the open loop approximation of the torque capacity

required to achieve a desired slip.

DEFINITIONS

INPUTS

Registers:

- NTBART = Filtered transmission turbine speed.

- SLIP\_TCAP = Total desired slip to be used to calculate torque capacity.

- TCAP\_CONV1 = Torque being carried by the torque converter; ft-lbs.

- TQ\_BAR = Net torque into torque converter, filtered TQ\_NET.

Calibration Constants:

- K\_CONV = Torque converter coefficient that relates input torque to slip,

multiplied by turbine speed; ft-lbs/rpm-rpm.

OUTPUTS

Registers:

- TCAP\_CONV1 = See above.

- TCAP\_INTR1 = Interim requested torque capacity, ft-lbs.

PROCESS

STRATEGY MODULE: CCC\_TCAP\_CALC\_COM2

always ---------------------------| TCAP\_CONV1 = K\_CONV \* SLIP\_TCAP \*

| NTBART

| TCAP\_INTR1 = TQ\_BAR - TCAP\_CONV1

| TCAP\_INTR1 = MAX(TCAP\_INTR1,0.03125)

| (0.03125 is smallest value > 0)

28-81

CONVERTER CLUTCH CONTROL, TORQUE CAPACITY CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.15 TORQUE CAPACITY CONVERSION (CDAK0)

OVERVIEW

This module determines the bypass clutch PWM duty cycle required to obtain

the requested Torque Capacity (TCAP\_REQ1). This calculation is based only

upon hardware characteristics.

DEFINITIONS

INPUTS

Registers:

- PWM\_OUT = Bypass Clutch PWM output pressure, psi.

- TCAP\_REQ1 = Requested Bypass Clutch Torque Capacity, ft-lbs.

Calibration Constants:

- FNDCHOFF = Duty cycle intercept when PWM\_OUT is greater than or equal to

PWM\_BREAKPNT, function of TOT.

- FNDCLOFF = Duty cycle intercept when PWM\_OUT is less than PWM\_BREAKPNT,

function of TOT.

- FNDCHSLP = Duty cycle slope when PWM\_OUT is greater than or equal to

PWM\_BREAKPNT, function of TOT.

- FNDCLSLP = Duty cycle slope when PWM\_OUT is less than PWM\_BREAKPNT,

function of TOT.

- K\_CLUTCH = Inverse of converter bypass clutch, gain; psi/lb-ft.

- K\_VALVE = Bypass Clutch control valve pressure gain; psi/psi (unitless).

- PWM\_BREAKPNT = PWM output pressure at which PWM gain changes, psi.

- PWM\_OFFSET = Maximium PWM output pressure at zero (0) pressure difference

across converter clutch; psi.

28-82

CONVERTER CLUTCH CONTROL, TORQUE CAPACITY CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- BCSDC = Modulated Bypass Clutch Duty Cycle.

- P\_DELTA = Pressure difference across bypass clutch, psi.

- PWM\_OUT = See above.

- TCAP\_REQ1 = See above.

28-83

CONVERTER CLUTCH CONTROL, TORQUE CAPACITY CONVERSION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_TCAP\_CONV\_COM3

TCAP\_REQ1 <= 0 -----------------| BCSDC = 0

| PWM\_OUT = 0

| P\_DELTA = 0

| EXIT THIS MODULE

Calculate pressure difference (P\_DELTA) across converter clutch required to

provide TCAP\_REQ1, based on clutch size:

always -------------------------| P\_DELTA = K\_CLUTCH \* TCAP\_REQ1

Calculate PWM output pressure (PWM\_OUT) required to provide P\_DELTA across

the converter clutch, based on the bypass clutch control valve hardware

characteristics:

always -------------------------| PWM\_OUT = PWM\_OFFSET + (K\_VALVE \* P\_DELTA)

Calculate PWM duty cycle (BCSDC) required to provide PWM\_OUT presure, based

upon solenoid characteristics. The formula used below is based upon analysis

of solenoid data from the vehicle:

PWM\_OUT < PWM\_BREAKPNT --------| BCSDC = FNDCLOFF(TOT) +

| (FNDCLSLP(TOT) \* PWM\_OUT)

|

| --- ELSE ---

|

| BCSDC = FNDCHOFF(TOT) +

| (FNDCHSLP(TOT) \* PWM\_OUT)

28-84

CONVERTER CLUTCH CONTROL, PID SLIP CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

28.16 PID SLIP CONTROL (CDAM0)

OVERVIEW

This module performs closed PID control on slip error and produces a desired

slip offset. This desired slip offset is added to the normal desired slip

(SLIP\_DES\_S) which is inputted into the torque capacity equation.

DEFINITIONS

Registers:

- BG\_TMR = Background loop timer.

- ERR\_T0\_FD = Filtered value of ERR\_T0 for derivative PID slip control.

- ERR\_T0\_FI = Filtered value of ERR\_T0 for integral PID slip control.

- ERR\_T0\_FP = Filtered value of ERR\_T0 for proportional PID slip control.

- ERR\_T1 = Last pass slip error.

- ERR\_T0 = Current slip error (SLIP\_DES\_S - SLIP\_ACT).

- NTBART = Filtered transmission turbine speed.

- SLIP\_ACT = Actual value of slip (signed).

- SLIP\_DES\_S = Desired value of slip, signed.

- SLIP\_ERR\_D = Derivative slip error.

- SLIP\_ERR\_I = Integral slip error.

- SLIP\_ERR\_P = Proportional slip error.

- SLIP\_TCAP = Total desired slip to be used for torque capacity

calculation.

- SLP\_ERR\_PID = Total PID slip error.

- STROKE\_TMR = STROKE mode timer.

- TCAP\_REQ1 = Final requested torque capacity, ft-lbs.

- TQ\_BAR = Filtered TQ\_NET.

Bit Flags:

- AC\_EN\_TRANS = Flag to delay A/C activation process; 0 -> delay.

- FLG\_AC\_CTL = Flag indicating when to use A/C comp. slip target; 1 -> use

target.

28-85

CONVERTER CLUTCH CONTROL, PID SLIP CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_DB\_REG = Flag indicating slip is within Deadband Region; 1 -> Slip

within Deadband Region.

- FLG\_PID\_CTL = Modulated bypass clutch control flag; 1 -> Modulated bypass

clutch in PID control.

- FLG\_RMP\_OPEN = Ramp from hard lock to slip control mode.

- FLG\_SFTTOPID = Flag indicating last background pass was shifting tcap\_req

calculation.

- FLG\_STR\_LST = Last pass value of flg\_stroke.

Calibration Constants:

- GAIN\_C = Overall PID slip control gain.

- GAIN\_D = Derivative PID slip control gain.

- GAIN\_I = Integral PID slip control gain.

- GAIN\_P = Proportional PID slip control gain.

- IERRINT = Integral slip error initialization value when entering PID

control.

- IERRMAX = Maximum allowable integral slip error value (SLIP\_ERR\_I).

- IERRMIN = Minimum allowable integral slip error value (SLIP\_ERR\_I).

- K\_CONV = Torque converter coefficient that relates input torque to slip,

multiplied by turbine speed; ft-lbs/rpm-rpm.

- SW\_AC\_PID = Switch to freeze P and I terms while holding slip durring an

AC hit.

- SW\_DB\_D = Switch allow contribution of derivative term when in Deadband

Region; 1 -> allow contribution.

28-86

CONVERTER CLUTCH CONTROL, PID SLIP CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_PID\_SLIP\_CTL\_COM1

FLG\_PID\_CTL = 0 ------------------|

|

SLIP\_DES\_S >= 0 ------------------|AND -| FLG\_PID\_CTL = 1

| | ERR\_T0 = 0

FLG\_SFTTOPID = 0 -----------------| | ERR\_T0\_FP = 0

| | ERR\_T0\_FI = 0

FLG\_RMP\_OPEN = 0 -----------------| | ERR\_T0\_FD = 0

| | ERR\_T1 = 0

FLG\_STR\_LST = 0 ------------------| | SLIP\_DES\_S = SLIP\_ACT

| slip\_err\_i = IERRINT

| (initialize slip error)

|

| --- ELSE ---

FLG\_PID\_CTL = 0 ------------------| |

| |

SLIP\_DES\_S >= 0 ------------------|AND -| FLG\_PID\_CTL = 1

| | ERR\_T0 = 0

FLG\_SFTTOPID = 1 -----------| | | ERR\_T0\_FP = 0

| | | ERR\_T0\_FI = 0

FLG\_RMP\_OPEN = 1 -----------|OR --| | ERR\_T0\_FD = 0

| | ERR\_T1 = 0

FLG\_STR\_LST = 1 ------------| | SLIP\_DES\_S = SLIP\_ACT

| slip\_err\_i = (((TQ\_BAR - TCAP\_REQ1)

| / (NTBART \* K\_CONV))

| - SLIP\_DES\_S) / GAIN\_C

| (initialize slip error to produce

| to produce the same TCAP\_REQ1 as

| before the shift)

|

| --- ELSE ---

SLIP\_DES\_S < 0 -------------------| |

|OR --| FLG\_PID\_CTL = 0

STROKE\_TMR > 0 -------------------| |

| --- ELSE ---

|

| slip\_err\_i = SLIP\_ERR\_I

28-87

CONVERTER CLUTCH CONTROL, PID SLIP CONTROL - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_PID\_CTL = 0 ------------------------| SLIP\_ERR\_P = 0

| slip\_err\_i = 0

|

| --- ELSE ---

FLG\_DB\_REG = 1 -------------------| |

| |

FLG\_AC\_CTL = 1 -------------| |OR --| NO ACTION

| | | (this freezes the P & I terms

AC\_EN\_TRANS = 1 ------------|AND -| | when in dead band reigon or

| | when holding slip durring

SW\_AC\_PID = 1 --------------| | an AC hit)

|

| --- ELSE ---

|

TCAP\_REQ1 > 0.03125 --------------------| SLIP\_ERR\_P = GAIN\_P \* ERR\_T0\_FP

(0.03125 is smallest value > 0) | inc(slip\_err\_i, GAIN\_I \*

| ERR\_T0\_FI \* BG\_TMR)

| (this updates both P & I terms

| of the PID controler

|

| --- ELSE ---

|

| SLIP\_ERR\_P = GAIN\_P \* ERR\_T0\_FP

| (this freezes the I term when

| TCAP\_REQx is <= 0.03125 )

always ---------------------------------| SLIP\_ERR\_I = min(IERRMAX,

| ((max(slip\_err\_i,IERRMIN)

|

| (restrict value of integral term)

FLG\_PID\_CTL = 1 ------------------|

|AND -| SLIP\_ERR\_D = GAIN\_D \* ((ERR\_T0\_FD -

FLG\_DB\_REG = 0 -------------| | | ERR\_T1) / BG\_TMR)

|OR --| |

SW\_DB\_D = 1 ----------------| |

| --- ELSE ---

|

FLG\_PID\_CTL = 0 ------------------------| SLIP\_ERR\_D = 0

|

| --- ELSE ---

|

| no action

always ---------------------------------| SLP\_ERR\_PID = GAIN\_C \* (SLIP\_ERR\_P

| + SLIP\_ERR\_I + SLIP\_ERR\_D)

|

| SLIP\_TCAP = SLIP\_DES\_S +

| SLP\_ERR\_PID

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CHAPTER 29

INPUT CONVERSIONS AND FILTERS

29-1

ENGINE INPUT PROCESSING, NEUTRAL/DRIVE TRANSITION LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY \_& CONFIDENTIAL

29.1 NEUTRAL/DRIVE TRANSITION LOGIC (CDAN2)

OVERVIEW

The software flags NDSFLG and DNDSUP are the flags used by the engine control

strategy when engine loading information is required. With manual and

non-EEC controlled automatics, NDSFLG is set and cleared based on the state

of the gear/clutch or starter safety switches. For EEC controlled automatics

with a transmission shaft speed sensor, NDSFLG is set and cleared based on

the manual lever position and transmission shaft speed.

DNDSUP represents the best approximation of the actual time of the

application or removal of transmission load (Neutral -> Drive or Drive ->

Neutral transitions). With manual transmissions, DNDSUP always reflects the

state of NDSFLG. For automatic transmissions, DNDSUP will be inferred from

| either turbine speed or time delay functions (FN394F(ECT) & FN394R(ECT)), or

| will directly reflect NDSFLG. If a turbine speed sensor is present, the

strategy will attempt to use the turbine speed algorithm. If the turbine

speed algorithm cannot be used, then the strategy will use the time delay

| functions to determine DNDSUP. If this cannot be done either, due to a

| failed ECT sensor, then DNDSUP will reflect the state of NDSFLG. NDSFLG or

DNDSUP are typically used in idle speed control mode select and air flow

computations, fuel enrichment on auto transmission neutral/drive transitions,

adaptive fuel, decel fuel shutoff and vehicle speed control (as well as

selftest).

Raw switch input state (NDSFLG):

- Manual transmissions can be configured with a clutch and gear switch, a

clutch switch only, a gear switch only or neither switch. The input

therefore can be used to determine a neutral state (trans in neutral or

clutch depressed) versus in gear state. If neither clutch or gear switch

is used, the module pull up voltage provides an "in gear" indication

which can be overridden by proper selection of the TRLOAD software

switch. (Set TRLOAD = 0).

- Non-EEC controlled automatic transmissions typically use the starter

safety switch to indicate neutral or drive. When the switch is in the

Park or Neutral position, it provides a ground for the module pull up

voltage through the starter relay coil, indicating "neutral". When not

in Park or Neutral, the switch is open and the pull up voltage is not

bled off, indicating "drive".

| - Electronic automatic transmissions typically use either a six position

| Manual Lever Position sensor (MLPS) or multiple discrete switches to

determine the operator selected gear. The MLPS is a ratiometric sensor

with six discrete resistors in series. The sensor is decoded by looking

at the differing voltages produced in each of the lever positions. If

discrete switches are used, the lever position is determined by the

combination of open and closed switches.

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ENGINE INPUT PROCESSING, NEUTRAL/DRIVE TRANSITION LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY \_& CONFIDENTIAL

DEFINITIONS

Registers:

- DNDSUP = Delayed neutral drive indication. For automatic transmissions;

1 -> transmission is in gear, 0 -> transmission is in neutral.

For manual transmissions; DNDSUP = 0.

| - ECT = Coolant temperature, DEGF.

- INDS = Instantaneous value of the Neutral Drive switch input, counts.

- NDDTIM = Timer since NDSFLG changed states, sec.

- REVFLG = Reverse engagement flag; 1 -> reverse, 0 -> drive.

Bit Flags:

- NDFFLG = Neutral/drive state flag, as indicated by the time delay

| functions (FN394F & FN394R); 1 -> drive.

| - NDSFLG = For auto trans; 1 -> MLPS indicates in gear, 0 -> MLPS indicates

| neutral/park. For man trans; 1 -> clutch out and/or transmission in

| gear, 0 -> clutch in and/or transmission in neutral.

- PDL = Manual lever position.

Calibration Constants:

| - CFMFLG = Flag indicating that ECT sensor is in/out of range.

| - FN394F(ECT) = Time delay, as a function of ECT, before a neutral/park to

| in-gear change is reflected in DNDSUP, sec.

| - FN394R(ECT) = Time delay, as a function of ECT, before a neutral/drive to

| reverse transition is reflected in DNDSUP, sec.

- NDDELT = Time delay before an in-gear to neutral/park change is reflected

in DNDSUP, sec.

- NDS\_SWPT = NDS input switch point.

- TRLOAD = Transmission Load switch;

0 -> Manual Transmission, no clutch or gear switches,

forced neutral state (NDSFLG = 0).

1 -> Manual Transmission, no clutch or gear switch.

2 -> Manual Transmission, one clutch or gear switch.

3 -> Manual Transmission, both clutch and gear switches.

4 -> Auto Transmission, non-electronic, neutral drive switch.

| 5 -> Auto Transmission, non-electronic, neutral pressure

switch, (AXOD).

6 -> Auto Transmission, electronic, PRNDL sensor - park,

reverse, neutral, overdrive, manual 1, manual 2.

7 -> Auto Transmission, electronic, multiple discrete switches

for manual lever position. (F4E)

- TSSHP = Turbine speed sensor hardware present switch; 1 -> present.

29-3

ENGINE INPUT PROCESSING, NEUTRAL/DRIVE TRANSITION LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY \_& CONFIDENTIAL

- TSTRAT = Transmission Strategy Switch; 0 -> no transmission control (man,

AOD, ATX, etc.), 1 -> shift indicator.

PROCESS

STRATEGY MODULE: INPUT\_NDS\_COM3

NDSFLG LOGIC - Determine Neutral/Drive state from raw switch input.

INDS < NDS\_SWPT ------------------|

;N/D switch |AND -|

| |

TRLOAD <= 4 ----------------------| |

|

PDL = 5 OR 7 ---------------------| |

;MSP indicates | |

| neutral or park |AND -|OR --| Do: nddtim\_cntrl\_0

| | | | NDSFLG := 0

| TRLOAD >= 6 ----------------------| | | ;neutral state

| ;MLSP sensor present or | |

| ;automatic switches present | |

| | |

| TRLOAD = 0 -----------------------------| |

| ;forced neutral | --- ELSE ---

| |

| | Do: nddtim\_cntrl\_1

| | NDSFLG := 1

| | ;drive/loaded state

| BEGIN: nddtim\_cntrl\_0

| NDSFLG = 1 -----------------------------------| NDDTIM := 0

| | ;NDSFLG state is in

| | ;transition

| | ;zero NDDTIM timer

| |

| | --- ELSE ---

| |

| | Increment NDDTIM

| END: nddtim\_cntrl\_0

| BEGIN: nddtim\_cntrl\_1

| NDSFLG = 0 -----------------------------------| NDDTIM := 0

| | ;NDSFLG state is in

| | ;transition

| | ;zero NDDTIM timer

| |

| | --- ELSE ---

| |

| | Increment NDDTIM

| END: nddtim\_cntrl\_1

29-4

ENGINE INPUT PROCESSING, NEUTRAL/DRIVE TRANSITION LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY \_& CONFIDENTIAL

REVFLG - FORWARD/REVERSE LOGIC - Applies to NDS or NPS

PDL = 6 --------------------------------|

;manual lever indicates reverse |AND -| REVFLG := 1

| | ;trans in reverse

TSTRAT >= 4 ----------------------------| |

;electronic trans with MLPS | --- ELSE ---

|

| REVFLG := 0

| ;electronic trans in

| ;forward

| ;or manual transmission

NDFFLG LOGIC - Determine Neutral/Drive state from time delay functions.

NDSFLG = 0 -----------------------|

;switch indicates neutral |AND -|

| |

NDDTIM >= NDDELT -----------------| |

;loaded to unloaded delay |

|

NDSFLG = 1 -----------------------| |

;switch indicates drive | |

| |

REVFLG = 1 -----------------------|AND -|OR --| NDFFLG := NDSFLG

;in reverse | | | ;update delayed

| | | ;neutral/Drive flag

| NDDTIM >= FN394R(ECT) ------------| | |

;neutral to reverse delay | |

| |

NDSFLG = 1 -----------------------| | |

;switch indicates drive | | |

| | |

REVFLG = 0 -----------------------|AND -| |

;forward gear | |

| |

| NDDTIM >= FN394F(ECT) ------------| |

;neutral to drive delay |

|

| --- ELSE ---

|

| No change to NDFFLG

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ENGINE INPUT PROCESSING, NEUTRAL/DRIVE TRANSITION LOGIC - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY \_& CONFIDENTIAL

There are two ways to determine neutral/drive transitions. The following

| logic selects which method is used to set DNDSUP:

Automatic Transmissions without turbine speed sensor will use the time delay

functions. If the time delay functions cannot be used because of a failed

| ECT sensor, then the raw N/D switch input is used.

Manual Transmissions will always default to the raw N/D (clutch) input

because TSSHP will be calibrated to zero and TRLOAD will be calibrated <= 3.

Select N/D Transition Detection Method

TRLOAD > 3 -----------------------------|

;automatic transmission |AND -| DNDSUP := NDFFLG

| | ;infer neutral/drive

| CFMFLG = 0 -----------------------------| | ;transitions from

| ;ECT sensor OK | ;time delay functions

|

| --- ELSE ---

|

| DNDSUP := NDSFLG

| ;use the raw input from

| ;the neutral/drive switch

29-6

INPUT CONVERSIONS AND FILTERS, INFERRED BAROMETRIC PRESSURE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

29.2 BAROMETRIC PRESSURE - INFERRED (CDAL0)

OVERVIEW

The barometric pressure is inferred from other sensor inputs. With air meter

equipped engines redundant sensor and actuator information exists which

allows for the inference of barometric pressure. The basic equation is:

29.92 \* air mass from airmeter

Inferred BP = --------------------------------------------------------

sqrt(560/(ACT+460)) \* inferred air mass (29.92,100 ACT)

The model implied by the inferred BP equation is that the inferred air mass

is really an air volume flow calculation, converted to mass units at the

standard temperature and pressure. The air meter is a true air mass

measurement device. Thus deviations in mass from the inferred calculation

are attributed first to inlet temperature, which is measured and then to a

drop in inlet pressure, which is the inferred BP.

In the EEC the air mass flows are converted to LOAD by the formula:

load = air mass / (N \* ENGCYL \* SARCHG).

The inferred BP formula in EEC terms is thus:

29.92 \* LOAD from airmeter

IBAP = --------------------------

FN059(ACT) \* TOTLDST

TOTLDST is the inferred air mass RAM value. It is the sum of the flow

through the throttle body, TPLDST and the flow through the air bypass valve,

BYLDST. TPLDST is a table lookup versus N and TP\_REL, BYLDST is the load

equivalent of BYMAST, the air mass flow through the air bypass valve. BYMAST

is calculated from a table lookup of air bypass duty cycle, ISCDTY and a

calculation of percent load, PCT\_LOAD.

For calibration purposes, the calculated inferred value of barometric

pressure, can be fixed by using the calibrateable value BAPFMM.

DEFINITIONS

Registers:

- ACT = Air charge temperature, deg F.

- BG\_TMR = Background loop timer, sec.

- BP = Barometric Pressure. (Note: Upper byte of BP\_WORD.)

- BPUPDTTMR = Timer for determing warm engine, sec.

- BP\_OK\_ACC = Time accumulator during which BP is being updated.

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INPUT CONVERSIONS AND FILTERS, INFERRED BAROMETRIC PRESSURE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- DELTOTLD = Change in inferred load (TOTLDST), unitless.

- ECT = Engine coolant temperature, deg F.

- IBAP = Unfiltered barometric pressure, inches Hg.

- LOAD = Normalized inducted air charge, unitless.

- N = Engine speed, rpm.

- TOTLDST = Total inferred load, unitless.

- TP\_REL = Relative throttle position, counts.

Bit Flags:

- BFMFLG = Barometric pressure sensor has failed or inferred BP value not

yet established.

- KAM\_ERROR = KAM data not valid; 1 -> KAM data invalid.

- MAF\_INTP\_FLG = Flag indicating that MAF signal is not reliable, unitless.

- MFMFLG = Flag indicating that MAF sensor has failed, unitless.

- TFMFLG = Flag indicating that TP sensor has failed, unitless.

Calibration Constants:

- BAPFMM = Default value for barometric pressure used during failure mode,

inches Hg.

- BP\_CAL\_DES = Switch to fix barometric pressure with the failure-mode

value for calibration purposes; 0 -> use calculated value, 1 -> fix

calculated value.

- BP\_OK\_TM = Time allowed after KAM reset before clearing BFMFLG.

- BPSSW = Barometric pressure calculation method switch; 0 -> inferred, 1

-> sensed.

- BPUPDENTM = Minimum time since a warm engine state is reached to allow

inference of barometric pressure, sec.

- DELTOTHI = Maximum allowable change in inferred load to allow inference

of barometric pressure, unitless.

- ECTBPLO = Minimum ECT required to define warm engine state for inference

of barometric pressure, deg F.

- FN059(ACT) = Temperature correction factor (square root of {560/[ACT +

460]}), unitless.

- LDBPLO = Minimum allowable LOAD to allow inference of barometric

pressure, unitless.

- NBPHI = Maximum allowable engine speed to allow inference of barometric

pressure, rpm.

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INPUT CONVERSIONS AND FILTERS, INFERRED BAROMETRIC PRESSURE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- NBPLO = Minimum allowable engine speed to allow inference of barometric

pressure, rpm.

- TPBPLO = Minimum allowable throttle position to allow inference of

barometric pressure, counts.

- TPBPHI = Maximum allowable throttle position to allow inference of

barometric pressure, counts.

PROCESS

STRATEGY MODULE: INPUT\_BP\_INFERRED\_COM1

;This process is executed once per background loop.

BP\_CAL\_DES = 1 ----------------| BP := BAPFMM

;fixed value desired | ;assign failure mode value

|

| Exit

|

| --- ELSE ---

|

BPSSW = 1 ---------------------| Exit

;sensed barometric pressure | ;exit this process,

;desired | ;do not execute the logic

| ;below

|

| --- ELSE ---

|

ECT > ECTBPLO -----------------| Do: bp\_inferred\_main

;high enough ECT for | ;let BPUPDTTMR run freely

;warm engine |

| --- ELSE ---

|

| BPUPDTTMR := 0

| Do: bp\_inferred\_main

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INPUT CONVERSIONS AND FILTERS, INFERRED BAROMETRIC PRESSURE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: bp\_inferred\_main

If operating conditions allow, infer the barometric pressure. If any sensor

used in the inference has failed, assign the failure mode value of BP and set

flag BFMFLG, to show failure to infer.

The filter routine is called only after IBAP is updated. If no update is

made, the filtered value remains unchanged. This prevents filtering toward a

single occurrence of an inappropriate inference. This might occur, following

a transient, when the entry condition parameters have not yet been updated

and a poor value of LOAD is used.

The cummulative time taken to infer BP is stored in BP\_OK\_ACC for use in the

BFMFLG logic.

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INPUT CONVERSIONS AND FILTERS, INFERRED BAROMETRIC PRESSURE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MAF\_INTP\_FLG = 0 --------|

;MAF signal is OK |

|

TFMFLG = 0 --------------|

;TP sensor is OK |

|

DELTOTLD < DELTOTHI -----|

;inferred load not |

;too transient |

|

N > NBPLO ---------------|

;high enough RPM |

|

N < NBPHI --------------|AND -| IBAP := 29.92 \* LOAD /

;low enough RPM | | (FN059(ACT) \* TOTLDST)

| | ;infer barometric pressure

TP\_REL > TPBPLO ---------| |

;high enough TP | | Do: bp\_filter\_main

| | ;filter the instantaneous

TP\_REL < TPBPHI ---------| | ;barometric pressure

;calibration devel only | |

| | BP\_OK\_ACC := BP\_OK\_ACC + BG\_TMR

BPUPDTTMR > BPUPDENTM ---| | ;conditions OK for

;warm engine long | | ;time accumulation

;enough ECT | |

| | Do: bp\_ok

LOAD > LDBPLO -----------| |

;high enough LOAD |

| --- ELSE ---

MFMFLG = 1 --------------| |

;MAF sensor failed |OR --| IBAP := BAPFMM

| | BFMFLG := 1

TFMFLG = 1 --------------| | ;sensor on which inference

;TP sensor failed | ;relies has failed,

| ;assign failure mode value

| ;and set failure flag

|

| BP\_OK\_ACC = 0

| ;clear accumulator

|

| Do: bp\_filter\_main

| ;filter the instantaneous

| ;barometric pressure

|

| --- ELSE ---

|

| No action

| ;conditions do not allow inference

| ;but no sensor failures,

| ;do not call filtering routine

END: bp\_inferred\_main

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INPUT CONVERSIONS AND FILTERS, INFERRED BAROMETRIC PRESSURE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: bp\_ok

If the KAM is reset, the inferred BP value may not be accurate, especially at

high altitudes. This could cause problems with the EGR test. To prevent the

inferred value being used elsewhere before it is established, the BP failure

flag, BFMFLG, is held set until a resonable amount of time, BP\_OK\_TM, for

calculation and filtering to have taken place.

KAM\_ERROR = 1 -----------------| BFMFLG := 1

;KAM data invalid | ;inferred BP unreliable

| BP\_OK\_ACC := 0

| ;clear acculmulator

|

| --- ELSE ---

BFMFLG = 1 --------------| |

|AND -| BFMFLG := 1

BP\_OK\_ACC < BP\_OK\_TM ----| | ;time to infer not complete

|

| --- ELSE ---

MFMFLG = 0 --------------| |

;no MAF sensor fault |AND -| BFMFLG := 0

| | ;clear flag

TFMFLG = 0 --------------| | ;inferred value reliable

;no TP sensor fault |

| --- ELSE ---

|

| No action

END: bp\_ok

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INPUT CONVERSIONS AND FILTERS, BAROMETRIC PRESSURE FILTER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

29.3 BAROMETRIC PRESSURE FILTER (CDAL0)

OVERVIEW

This module filters the instantaneous barometric pressure, either sensed or

inferred. The filtered value is clipped to within an allowed range.

DEFINITIONS

INPUTS

Registers:

- IBAP = Unfiltered barometric pressure, inches Hg.

Bit Flags:

- KAM\_ERROR = Flag indicating Keep Alive Memory is invalid; 1 -> invalid,

unitless.

Calibration Constants:

- BAPFMM = Alternate value for barometric pressure used during failure or

calibration override, inches Hg.

- BPMAX = Maximum allowed value for barometric pressure, inches Hg.

- BPMIN = Minimum allowed value for barometric pressure, inches Hg.

- TCBBAR = Time constant for barometric pressure filter, sec.

OUTPUTS

Registers:

- BP = Filtered barometric pressure, inches Hg.

OTHER

- bp\_temp = Filtered, unclipped value of barometric pressure, inches Hg.

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INPUT CONVERSIONS AND FILTERS, BAROMETRIC PRESSURE FILTER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_BP\_FILTER\_COM1

BEGIN: bp\_filter\_main

;This process is executed only when explicitly called.

Since this filter routine is executed only when it is explicitly called, the

time constant specified below is not related to the passage of absolute time.

Instead, it relates only to the time during which the routine is active.

During such time, first order filtering, with the time constant specified

below, is produced.

KAM\_ERROR = 1 --------------------------| BP := BAPFMM

;memory error | ;assign failure mode value

|

| --- ELSE ---

|

| bp\_temp := ROLAV(IBAP,TCBBAR)

| ;filter instantaneous

| ;BP reading

|

| BP := clip(bp\_temp,BPMIN,BPMAX)

| ;clip to allowed range

END: bp\_filter\_main

29-14

TRANSMISSION INPUT CONVERSIONS, ETV OVERCURRENT MONITOR VOLTAGE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

29.4 ETV OVERCURRENT MONITOR VOLTAGE (CDAG0)

OVERVIEW

(Performed during A to D conversion)

ML-I Enhanced EEC requires compensation of EPCOCM1 (EPC overcurrent monitor

test parameter) for changes in VREF (+/- 5 %) to improve the precision of the

counts value. This is done by multiplying the A to D result (EPCOCM1\_CNTS)

by 512/IVCAL, where 512 is A to D counts for 2.5 volts and IVCAL is the A/D

conversion of a precision voltage that equals 2.5 volts.

With the ML-II Enhanced EEC, compensation of the A to D conversion of the EPC

overcurrent monitor voltage (EPCOCM1\_CNTS) is no longer required. The Analog

Input Conditioner chip (part of the ML-II E-EEC) eliminates this need for

compensation - the A/D now references a precision voltage.

EPCOCM1 is now set equal to EPCOCM1\_CNTS.

DEFINITIONS

INPUTS

Registers:

- EPCOCM1\_CNTS = A to D conversion of the ETV overcurrent monitor voltage,

counts.

OUTPUTS

Registers:

- EPCOCM1 = Corrected ETV overcurrent monitor voltage, counts.

PROCESS

STRATEGY MODULE: INPUT\_EPCOCM1\_COM2

always ---------------------------------| EPCOCM1 = EPCOCM1\_CNTS

29-15

INPUT CONVERSIONS AND FILTERS, POWER MODE - GAA0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

29.5 POWER MODE (CDAA0)

OVERVIEW

This module determines Power-On or Power-Off mode and sets the flag,

FLG\_PWR accordingly. If the throttle position is greater than the sum of the

minimum throttle position, RATCH, and some calibratable delta, DELTAT, then

the engine/transmission is considered to be in the Power-On mode. Otherwise,

the engine/transmission is considered to be in the Power-Off mode.

Hysteresis is provided for mode stability.

During a throttle position sensor failure, the power mode is determined

by the actual speed ratio (SPD\_RATIO). If the speed ratio is greater than

some calibratable minimum, SPD\_PM, then the mode is considered to be

Power-Off. Again, hysteresis is provided for mode stability.

DEFINITIONS

INPUTS

Registers:

- SPD\_RATIO = Speed Ratio.

- RATCH = Kicker off lowest filtered throttle position.

- TP = Throttle position, counts.

- TP\_REL = Relative Throttle Position, TP - RATCH.

Bit Flags:

- TFMFLG = Flag indicating TP sensor is in/out of range.

Calibration Constants:

- DELTAT = Part throttle to closed throttle breakpoint for Power mode.

- HYSTSPD = Hysteresis for SPD\_PM for FMEM Power mode.

- HYSTST = Hysteresis for DELTAT for Power Mode.

- SPD\_PM = Minimum Speed Ratio for Power-Off mode.

OUTPUTS

Bit Flags:

- FLG\_PWR = Power Mode flag: 1 -> Power-On mode; 0 -> Power-Off mode.

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INPUT CONVERSIONS AND FILTERS, POWER MODE - GAA0

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PROCESS

STRATEGY MODULE: EQPWRMODE\_GA

TFMFLG = 0 --------------------------|

(normal power mode determination) |

|AND -|

TP\_REL <OR= DELTAT ------------|S Q--| |

| |

TP\_REL > DELTAT + HYSTST ------|C |

|OR --| Set FLG\_PWR = 0

TFMFLG = 1 --------------------------| | | (power off mode)

(FMEM power mode determination) | | |

|AND -| | --- ELSE ---

SPD\_RATIO >OR= SPD\_PM ---------|S Q--| |

| | Set FLG\_PWR = 1

SPD\_RATIO < SPD\_PM - HYSTSPD --|C (power on mode)

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INPUT CONVERSIONS AND FILTERS, COLD TEMPERATURE TV SOLENOID OPERATION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

29.6 COLD TEMPERATURE DETERMINATION FOR TV SOLENOID OPERATION (CDAA0)

OVERVIEW

The amount of Engagement TV pressure is a function of the Transmission Oil

Temperature, TOT. This logic sets the flag, FLG\_TVENG\_CD, if the TOT sensor

indicates cold and the flag, FLGTVENG\_CD if moderately cold. FLG\_TVENG\_CD

will be cleared when the time since the first engagement exceeds a

calibratable value, even if TOT does not increase.

The amount of start-up TV is a function of TOT also. This logic sets the

flag, FLG\_TVSTR\_CD if the TOT sensor indicates cold temperature.

DEFINITIONS

INPUTS

Registers:

- TOT = Transmission Oil Temperature, deg. F.

Calibration Constants:

- TOTTV1 = Maximum TOT to use TVCHRG for start-up, deg F.

- TOTTV2 = Minimum ECT to use TVEMAX engagement TV, deg F.

- TOTTV3 = Minimum ECT to use TVEMOD engagement TV, deg F.

OUTPUTS

Bit Flags:

- FLG\_TVENG\_CD = Flag which indicates cold temperature for engagement TV:

0 -> Don't use TVEMAX in engagement TV; 1 -> Use TVEMAX in engagement TV.

- FLG\_TVENG\_MD = Flag which indicates moderate temperature for engagement

TV: 0 -> Don't use TVEMOD in engagement TV; 1 -> Use TVEMOD in

engagement TV.

- FLG\_TVSTR\_CD = Flag which indicates cold temperature for start-up TV: 0

-> Don't use TVCHRG in start-up TV; 1 -> Use TVCHRG in start-up TV.

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INPUT CONVERSIONS AND FILTERS, COLD TEMPERATURE TV SOLENOID OPERATION - CDAN2

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EQCTEMP\_GA

TOT <= TOTTV1 ----------------------| FLG\_TVSTR\_CD = 1

|

| --- ELSE ---

|

| FLG\_TVSTR\_CD = 0

TOT <= TOTTV2 ----------------------| FLG\_TVENG\_CD = 1

|

| --- ELSE ---

|

| FLG\_TVENG\_CD = 0

TOT <= TOTTV3 ----------------------| FLG\_TVENG\_MD = 1

|

| --- ELSE ---

|

| FLG\_TVENG\_MD = 0

29-19

INPUT CONVERSIONS AND FILTERS, DYNAMIC TV DUE TO COLD TRANSMISSION - GAA0

PED-PTPE, FoMoCo, PROPRIETARY & CONFIDENTIAL

29.7 DYNAMIC TV DUE TO COLD TRANSMISSION (CDAA0)

OVERVIEW

The accumulator pressure is the hydraulic pressure used to apply,

release, and hold the various clutches and bands in the transmission during

shifts. When the transmission is not shifting, the hydraulic pressure is

determined by the line pressure. The accumulator pressure is less than the

line pressure. Therefore, it is necessary to add additional hydraulic

pressure via the TV solenoid during shifts. This additional pressure is

called "dynamic TV."

The accumulator in the E4OD transmission may stick when the transmission

is cold. When the accumulator sticks, the transmission always operates with

accumulator pressure; during shifts and during steady-state gear conditions.

Of course, the pressure is inadequate during the steady-state conditions,

since the EEC-IV is not adding the additional TV which is added during the

shifts. With inadequate pressure, the transmission is unable to transmit

large amounts of torque.

Therefore, logic is needed to also add dynamic TV when conditions exist,

such that the accumulator may stick.

DEFINITIONS

INPUTS

Registers:

- TOT = Transmission Oil Temperature.

Calibration Constants:

- TOTTV4 = The maximum temperature where it is no longer necessary to add

dynamic TV due to the accumulator sticking.

OUTPUTS

Registers:

- FLG\_DYN\_CD = Flag which indicates that it is necessary to add dynamic TV

due to cold transmission conditions.

PROCESS

TOT < TOTTV4 ----------------------------| Set FLG\_DYN\_CD = 1

|

| --- ELSE ---

|

| Set FLG\_DYN\_CD = 0

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ENGINE INPUT PROCESSING, ENGINE SPEED CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

29.8 ENGINE SPEED CALCULATION (CDAM0)

OVERVIEW

The background RPM value (N) is calculated whenever the foreground has

signalled that PIP information is available, NEW\_RPM = 1. Also at this time,

calculations of the rate of change of RPM (DNDTI) are made. If the time

since last PIP up-edge is large, RPM is set to zero and the ENG\_STALLED flag

is set. ENG\_STALLED is used in the background PIP routines.

The calculation of RPM is:

60 Seconds/Min

RPM = -------------------------------------------------------------

Number of PIPs/rev \* DT12S Ticks/PIP \* Number of seconds/tick

.-----------------------------------------------.

| | N | N\_BYTE |

|---------------+---------------+---------------|

| Precision | double (word) | single (byte) |

| Range | 0 to 7000+ | 0 to 4080 |

| Resolution | 0.25 | 16 |

| Initial value | 0 | 0 |

| Units | RPM | RPM |

`-----------------------------------------------'

Note:

If the PIP period becomes >= TSTALL, N and N\_BYTE are set to zero.

This ensures that if the PIP signal goes away because of a stall,

N and N\_BYTE will become zero to trigger CRANK mode.

DEFINITIONS

Registers:

- APT = Throttle mode; -1 = closed, 0 = part, 1 = wide open.

- BG\_TMR = Background loop timer, sec.

- DNDTI = Unfiltered derivative of RPM.

- DNDT\_DAS = Filtered rate of change of RPM for DASPOT, RPM/S.

- DNDT\_IMCC = Filtered rate of change of RPM for intake manifold

communication control, RPM/S.

- DNDT\_PSS = Filtered rate of change of RPM for predictive shift

scheduling, RPM/S.

- DNDT\_SPK = Filtered rate of change of RPM for OSCMOD, RPM/S.

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ENGINE INPUT PROCESSING, ENGINE SPEED CALCULATION - CDAN2

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- DT12S = Period between two adjacent rising PIP edges, ticks.

- N = Engine RPM.

- NBAR = Filtered engine RPM.

- NDBAR = Filtered engine speed.

- NFIL = Filtered engine speed for predictive upshifts.

- N\_BYTE = Byte value of N.

- N\_PREV = Previous value of N.

- TSLPIP = A timer that indicates the time since last PIP low-to-high

transition.

Bit Flags:

- ENG\_STALLED = Engine stalled (stopped) flag.

- FIRST\_SYNC = Indicates whether the first CID edge has been detected; 1 ->

first CID edge has been detected.

- FUEL\_IN\_SYNC = Fuel synchronized with PIP.

- j1979\_01\_0C = Current RPM for SCP interface.

- NEW\_RPM = Flag indicating new PIP information is available for RPM

calculation.

- SYNFLG = SYNCTR in synchronisation with signature PIP.

Calibration Constants:

- ENGCYL = Number of PIP's per engine revolution.

- TCN = Time constant for N, sec.

- TCNDBR = Time constant for NDBAR, sec.

- TCNDT\_DAS = Time constant for DNDT\_DAS, sec.

- TCNDT\_IMCC = Time constant for DNDT\_IMCC, sec.

- TCNDT\_PSS = Time constant for DNDT\_PSS, sec.

- TCNDT\_SPK = Time constant for DNDT\_SPK, sec.

- TCNFIL = Time constant for NFIL, sec.

- TSTALL = Time since last PIP before a stall is assumed, msec.

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ENGINE INPUT PROCESSING, ENGINE SPEED CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_N\_CALC\_COM2

BEGIN: rpm\_main

This is a background task from top downwards.

TSLPIP >= TSTALL ---------| ENG\_STALLED := 1

;engine is stopped | SYNFLG := 0

| FUEL\_IN\_SYNC := 0

| FIRST\_SYNC := 0

| N := 0

| N\_BYTE := 0

| N\_PREV := 0

| NBAR := 0

| NDBAR := 0

| DNDTI := 0

| NFIL := 0

| DNDT\_SPK := 0

| DNDT\_DAS := 0

| DNDT\_IMCC := 0

| DNDT\_PSS := 0

|

| --- ELSE ---

|

NEW\_RPM = 1 --------------| ENG\_STALLED := 0

;new PIP information | NEW\_RPM := 0

;for calculation of RPM | ;clear flags

|

| N\_PREV := N

| ;save previous value

| N := 60 / (ENGCYL \* DT12S \* tscf)

| N\_BYTE := N

| ;byte value of N

|

| DNDTI := (N - N\_PREV) / BG\_TMR

|

| NFIL := ROLAV\_TC(N,TCNFIL)

| dndtpss := (N - NFIL) / TCNFIL

|

| DNDT\_SPK := ROLAV\_TC(DNDTI,TCNDT\_SPK)

| DNDT\_IMCC := ROLAV\_TC(DNDTI,TCNDT\_IMCC)

| DNDT\_DAS := ROLAV\_TC(DNDTI,TCNDT\_DAS)

| DNDT\_PSS := ROLAV\_TC(dndtpss,TCNDT\_PSS)

| ;calculate rate of change

|

| NBAR := ROLAV\_TC(N, TCN)

| NDBAR := ROLAV\_TC(N, TCNDBR)

| ;RPM data updated this loop

|

| --- ELSE ---

|

| ENG\_STALLED := 0

Where: tscf is the ticks to seconds conversion factor.

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ENGINE INPUT PROCESSING, ENGINE SPEED CALCULATION - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

APT >= 0 -----------------| DNDT\_DAS := 0

END: rpm\_main

BEGIN: pid\_definitions

SAE standard j1979 requires that a parameter for RPM (j1979\_01\_0C) be

available for the scan tool.

pid\_def(j1979\_01\_0C, N)

END: pid\_definitions

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ENGINE INPUT PROCESSING, PIP INPUT ROUTINE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

29.9 PIP INPUT ROUTINE (CDAM0)

OVERVIEW

This module describes PIP related background actions.

The foreground logic first checks to ensure that the edge is "valid" and then

sets values for a flags such as NEW\_RPM and NEW\_PIP that are used for

handshaking with the background calculations.

The background logic calculates some values used by the foreground (such as

MIN\_PIP\_DLY) and reinitializes several parameters when the engine stalls.

The Profile Ignition Pickup (digital input, PIP) Sensor is a Hall Effect

Sensor. The Hall Effect Sensor outputs a square wave pulse producing one

profile pulse of the narrow band of the cycle being sampled. A discrepancy

exists between the Hall Effect Sensor and PIP since PIP is not precisely a 50

percent duty cycle. The software has been designed to accomodate this

difference providing greater accuracy by use of the KAY factor.

PIP NOISE FILTER

\*\*\*\*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\*\*

\* \* \* \*

\* \* \* \*

\* \* \* \*

\* \* \* \*

\* \*\*\*\*\*\*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\*

| <-------------------> |

PIP up edge to PIP up edge

filter

| <-----> |

PIP up edge to PIP down edge

filter

In the EEC-IV system, a method of noise blanking to eliminate some of the

noise occurs on the PIP input. A PIP up edge to PIP up edge filter is used.

An interval value is usually picked out of a table and is in the units of

clock ticks. The equivalent millisecond value of this time corresponds to

some high value of engine rpm. If a PIP up edge follows a previous PIP up

edge at an interval less than this time, then that PIP up edge is ignored,

and treated as noise.

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ENGINE INPUT PROCESSING, PIP INPUT ROUTINE - CDAN2

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The table value (TABVAL) is divided by four and is used to filter the PIP up

edge to PIP down edge interval. If the computed time from the PIP down edge

to the previous PIP up edge is less than (TABVAL/4), then that PIP down edge

is ignored.

A typical value for the table value would be the equivalent time interval for

the PIP input at maximum engine rpm. For an 8 cylinder engine, the value

would be 2.5 milliseconds (833 clock ticks for 12 mhz).

MNPIPn - PIP FILTER

The PIP filter ignores PIP transitions which occur at a higher rate than the

maximum possible engine RPM. The maximum possible engine RPM is generally

assumed to be the RPM at which the valves begin to "float".

MNPIPn is used in the engine speed limiting strategy and is described here.

For example, with four cylinder engine (2 pips/rev) at max RPM of 6500 RPM

with

a clock frequency of 18MHz we have:

60 18 \* 1000000

MNPIPn = -------- \* ------------

2 \* 6500 96

= 865

Base values equivalent to 6500 RPM:

.---------------------------------------------------------.

| MNPIPn | cylinder (n) | frequency (MHz) | module |

|===============+==============+=================+========|

| MNPIP4 = 865 | 4 | 18 | 8065 |

| MNPIP6 = 576 | 5 | 18 | 8065 |

| MNPIP8 = 432 | 8 | 18 | 8065 |

`---------------------------------------------------------'

Note: MNPIPn should correspond to an RPM which is greater than the speed

at which the strategy turns off the fuel for speed limiting.

DEFINITIONS

Registers:

- FIRST\_PIP = Indicates that first PIP has been received.

- FIRST\_PIP\_LO = 1 -> first low PIP has been received.

- INJ\_PIP\_CNT1 = Injector PIP counter bank1.

- INJ\_PIP\_CNT2 = Injector PIP counter bank2.

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ENGINE INPUT PROCESSING, PIP INPUT ROUTINE - CDAN2

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- MIN\_PIP\_DLY = Minimum PIP delay time filter (blanking).

- NEW\_PIP = New high PIP has occurred.

- NEW\_RPM = New RPM calculation required.

- TSLPIP = Time since last PIP.

Bit Flags:

- ENG\_STALLED = Flag set to one when the engine has stalled (TSLPIP >

TSTALL).

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ENGINE INPUT PROCESSING, PIP INPUT ROUTINE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_PIP\_BG\_COM1

BEGIN: pip\_background

PIP COUNTER CONTROL LOGIC

ENG\_STALLED = 1 -----------------| FIRST\_PIP := 0

;engine is stopped - no PIP's | FIRST\_PIP\_LO := 0

| INJ\_PIP\_CNT1 := 1

| INJ\_PIP\_CNT2 := 1

NEW\_PIP = 1 ---------------------| TSLPIP := 0

;a PIP has arrived since the | ;reset timer

;last background loop | NEW\_PIP := 0

unconditionally -----------------| MIN\_PIP\_DLY := MNPIPn

| ;minimum time between valid PIP's

| ;where n is No. of cyls (4,6,8)

END: pip\_background

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ENGINE INPUT PROCESSING, PIP INPUT ROUTINE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

29.10 PIP INPUT ROUTINE (CDAM0)

OVERVIEW

This module describes foreground actions to be performed on a PIP interupt.

The foreground logic first checks to ensure that the edge is "valid" and then

sets values for a flags such as NEW\_RPM and NEW\_PIP that are used for

handshaking with the background calculations. Also, a number of time related

parameters are calculated such as DT12S and LAST\_HI\_PIP.

The background logic calculates some values used by the foreground (such as

MIN\_PIP\_DLY) and reinitializes several parameters when the engine stalls.

DEFINITIONS

Registers:

- ANPIP1 = Actual number of PIP events.

- ANPIP2 = Actual number of PIP events.

- DATA\_TIME = 3 byte time of transition.

- DT12S = The period of time between two adjacent rising edges of PIP.

- DT23S = Last DT12S time.

- DT34S = Last DT23S (used in HDR EDIS test).

- FIRST\_PIP = Indicates that first PIP has been received.

- FIRST\_PIP\_LO = 1 -> first low PIP has been received.

- HFDLTA = Time from PIP up to this PIP down edge.

- LAST\_HI\_PIP = Time of last high PIP transition.

- MIN\_PIP\_DLY = Minimum PIP delay time filter (blanking).

- N = Engine speed, revolutions per minute, RPM.

- NEW\_PIP = New high PIP has occurred.

- NEW\_RPM = New RPM calculation required.

- PIPCNT = Number of PIP's which have occurred.

- PIP\_HIGH = PIP input level.

- TSLPIP = Time since last PIP.

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ENGINE INPUT PROCESSING, PIP INPUT ROUTINE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_PIP\_FG\_COM1

PIP edge foreground logic (performed on PIP interrupt)

unconditionally -----------------| pip\_delta\_time := DATA\_TIME - LAST\_HI\_PIP

| ;time since the last up edge

PIP up edge foreground logic

PIP\_HIGH = 1 --------------|

;up edge |AND -| TSLPIP := 0

| | ;reset on the first pip

FIRST\_PIP = 0 -------------| | NEW\_PIP := 1

;this is the first PIP |

| Do: valid\_hi\_pip\_processing

|

| --- ELSE ---

PIP\_HIGH = 1 --------------| |

|AND -| NEW\_RPM := 1

pip\_delta\_time >= | | NEW\_PIP := 1

MIN\_PIP\_DLY ----| | DO: valid\_hi\_pip\_processing

;enough time between edges |

;for valid PIP |

| --- ELSE ---

|

PIP\_HIGH = 1 --------------------| PIP\_HIGH := 0

;up edge, but not a | ;ignore edge.

;valid PIP

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ENGINE INPUT PROCESSING, PIP INPUT ROUTINE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PIP down edge foreground logic

PIP\_HIGH = 0 --------------|

|

FIRST\_PIP = 1 -------------|

;a PIP has been seen |AND -| HFDLTA := DATA\_TIME - LAST\_HI\_PIP

| | ;time from pip up to this

pip\_delta\_time >= | | ;pip down edge

MIN\_PIP\_DLY ----| |

;enough time between edges | Do: valid\_low\_pip\_processing

;for valid PIP |

| --- ELSE ---

|

PIP\_HIGH = 0 --------------------| PIP\_HIGH := 1

;down edge, but not | ;ignore edge.

;a valid PIP

BEGIN: valid\_hi\_pip\_processing

Performed during PIP high interrupt.

unconditionally -----------------| DT34S := DT23S

| DT23S := min(65535, DT12S)

| DT12S := DATA\_TIME - LAST\_HI\_PIP

| LAST\_HI\_PIP := DATA\_TIME

| ;save time of this edge.

| PIPCNT := PIPCNT + 1

| ;clip at 255

| ANPIP1 := ANPIP1 + 1

| ;clip at 255

| ANPIP2 := ANPIP2 + 1

| ;clip at 255

| FIRST\_PIP := 1

END: valid\_hi\_pip\_processing

BEGIN: valid\_low\_pip\_processing

FIRST\_PIP\_LO = 0 ----------------| FIRST\_PIP\_LO := 1

| TSLPIP := 0

END: valid\_low\_pip\_processing

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ENGINE INPUT PROCESSING, PIP INPUT ROUTINE - CDAN2

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CHAPTER 30

TIMERS

30-1

TIMERS - CDAN2

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30.1 TIMER SUMMARY (CDAN0)

TIMER DESCRIPTION

----- -----------

GEAR4TMR Time since 3-4 shift (sec)

NACTMR Time not at closed throttle (sec)

PRGTMR Canister purge accumulation timer (sec)

PUTMR Time since CPU power-up (msec)

RUN\_TMR Time since entering run mode (sec)

TSEGRE Accumulated time EGR is enabled (sec)

TSLPIP Time since last PIP (msec)

USPD\_RUN\_TMR Time since engine start-up (sec)

DEFINITIONS

Registers:

- APT = Throttle mode flag; -1 -> closed throttle, 0 -> part throttle, 1 ->

wide open throttle.

- GEAR4TMR = Time since 3-4 shift, sec.

- GR\_CM = Commanded gear for shift solenoids.

- N = Engine speed, RPM.

- NACTMR = Time not at closed throttle (sec)

- PRGTMR = Canister purge accumulation timer (sec)

- PUTMR = Time since CPU power-up (msec)

- RUN\_TMR = Time since entering run mode (sec)

- TCSTRT = Temperature of ECT at cold start-up, deg F.

- TSEGRE = Accumulated time EGR is enabled (sec)

- TSLPIP = Time since last PIP (msec)

- USPD\_RUN\_TMR = Time since engine start-up, sec.

Bit Flags:

- EGREN = EGR enabled flag, 1 -> EGR enabled.

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TIMERS - CDAN2

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- GEAR4TH = 4th gear flag, 1 -> in 4th gear.

- NEW\_PIP = New PIP rising edge occurred this background loop.

- UNDSP = Underspeed flag; 1 -> Underspeed mode or Crank.

Calibration Constants:

- CTLOW = Cold start maximum ECT, deg F.

- EGRMPT = Egrate ramp time for TCSTRT <= CTLOW, sec.

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TIMERS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: TIMER\_CD

GEAR4TMR - TIME SINCE TRANSMISSION 3-4 SHIFT FOR DASPOT DELAY

GR\_CM = 4 ------------------------------| GEAR4TH = 1

| count up GEAR4TMR

| clip at maximum value

|

| --- ELSE ---

|

| GEAR4TH = 0

| GEAR4TMR = 0

NACTMR - NOT AT CLOSED THROTTLE TIME

APT = 0 (PART THROTTLE mode)-----|

|OR --| COUNT UP NACTMR

APT = 1 (WIDE OPEN THROTTLE mode)| |

| --- ELSE ---

|

| NACTMR = 0

PRGTMR - CANISTER PURGE TIMER

CANISTER PURGE OUTPUT ON --------------| COUNT UP PRGTMR

|

| --- ELSE ---

|

| FREEZE PRGTMR

PUTMR - TIME SINCE CPU POWER-UP

CPU POWER ON --------------------------| COUNT UP PUTMR

RUN\_TMR - TIME SINCE ENTERING RUN MODE

UNDSP = 0 -----------------------------| Increment RUN\_TMR

|

| --- ELSE ---

|

| Freeze RUN\_TMR

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TIMERS - CDAN2

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TSEGRE - ACCUMULATED TIME EGR IS ENABLED

TCSTRT > CTLOW ------------------------| TSEGRE = EGRMPT ('R' = 1)

|

| --- ELSE ---

|

EGR ENABLED ---------------------------| COUNT UP TSEGRE

(EGREN = 1) | (CLIP AT EGRMPT)

|

| --- ELSE ---

|

| FREEZE TSEGRE

TSLPIP - TIME SINCE LAST PIP

NEW\_PIP = 1 ---------------------------| TSLPIP = 0

| NEW\_PIP = 0

|

| --- ELSE ---

|

| Count up TSLPIP

Where NEW\_PIP is set equal to 1 upon a PIP interrupt.

USPD\_RUN\_TMR - TIME SINCE ENGINE START-UP (Word)

CRKFLG = 1 ---------------------| USPD\_RUN\_TMR = 0

(Not RUN or UNDERSPEED mode) | (Hold timer to zero)

|

| --- ELSE ---

|

| Allow USPD\_RUN\_TMR to increment

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TIMERS - CDAN2

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CHAPTER 31

FAILURE MODE MANAGEMENT

31-1

ENGINE INPUT PROCESSING, ANALOG PRESSURE INPUT - CDAN2

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31.1 ANALOG A/C HEAD PRESSURE INPUT (CDAN0)

FEATURE MEMBERSHIP : INPUT

EXECUTION CONTEXT : Background

FUNCTIONAL REQUIREMENTS :

This module converts the analogue input from the A/C head pressure sensor

into a value of A/C head pressure in PSI. It performs diagnostics on the

input and controls the relevant OBDII codes.

This module also controls the flag ACPRES\_HSF which is a request for the high

speed fan due to high A/C head pressure, and ACPRES\_FLG which is the A/C

system disable flag due to excessive head pressure.

FUNCTIONAL DESCRIPTION :

This module processes the A/C head pressure sensor input. IACPRES\_SEN is

read from an analogue input, checked to diagnose any failures of the sensor,

and the output is a good or failsafe value as ACPRES.

The Open and Short Circuit tests are run every background loop, if CCM

testing is enabled. Once a MALF Flag is set, the FMEM value is substituted.

The Insufficient Pressure Change test compares the pressure when the A/C

system is off, AC\_OFF\_PRES, with the pressure of the system AC\_PRES\_TM

seconds after the clutch has been engaged. It looks for a pressure rise of

AC\_PRES\_DLTA. If a rise of this magnitude is not seen then P1463\_TM\_LMT

seconds later the code P1463 will be set and ACPRES will be set to the FMEM

value. If later during the engagement of the clutch the pressure rises

sufficiently the code will be cleared and normal operation will continue.

The FMEM value, ACPRES\_FMEM, should be set high enough to turn the High speed

fan on, but not so high as to turn the compressor off.

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ENGINE INPUT PROCESSING, ANALOG PRESSURE INPUT - CDAN2

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DEFINITIONS

Registers:

- ACITMR = A/C clutch idle turn on delay timer.

- ACPRES = A/C Head Pressure.

- ACPRES\_TST = Temporary value of A/C head pressure, used during testing.

- AC\_OFF\_PRES = A/C head pressure when the A/C is off, PSI.

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled.

- CCM\_ER\_ENA = Engine running on demand test for CCM enabled.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag; 1 -> test

enabled.

- IACPRES\_SEN = A/C pressure, counts, from analogue.

- P1461\_TMR = Timer for fault P1461, Pressure above maximum.

- P1462\_TMR = Timer for fault P1462, Pressure below minimum.

- P1463\_TMR = Timer for fault P1463, Insufficient pressure change.

Bit Flags

- PxxxMALF = OBDII malfunction flag for fault xxxx; 1 -> a malfunction

currently exists for fault xxxx.

- ACC\_KAM\_FLG = KAM flag to signify that AC has been engaged.

- ACRQST = A/C Requested; 1 -> request.

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ENGINE INPUT PROCESSING, ANALOG PRESSURE INPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- ACPSEN\_HP = AC Pressure Sensor Hardware Present switch.

- AC\_PRES\_DLTA = AC Pressure Delta for code 1463, PSI.

- ACPRES\_CL = A/C head pressure below which A/C can function.

- ACPRES\_SH = A/C head pressure above which A/C should be disabled.

- ACPRES\_FMEM = FMEM value for ACPRES.

- ACPRE\_HSF\_SH = A/C head pressure to request high speed fan.

- ACPRE\_HSF\_CL = A/C head pressure that High speed fan no longer required.

- AC\_PRES\_TM = Time delay before performing A/C pressure rise test.

- FN703Q(IACPRES\_SEN) = A/C head pressure transfer function, for use with

analogue sensor input.

- IACPRES\_MAX = Maximum allowable value of AC Pressure, counts.

- IACPRES\_MIN = Minimum allowable value of AC Pressure, counts.

- P1461\_TM\_LMT = Time limit before setting code P1461.

- P1462\_TM\_LMT = Time limit before setting code P1462.

- P1463\_TM\_LMT = Time limit before setting code P1463.

OUTPUTS

- ACPRES = A/C head pressure (PSI).

- ACPRES\_FLG = High A/C head pressure, 1 -> Disable A/C system.

- ACPRES\_HSF = Flaf indicating requested status of HSF due to A/C head

pressure.

- P1461 = A/C Pressure Sensor above maximum.

- P1462 = A/C Pressure Sensor below minimum.

- P1463 = A/C pressure sensor insufficient change.

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ENGINE INPUT PROCESSING, ANALOG PRESSURE INPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_ACPRES\_COM2

BEGIN: A/C PRESSURE TEST

ACPSEN\_HP = 0 --------------------| | ACPRES := 0

|OR --| ;Set ACPRES to zero, basic

ACC\_KAM\_FLG = 0 ------------------| | ;strategy assumption

;A/C hardware not present or |

;A/C system not been run before | ACPRES\_FLG := 0

| ACPRES\_HSF := 0

| ;HSF not required

|

| P1461\_TMR := 0

| P1462\_TMR := 0

| P1463\_TMR := 0

| Clear\_malf (P1461,P1462,P1463)

|

| --- ELSE ---

|

| ACPRES\_TST := FN703Q(IACPRES\_SEN)

|

| ;Assign a temporary pressure

| ;and perform testing

|

| DO: AC OFF PRESSURE

| DO: FAILURE CHECKS

| DO: ACPRES ASSIGN

| DO: ACPRES HSF REQUEST

| DO: ACPRES FLAG

END: A/C PRESSURE TEST

BEGIN: AC OFF PRESSURE

ACRQST = 0 -----------------------------| AC\_OFF\_PRES := ACPRES\_TST

;A/C not requested | ;Assign reference value

| ;for A/C off pressure

|

| --- ELSE ---

|

| NO ACTION

END: AC OFF PRESSURE

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ENGINE INPUT PROCESSING, ANALOG PRESSURE INPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FAILURE CHECKS

CCM\_ER\_ENA = 0 -------------------|

| | P1461\_TMR := 0

CCM\_EO\_ENA = 0 -------------------|AND -| P1462\_TMR := 0

| | P1463\_TMR := 0

CCM\_TST\_ENA = 0 ------------------| |

| ;CCM testing disabled, hold

| ;error timers to zero until

| ;testing resumes

|

| --- ELSE ---

|

IACPRES\_SEN <= IACPRES\_MAX -------| | P1461\_TMR := 0

|AND -| P1462\_TMR := 0

IACPRES\_SEN >= IACPRES\_MIN -------| | DO: Clear\_malf (P1461,P1462)

|

| ;No open/short failure,

| ;clear MALF flags and do

| ;range checks

|

| DO: AC RANGE CHECKS

|

| --- ELSE ---

IACPRES\_SEN > IACPRES\_MAX --------| |

|AND -| DO: Store\_code (P1461)

P1461\_TMR > P1461\_TM\_LMT ---------| | P1462\_TMR := 0

| P1463\_TMR := 0

| DO: Clear\_malf (P1462,P1463)

| ;Open circuit failure

|

| --- ELSE ---

IACPRES\_SEN < IACPRES\_MIN --------| |

|AND -| DO: Store\_code (P1462)

P1462\_TMR > P1462\_TM\_LMT ---------| | P1461\_TMR := 0

| P1463\_TMR := 0

| DO: Clear\_malf (P1461,P1463)

| ;Closed circuit failure

|

| --- ELSE ---

|

| P1463\_TMR := 0

|

| ;Open/Short failure pending,

| ;hold range failure timer

| ;to zero, allow others to

| ;increment

END: FAILURE CHECKS

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ENGINE INPUT PROCESSING, ANALOG PRESSURE INPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: AC RANGE CHECKS

ACITMR < AC\_PRES\_TM -------------------------| P1463\_TMR := 0

| ;Cannot perform tests yet

| ;A/C not been on long enough

| ;hold error timer to zero

|

| --- ELSE ---

|

ACPRES\_TST > AC\_OFF\_PRES + AC\_PRES\_DLTA -----| P1463\_TMR := 0

;Pressure rise OK, no error | DO: Clear\_malf (P1463)

|

| --- ELSE ---

|

P1463\_TMR > P1463\_TM\_LMT --------------------| DO: Store\_code (P1463)

| ;Fault present long enough

| ;store code

|

| --- ELSE ---

|

| NO ACTION

| ;Allow free running timer

| ;to increment

END: AC RANGE CHECKS

BEGIN: ACPRES ASSIGN

P1461MALF = 1 --------------------|

|

P1462MALF = 1 --------------------|OR --| ACPRES := ACPRES\_FMEM

| | ;Set ACPRES to FMEM pressure

P1463MALF = 1 --------------------| | ;to initiate failure mode action

|

| --- ELSE ---

|

| ACPRES := ACPRES\_TST

| ;Assign ACPRES to correct value

| ;from sensor for normal operation

END: ACPRES ASSIGN

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ENGINE INPUT PROCESSING, ANALOG PRESSURE INPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ACPRES HSF REQUEST

ACPRES > ACPRE\_HSF\_SH -----------| S Q -| ACPRES\_HSF

;High A/C head pressure | ;High speed fan required

|

ACPRES < ACPRE\_HSF\_CL -----------| C

;Fan no longer required

END: ACPRES HSF REQUEST

BEGIN: ACPRES FLAG

ACPRES > ACPRES\_SH --------------| S Q -| ACPRES\_FLG

;Pressure too high, turn A/C off|

|

ACPRES < ACPRES\_CL --------------| C

END: ACPRES FLAG

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ENGINE INPUT PROCESSING, AIR CHARGE TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.2 AIR CHARGE TEMPERATURE SENSOR INPUT AND SELFTEST (CDAN2)

OVERVIEW

The A/D is read and the raw counts (ACT\_CNTS) are converted into deg F,

(ACT\_ENG). ACT\_ENG is the value used when performing any input testing and

also reported to the scan tool. Next, the ACT\_ENG value is tested for "out

of range" or other failure conditions. If the ACT sensor reading is in

range, ACT is set equal to ACT\_ENG. Otherwise, the last "good" value will be

used for ACT until the failure has been present for a sufficient amount of

time. At that time, the appropriate malfunction flags (P0113MALF, P0112MALF

and AFMFLG) are set and the FMEM strategy will substitute either the smaller

of TCSTRT or ACT\_FMEM during warm-up or ACT\_FMEM thereafter.

The ACT test does not contain a specific monitor flag for input into the

OBD-II Trip flag. It is assumed that when CCM\_MON\_TIM is reached (see

OBDII\_CCM\_MON module), a failure, if present, would have been detected.

This module does not contain any specific on-demand (KOEO or KOER) tests.

DEFINITIONS

Registers:

- ACSTRT = ACT at start-up; arithmetic average of the first eight ACT

readings, deg F.

- ACSTRT\_ACCUM = ACSTRT accumulater, deg F.

- ACT = Engineering units value with any FMEM corrections applied, deg F.

- ACT\_CNTS = Raw A/D counts from sensor.

- ACT\_ENG = Engineering units value for ACT before any FMEM action, deg F.

Used for output to the scan tool.

- ACT\_ER\_TMR = Timer that runs when a fault is present. This timer is

shared by both the high and low failures.

- ACT\_FM\_TMR = Timer that is cleared when the failure conditions for FMEM

mode are met, sec.

- ECTCNT = Number of times A/D is read.

- j1979\_01\_0F = Inlet air temperature, deg C + 40. (ie a j1979\_01\_0f of 70

is equal to an ACT of 30 deg C)

- PUTMR = Time since power-up, sec.

- TCSTRT = ECT at startup, deg F.

Bit Flags:

| - ACT\_FRST\_FL = First pass ACT reading flag; 0 -> First pass for ACT A/D

| reading.

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ENGINE INPUT PROCESSING, AIR CHARGE TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- AFMFLG = Flag indicating that ACT sensor has failed.

- CCM\_EO\_ENA = Key-on engine off on-demand test in progress.

- CCM\_ER\_ENA = Key-on engine on on-demand test in progress.

- CCM\_TST\_ENA = Continuous CCM test enabled.

- FFG\_ACT = OBD-II system FMEM flag for ACT; 1-> ACT is currently

unreliable.

- FFG\_ECT = OBD-II system FMEM flag for ECT; 1 -> ECT is currently

unreliable.

- OBD\_PARM\_RST = Flag set whenever OBDII is reset, KAM is in error or

on-demand tests are entered or exited.

- PxxxMALF = OBD-II malfunction flag for fault xxx; 1 -> a malfunction

currently exists for fault xxx, where Pxxx is a valid OBD-II code.

- WRMEGO = EGO sensor should be warm; 1 -> warm, 0 -> not warm.

Calibration Constants:

- ACT\_ER\_TM = Time with failure present required to set code, sec.

- ACT\_FMEM = Default FMEM value for ACT, deg F.

- ACT\_FM\_TM = Minimum time in FMEM mode once initiated, sec.

- ACT\_HI\_ER = Maximum acceptable value for ACT, deg F.

- ACT\_LO\_ER = Minimum acceptable value for ACT, deg F.

- ACT\_TC = ACT time constant for filtering input.

- FN703F(ACT\_CNTS) = Function to convert from A/D counts to deg F. Note:

Since the failure mode testing is done in engineering units, the sensor

transfer function MUST be calibrated from below ACT\_LO\_ER to above

ACT\_HI\_ER.

- NUMEGO = Number of EGO sensors present in system.

- TKYON2 = Time delay before Key-on updates are permitted, sec.

OTHER

- act\_codes: Set of {P0113,P0112}.

- malfunction(ccm,pxxx) = Logic process imported from the MIL control

module, where pxxx is a valid OBD-II code.

- P0112 = Air charge temp. (ACT) sensor circuit above maximum voltage/ 40

deg F indicated.

- P0113 = Air charge temp. (ACT) sensor circuit below minimum voltage/ 254

deg F indicated.

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ENGINE INPUT PROCESSING, AIR CHARGE TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_ACT\_OBDII\_COM1

BEGIN: pid\_definitions

unconditionally ------------------------| pid\_def(j1979\_01\_0f,

| (((ACT\_ENG - 32)\*5/9) + 40))

| (deg C + 40)

END: pid\_definitions

Initialize ACT at power-up so a "reasonable" value is available until the

input can be read.

BEGIN: act\_init

power-up initialization ----------------| ACT\_ENG := 60

| ACT := 60

END: act\_init

BEGIN: act\_start\_up

OBD\_PARM\_RST is set whenever OBDII is reset or KAM is in error or on-demand

tests are entered or exited. At this time the error timer needs to be

cleared to prevent codes being carried forward.

CCM\_TST\_ENA = 0 ------------|

|

CCM\_E0\_ENA = 0 -------------|AND -|

| |

CCM\_ER\_ENA = 0 -------------| |OR --| ACT\_ER\_TMR := 0

| | ;if test not asked for

OBD\_PARM\_RST = 1 -----------------| | ;clear timer to zero

|

| ACT\_ENG := FN703F(ACT\_CNTS)

| ;convert to engineering units

| Do: act\_input\_check

| ;check for out of range

|

| --- ELSE ---

|

| Normal engine operation

|

| ACT\_ENG := FN703F(ACT\_CNTS)

| ;convert to engineering units

| Do: act\_input\_check

| ;check for out of range

END: act\_start\_up

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ENGINE INPUT PROCESSING, AIR CHARGE TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: act\_input\_check

Check for "open/short" failures. Perform FMEM action if a failure is

detected. Set malfunction flag when a malfunction has been present for a

sufficient time.

ACT\_ENG > ACT\_HI\_ER --------------|

;temperature too high |

|

ACT\_ER\_TMR > ACT\_ER\_TM -----------|

;failure present long |

;long enough |AND -| FFG\_ACT := 1

| | AFMFLG := 1

CCM\_TST\_ENA = 1 ------------| | | ;set failure flags

;continuous test | | | Do: malfunction(ccm,P0112)

| | | ACT\_FM\_TMR := 0

CCM\_EO\_ENA = 1 -------------|OR --| | ;clear failure mode timer

;engine off | | Do: act\_fmem

;on-demand test | | ;perform FMEM action

| |

CCM\_ER\_ENA = 1 -------------| |

;engine on on-demand test |

| --- ELSE ---

|

ACT\_ENG > ACT\_HI\_ER --------------------| Do: act\_fmem

;temperature too high | ;perform FMEM action

;not present long enough | FFG\_ACT := 1

;to set malfunction flag | ;no change to AFMFLG

|

| --- ELSE ---

|

|

ACT\_ENG < ACT\_LO\_ER --------------| |

;temperature too low | |

| |

ACT\_ER\_TMR > ACT\_ER\_TM -----------| |

;failure present | |

;long enough |AND -| FFG\_ACT := 1

| | AFMFLG := 1

CCM\_TST\_ENA = 1 ------------| | | ;set failure flag

;continuous test | | | Do: malfunction(ccm,P0113)

| | | ACT\_FM\_TMR := 0

CCM\_EO\_ENA = 1 -------------|OR --| | ;clear failure mode timer

;engine off | | Do: act\_fmem

;on-demand test | | ;perform FMEM action

| |

CCM\_ER\_ENA = 1 -------------| |

;engine on |

;on-demand test | --- ELSE ---

|

| (continued on next page)

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ENGINE INPUT PROCESSING, AIR CHARGE TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| (continued from previous page)

| |

ACT\_ENG < ACT\_LO\_ER --------------------| Do: act\_fmem

;temperature too low | ;perform FMEM action

;not present long enough | FFG\_ACT := 1

;to set malfunction flag | ;no change to AFMFLG

|

| --- ELSE ---

P0112MALF = 1 --------------| |

|OR --| |

P0113MALF = 1 --------------| |AND -| Do: act\_fmem

| | ;remain in FMEM mode

ACT\_FM\_TMR < ACT\_FM\_TM -----------| | ;until it times out

| FFG\_ACT := 1

| AFMFLG := 1

|

| --- ELSE ---

|

| ACT\_FRST\_FL = 0 ------------------------| ACT := ACT\_ENG

| ;first ACT value | ;initial value for ACT

| | ;rolling average filter

| | ACT\_ER\_TMR := 0

| | ;clear failure present timer

| | ACT\_FRST\_FL := 1

| | FFG\_ACT := 0

| | ;no failure

| |

| | --- ELSE ---

| |

| ACT := ROLAV\_TC(ACT\_ENG,ACT\_TC)

| ;no failure detected, return

| ;value for normal use

| ACT\_ER\_TMR := 0

| ;clear failure present timer

| Do: clear\_malf(P0112)

| Do: clear\_malf(P0113)

| ;clear failure flags

| Do: acstrt\_check

| ;calculate ACT at start

| FFG\_ACT := 0

| AFMFLG := 0

| ;no failure

END: act\_input\_check

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ENGINE INPUT PROCESSING, AIR CHARGE TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: act\_fmem

FMEM strategy will substitute either the smaller of TCSTRT or ACT\_FMEM during

warm-up or ACT\_FMEM after warm-up and fault codes set.

WRMEGO = 0 -----------------------|

;start up open loop |

|AND -| ACT := min(TCSTRT,ACT\_FMEM)

NUMEGO <> 0 ----------------------| | ;use minimum value

| |

FFG\_ECT = 0 ----------------------| |

;ECT in range |

| --- ELSE ---

P0112MALF = 1 --------------------| |

|OR --| ACT := ACT\_FMEM

P0113MALF = 1 --------------------| |

| --- ELSE ---

|

| Do not update ACT

END: act\_fmem

BEGIN: acstrt\_check

The calculation of ACSTRT (ACT at start) is based on the first eight ACT

readings.

PUTMR > TKYON2 -------------------|

;avoid noise during |

;engine cranking |AND -| ACSTRT\_ACCUM := ACSTRT\_ACCUM +

| | (ACT/8)

ECTCNT < 8 -----------------------| | ;compute arithemetic average

;accumulate first 8 | ;of the first 8 ACT readings

;ECTCNT is calculated | ACSTRT := ACT

;in ECT module | ;use current value until ACSTRT

| ;has been calculated

|

| --- ELSE ---

|

ECTCNT < 8 -----------------------------| ACSTRT := ACT

| ;use current value until ACSTRT

| ;has been calculated

|

| --- ELSE ---

|

| ACSTRT := ACSTRT\_ACCUM

| ;load ACSTRT with arithmetic

| ;average first 8 values

| ;after PUTMR > TKYON2

END: acstrt\_check

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INPUT AND FAILURE MODE AND SELF TEST, AODE INPUT EQUATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.3 AODE INPUT EQUATIONS (CDAA0)

OVERVIEW

Once per background loop, the output shaft speed is calculated if at least

one new rising edge occured since the last calculation. If the time since

the last edge becomes large, the shaft speed is set to zero. Zero output

shaft speed indicates that the shaft has stopped or the sensor has failed.

The following parameters are calculated primarily by the output shaft speed

sensor (OSS): NOBAR, VSBARTL, VSBART\_RT. In the event of an OSS failure,

these parameters will be calculated using the vehicle speed sensor (VSS).

DEFINITIONS

INPUTS

Registers:

- NO = Unfiltered output shaft speed.

- NOBART = Filtered output shaft speed for transmission use.

- RT\_NOVS = Ratio of actual N/V to base N/V in KAM.

- VS = Unfiltered vehicle speed.

- VSBARV = Filtered vehicle speed for Self-Test.

- VS\_LIM\_BAR = Filtered vehicle speed used for vehicle speed limiting.

Bit Flags:

- OSFMFLG = Output shaft speed sensor failure flag.

Calibration Constants:

- NVBASE = Base engine speed divided by vehicle speed.

- TCNO = Time constant for output shaft speed filtering.

- TCVST = Time constant for filtered vehicle speed.

- TSTRAT = Transmission type.

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INPUT AND FAILURE MODE AND SELF TEST, AODE INPUT EQUATIONS - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- NOBAR = Filtered output shaft speed.

- NOBART = See above.

- VSBARTL = Filtered vehicle speed for transmission use.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission

use.

- VSBARV = see above.

- VS\_SMPL\_TM = CLOCK time in milliseconds at the time VSBART is calculated.

PROCESS

STRATEGY MODULE: INPUT\_AODE\_EQNS\_COM1

VEHICLE SPEED PROCESSING

Always ----------------------------| VSBARV = ROLAV(VS,TCVST)

| NOBART = ROLAV(NO,TCNO)

| VS\_SMPL\_TM = current CLOCK time in

milliseconds

OSFMFLG = 0 -----------------|

(OSS OK) |AND -| NOBAR = NOBART

| | VSBART\_RT = NOBART/NVBASE

TSTRAT = 7 ------------------| | (clip VSBART\_RT to 127.5 max.)

(AODE Transmission) | VSBARTL = NOBART/(RT\_NOVS \* NVBASE)

|

| --- ELSE ---

|

| NOBAR = VS\_LIM\_BAR \* NVBASE \* RT\_NOVS

| VSBART\_RT = VSBARV \* RT\_NOVS

| VSBARTL = ROLAV(VS,TCVST)

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INPUT AND FAILURE MODE AND SELF TEST, BRAKE SWITCH INPUT AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.4 BRAKE SWITCH INPUT AND SELF TEST (CDAM0)

OVERVIEW

When the brake switch is depressed, the low speed digital input (BOO\_LVL) is

set to one. To prevent noise falsely triggering this input, the input must

be set to high (1) for at least two reads of the data image. The brake input

flag (BIFLG) is set and cleared in background to reflect the state of the

BOO\_LVL if there is a brake input to the module.

For the KOEO on-demand test, BIFLG must be low to pass. For KOER, the test

is to be called at the end of the KOER test. If both states have not been

seen, failure code P1703 is set.

DEFINITIONS

INPUTS

Registers:

- BOO\_LVL = Digital input.

- ER\_STATUS = State pointer that indicated current state of engine running

on-demand test.

Bit Flags:

- BIFLG = Current state of BOO input; 0 -> brake off.

- BOO\_KOER\_ENA = BOO KOER on demand selftest enabled, to be done at end of

KOER test.

- CCM\_EO\_ENA = Key on engine off on-demand test in progress.

- OPER\_RSP\_CHK = Flag to signal that it is time to check for operator

response (BOO, PSPS, etc).

- V\_BOOS\_OFF = Off state has been seen since last reset.

- V\_BOOS\_ON = On state has been seen since last reset.

Calibration Constants:

- BIHP = Brake input hardware present switch.

- ER\_INIT = Value for state of ER\_STATUS when engine running test first

inits.

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INPUT AND FAILURE MODE AND SELF TEST, BRAKE SWITCH INPUT AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Bit Flags:

- BIFLG = See above.

- BIFLG\_LST = Last pass value of BIFLG.

- V\_BOOS\_OFF = See above.

- V\_BOOS\_ON = See above.

OTHER

- BOO\_CODES = Set of {P1703}.

- store\_code(Pxxx) = Stores the fault code specified by Pxxx.

- P1703 = Brake input high in KOEO or no state change in KOER.

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INPUT AND FAILURE MODE AND SELF TEST, BRAKE SWITCH INPUT AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_BOO\_OBDII\_COM1

always ----------------------------| BIFLG\_LST := BIFLG

BIHP = 0 --------------------------| BIFLG := 0

;brake hardware not present | ;no hardware

|

| --- ELSE ---

BOO\_LVL = 1 -----------------| |

|AND -| BIFLG := 1

| | ;brake applied

BIHP = 1 --------------------| | V\_BOOS\_ON := 1

;brake input hardware | ;ON state "seen"

;present |

| --- ELSE ---

|

| BIFLG := 0

| ;brake not applied

| V\_BOOS\_OFF := 1

| ;OFF state "seen"

ER\_STATUS = ER\_INIT ---------------| V\_BOOS\_ON := 0

;engine running on-demand | V\_BOOS\_OFF := 0

;test starting now | ;restart flags to watch for

| ;response during on demand test

|

| --- ELSE ---

|

| No action

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INPUT AND FAILURE MODE AND SELF TEST, BRAKE SWITCH INPUT AND SELF TEST - CDAN2

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BIHP = 0 --------------------------| No action

;brake hardware not present |

| --- ELSE ---

OPER\_RSP\_CHK = 1 ------------| |

;end of KOER test | |

|AND -| Do: store\_code(P1703)

V\_BOOS\_ON = 0 --------| | |

;ON state has not | | |

;been seen |OR --| |

| |

V\_BOOS\_OFF = 0 --------| |

;OFF state has not been seen |

| --- ELSE ---

CCM\_EO\_ENA = 1 --------------| |

;KOEO on demand test |AND -| Do: store\_code(P1703)

| |

BIFLG = 1 -------------------| |

brake "on" |

| --- ELSE ---

|

| No action

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ENGINE INPUT PROCESSING, DISTRIBUTORLESS IGNITION SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.5 DISTRIBUTORLESS IGNITION SYSTEM/MISFIRE FMEM (CDAL0)

OVERVIEW

When a failure occurs, in the primary side of one of the coils or in the

wiring from the ignition module to one of the coils the ignition module will

not send an IDM signal to the EEC module for the affected cylinders. Through

logic developed for the Continuous Self Test Strategy, this lack of signal is

identified and classified, in foreground, as to which coil has suffered the

failure. Using this information, an event counter will determine if the

failure is continuous and if so, will allow a failure mode effects management

(FMEM) to be instituted. Also when a misfire is detected by the misfire

detection strategy fmem action for the affected cylinder will be instituted.

In either case only the last two cylinders in the firing sequence that have

been determined to fail will have FMEM action applied to them (e.g. if on an

eight cylinder engine cylinders 5, 4 and 8 are determined to be misfiring

only 4 and 8 will have FMEM action applied).

The FMEM actions include a strategy that (for sequential fueled systems) will

disable fuel to the two cylinders which are not receiving spark. In

addition, the fuel can be forced into open loop and the LAMBSE value can be

modified by the 'C' multiplier as a function of LOAD. Additional FMEM

actions can be the use of a spark adder, the disabling of the EGR and the

disabling of the A/C clutch to reduce the load.

DEFINITIONS

Registers:

- DISFMEMTMR = Timer that indicates time in DISFMEM.

Bit Flags:

- DISCUTOUT1 = Denotes one of two injectors which should not be fueled due

to a DIS primary side failure.

- DISCUTOUT2 = Denotes one of two injectors which should not be fueled due

to a DIS primary side failure.

- DIS\_FMEM = Flag indicating that a primary side failure has occurred on a

DIS system and that an alternate strategy has been requested.

- MIS200FLG\_1 = Misfire on cylinder 1, catalyst temperature criteria.

- MIS200FLG\_2 = Misfire on cylinder 2, catalyst temperature criteria.

- MIS200FLG\_3 = Misfire on cylinder 3, catalyst temperature criteria.

- MIS200FLG\_4 = Misfire on cylinder 4, catalyst temperature criteria.

- MIS200FLG\_5 = Misfire on cylinder 5, catalyst temperature criteria.

- MIS200FLG\_6 = Misfire on cylinder 6, catalyst temperature criteria.

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ENGINE INPUT PROCESSING, DISTRIBUTORLESS IGNITION SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- MIS200FLG\_7 = Misfire on cylinder 7, catalyst temperature criteria.

- MIS200FLG\_8 = Misfire on cylinder 8, catalyst temperature criteria.

- PxxxMALF = Malfunction flag for code Pxxx; 1 -> a malfunction currently

exists for fault Pxxx.

Calibration Constants:

- DISFMEMTM = Time limit on DISFMEM action. Allows for rechecking the

presence of the malfunction.

- DISFMEM\_DSRD = A calibratable flag which indicates whether FMEM action

should be taken upon detection of a primary side DIS failure.

- ENGCYL = The number of PIPs per engine revolution.

- MISFMEM\_DSRD = A calibratable flag which indicates whether FMEM action

should be taken upon detection of a misfire.

- PAIR\_A1 = One of the two cylinders using coil pack "A" in the DIS

ignition system.

- PAIR\_A2 = One of the two cylinders using coil pack "A" in the DIS

ignition system.

- PAIR\_B1 = One of the two cylinders using coil pack "B" in the DIS

ignition system.

- PAIR\_B2 = One of the two cylinders using coil pack "B" in the DIS

ignition system.

- PAIR\_C1 = One of the two cylinders using coil pack "C" in the DIS

ignition system.

- PAIR\_C2 = One of the two cylinders using coil pack "C" in the DIS

ignition system.

- PAIR\_D1 = One of the two cylinders using coil pack "D" in the DIS

ignition system.

- PAIR\_D2 = One of the two cylinders using coil pack "D" in the DIS

ignition system.

OTHER

- P0351 = Fault code, Coil A primary failure.

- P0352 = Fault code, Coil B primary failure.

- P0353 = Fault code, coil C primary failure.

- P0354 = Fault code, Coil D primary failure.

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ENGINE INPUT PROCESSING, DISTRIBUTORLESS IGNITION SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_DIS\_COM3

P0351MALF = 1 -------------|

(coil A circuit failure) |AND -|

| |

DISFMEM\_DSRD = 1 -----------| |

|OR --| DISCUTOUT1 = PAIR\_A1

MIS200FLG\_1 = 1 ------------| | | DIS\_FMEM = 1

(cylinder 1 misfire) |AND -|

|

MISFMEM\_DSRD = 1 -----------|

P0351MALF = 1 --------------|

(coil A circuit failure) |AND -|

| |

DISFMEM\_DSRD = 1 -----------| |

|

MIS200FLG\_4 = 1 ------------| |

| |

ENGCYL = 2 -----------------|AND -|

| |

MISFMEM\_DSRD = 1 -----------| |

|OR --| DISCUTOUT2 = PAIR\_A2

MIS200FLG\_5 = 1 ------------| | | DIS\_FMEM = 1

| |

ENGCYL = 3 -----------------|AND -|

| |

MISFMEM\_DSRD = 1 -----------| |

|

MIS200FLG\_6 = 1 ------------| |

| |

ENGCYL = 4 -----------------|AND -|

|

MISFMEM\_DSRD = 1 -----------|

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ENGINE INPUT PROCESSING, DISTRIBUTORLESS IGNITION SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P0352MALF = 1 --------------|

(coil B circuit failure) |AND -|

| |

DISFMEM\_DSRD = 1 -----------| |

|

MIS200FLG\_3 = 1 ------------| |

| |OR --| DISCUTOUT1= PAIR\_B1

ENGCYL = 2 -----------| |AND -| | DIS\_FMEM = 1

|OR --| |

ENGCYL = 4 -----------| | |

| |

MISFMEM\_DSRD = 1 -----------| |

|

MIS200FLG\_4 = 1 ------------| |

| |

ENGCYL = 3 -----------------|AND -|

|

MISFMEM\_DSRD = 1 -----------|

P0352MALF ------------------|

(coil B circuit failure) |AND -|

| |

DISFMEM\_DSRD = 1 -----------| |

|

MIS200FLG\_2 = 1 ------------| |

| |

ENGCYL = 2 -----------------|AND -|

| |

MISFMEM\_DSRD = 1 -----------| |

|OR --| DISCUTOUT2 = PAIR\_B2

MIS200FLG\_3 = 1 ------------| | | DIS\_FMEM = 1

| |

ENGCYL = 3 -----------------|AND -|

| |

MISFMEM\_DSRD = 1 -----------| |

|

MIS200FLG\_5 = 1 ------------| |

| |

ENGCYL = 4 -----------------|AND -|

|

MISFMEM\_DSRD = 1 -----------|

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ENGINE INPUT PROCESSING, DISTRIBUTORLESS IGNITION SYSTEM FMEM - CDAN2

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P0353MALF = 1 -------------|

(coil C circuit failure) |AND -|

| |

DISFMEM\_DSRD = 1 -----------| |

|

MIS200FLG\_2 = 1 ------------| |

| |

ENGCYL = 3 -----------------|AND -|

| |

MISFMEM\_DSRD = 1 -----------| |OR --| DISCUTOUT1 = PAIR\_C1

| | DIS\_FMEM = 1

MIS200FLG\_7 = 1 ------------| |

| |

ENGCYL = 4 -----------------|AND -|

|

MISFMEM\_DSRD = 1 -----------|

P0353MALF = 1 --------------|

(coil C circuit failure) |AND -|

| |

DISFMEM\_DSRD = 1 -----------| |

|

MIS200FLG\_6 = 1 ------------| |

| |

ENGCYL = 3 -----------------| |OR --| DISCUTOUT2 = PAIR\_C2

| | | DIS\_FMEM = 1

MISFMEM\_DSRD = 1 -----------| |

|

MIS200FLG\_4 = 1 ------------| |

| |

ENGCYL = 4 -----------------|AND -|

|

MISFMEM\_DSRD = 1 -----------|

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ENGINE INPUT PROCESSING, DISTRIBUTORLESS IGNITION SYSTEM FMEM - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

P0354MALF = 1 --------------|

(coil D circuit failure) |AND -|

| |

DISFMEM\_DSRD = 1 -----------| |

|OR -| DISCUTOUT1 = PAIR\_D1

MIS200FLG\_2 = 1 ------------| | | DIS\_FMEM = 1

| |

ENGCYL = 4 -----------------|AND -|

|

MISFMEM\_DSRD = 1 -----------|

P0354MALF = 1 --------------|

(coil D circuit failure) |AND -|

| |

DISFMEM\_DSRD = 1 -----------| |OR --| DISCUTOUT2 = PAIR\_D2

| | DIS\_FMEM = 1

MIS200FLG\_8 = 1 ------------| |

(cylinder 8 misfire) | |

ENGCYL = 4 -----------------|AND -|

|

MISFMEM\_DSRD = 1 -----------|

The following logic allows injector cutout to remain in effect for DISFMEMTM

seconds. Injectors will be turned on after FMEM has been in effect DISFMEMTM

seconds. If the malfunction remains, FMEM will again be inabled. To

maintain the FMEM action until powerdown, calibrate DISFMEMTM = 255 (sec).

Then DISFMEMTMR will never be greater than DISFMEMTM.

DIS\_FMEM = 0 ------------------| DISFMEMTMR := 0

(fmem not requested) | DISCUTOUT1 := 0

| DISCUTOUT2 := 0

|

| --- ELSE ---

|

DISFMEMTMR > DISFMEMTM --------| DIS\_FMEM := 0

(in fmem and the time to | DISFMEMTMR := 0

be in fmem exceeded) | MIS200FLG\_1 := 0

| MIS200FLG\_2 := 0

| MIS200FLG\_3 := 0

| MIS200FLG\_4 := 0

| MIS200FLG\_5 := 0

| MIS200FLG\_6 := 0

| MIS200FLG\_7 := 0

| MIS200FLG\_8 := 0

| DISCUTOUT1 := 0

| DISCUTOUT2 := 0

|

| --- ELSE ---

|

| (fmem to continue, disfmemtmr

| runs)

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ENGINE INPUT PROCESSING, ENGINE COOLANT TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.6 ECT SENSOR INPUT AND SELFTEST (CDAN0)

OVERVIEW

Initial checks are made to determine if an on-demand mode is activated. If

no on-demand mode is active the software falls through and runs the standard

sequence. The A/D is read and the raw counts (ECT\_CNTS) are converted into

deg F. (ECT\_ENG). ECT\_ENG is the value used when performing any input

testing and reported to the scan tool. Next, the ECT\_ENG value is tested for

"out of range" or other failure conditions. If the ECT sensor reading is in

range, ECT is set equal to ECT\_ENG. Otherwise, the last "good" value will be

used for ECT until the failure is present for a sufficient amount of time.

Then the appropriate malfunction flag (P0117MALF) is set and the FMEM

strategy substitutes TOT or ACT during CRANK or a default value during Run

Mode.

In addition to the "range" checks, a California's OBD-II regulation test for

the time required to reach feedback temperature is made. The time allowed is

based on a function (FN654W(INFAMB\_KAM)) from inferred ambient temperature.

Once this test is complete (pass or fail) ECT is considered monitored for

this OBD-II trip.

If an on-demand mode is active the KOER or KOEO range tests will be run along

with the standard continuous tests and FMEM action.

DEFINITIONS

Registers:

- ACT\_ENG = Air charge temperature before any FMEM action, deg F.

- ECT = Engine coolant temperature with FMEM corrections as required, deg

F.

- ECTCNT = Number of times that ECT sensor input was read.

- ECT\_CNTS = Raw A/D counts from sensor.

- ECT\_ENG = Engine coolant temperature before any FMEM action. Used for

FMEM testing and output to scan tool, deg F.

- TOT\_ENG = Transmission oil temperature before any FMEM action, deg F.

- ECT\_ER\_TMR = Timer that runs when a fault is present, sec.

- ECT\_FM\_TMR = Timer that is reset when the failure conditions for FMEM

mode are met, sec.

- ECT\_FMEM\_TMR = Timer to control ECT ramp to ECT\_FMEM rate, sec.

- ECT\_INST = Instantaneous ECT (no rolling average) with FMEM substitutions

if required.

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ENGINE INPUT PROCESSING, ENGINE COOLANT TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- INFAMB\_KAM = Inferred ambient air temperature, deg F.

- PUTMR = Time since power-up, sec.

- TCSTRT = ECT at start-up; arithmetic average of the first eight ECT

readings.

- TCSTRT\_ACCUM = TCSTRT accumulator, deg F.

- USPD\_RUN\_TMR = Time in underspeed or run mode, sec.

Bit Flags:

- CCM\_ECT\_MON = OBD-II monitor flag for ECT; 1 -> ECT is considered

monitored.

- CCM\_EO\_ENA = Indicates that engine off on-demand mode has been requested.

- CCM\_ER\_ENA = Indicates that engine running on-demand mode has been

requested.

- CCM\_TST\_ENA = Continuous CCM test enabled.

- CFMFLG = Flag indicating that ECT sensor is in/out of range.

- CRKFLG = Crank flag.

- ECT\_FRST\_FL = First pass ECT reading flag; 0 -> First pass for ECT A/D

reading.

- FFG\_ACT = OBD-II system FMEM flag for ACT; 1 -> ACT is currently not

reliable.

- FFG\_ECT = OBD-II system FMEM flag for ECT; 1 -> ECT is currently not

reliable.

- FFG\_TOT = OBD-II system FMEM flag for TOT; 1 -> TOT is currently not

reliable.

- TOT\_FRST\_FL = First valid A/D reading for TOT.

- OBD\_PARM\_RST = Flag set whenever OBDII is reset, KAM is in error or

on-demand tests are entered or exited.

- PxxxMALF = OBD-II malfunction flag for fault xxx; 1 -> a malfunction

currently exists for fault xxx, where Pxxx is a valid OBD-II code.

Calibration Constants:

- ECT\_ER\_TM = Time with failure present required to set code, sec.

- ECT\_FM\_TM = Minimum time in FMEM mode once initiated, sec.

- ECT\_FMEM = FMEM value used when ECT\_ENG is out of range, deg F.

- ECTFMM = FMEM default value for ECT, units are degrees F.

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ENGINE INPUT PROCESSING, ENGINE COOLANT TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- ECT\_HI\_ER = Maximum acceptable value for ECT, deg F.

- ECT\_HI\_KOEO = Maximum value to pass KOEO on-demand test, deg F.

- ECT\_HI\_KOER = Maximum value to pass KOER on-demand test, deg F.

- ECT\_LO\_ER = Minimum acceptable value for ECT, deg F.

- ECT\_LO\_KOEO = Minimum value to pass KOEO on-demand test, deg F.

- ECT\_LO\_KOER = Minimum value to pass KOER on-demand test, deg F.

- ECT\_TC1 = Time constant for filtering ECT, sec.

- ECT\_RAMP\_TM = Time between updates while ramping ECT to ECT\_FMEM, sec.

- ECT\_WUT = Minimum engine coolant temperature for code P0125, deg F.

- FN703F(ECT\_CNTS) = Function to convert from A/D counts to deg F.

- FN654W(INFAMB\_KAM) = Warm up time required to reach ECT\_WUT, sec.

- TKYON2 = Time delay before Key-on updates are permitted, sec.

- TSTRAT = Calibration device to show transmission type.

OTHER

- malfunction(ccm,Pxxx) = Logic process imported from the MIL control

module where Pxxx is a valid OBD-II code.

- store\_code(Pxxx) = Stores the fault code specified by Pxxx.

- ect\_codes = Set of {P0117,P0118,P0125}

- ect\_other\_codes = Set of {P1116}

- P0125 = Stabilized feedback temperature not reached in time.

- P1116 = Engine coolant temperature (ECT) higher or lower than expected

(KOER or KOEO).

- P0117 = Engine coolant temperature (ECT) sensor circuit below minimum

voltage / 254 deg F. indicated.

- P0118 = Engine coolant temperature (ECT) sensor circuit above maximum

voltage / -40 deg F. indicated.

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ENGINE INPUT PROCESSING, ENGINE COOLANT TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_ECT\_OBDII\_COM4

BEGIN: pid\_definitions

unconditionally --------| pid\_def(j1979\_01\_05, (((ECT\_ENG - 32)\*5/9) + 40))

| (degrees C + 40)

END: pid\_definitions

BEGIN: ect\_init

Initialize ECT\_ENG, ECT and ECT\_INST at power-up so a "reasonable" value is

available until the input can be read.

power-up initialization ------------| ECT\_ENG := 60

| ECT := 60

| ECT\_INST := 60

END: ect\_init

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ENGINE INPUT PROCESSING, ENGINE COOLANT TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ect\_start\_up

unconditionally --------------------| ECT\_ENG := FN703F(ECT\_CNTS)

| ;convert to deg F

OBD\_PARM\_RST is set whenever OBDII is reset or KAM is in error or on-demand

tests are entered or exited. At this time the error timer needs to be

cleared to prevent codes being carried forward.

CCM\_TST\_ENA = 0 --------|

|

CCM\_E0\_ENA = 0 ---------|AND -|

| |

CCM\_ER\_ENA = 0 ---------| |OR --| ECT\_ER\_TMR := 0

| | ;if test not asked for

OBD\_PARM\_RST = 1 -------------| | ;clear timer to zero

;reset | Do: ect\_failure\_check

| ;check for out of range

| ;perform FMEM action

| Do: ect\_warm\_up\_test

| ;test for warm-up, calculate TCSTRT

| ;set component monitored flags

|

| --- ELSE ---

|

CCM\_ER\_ENA = 1 ---------------------| Do: ect\_failure\_check

;engine Running on-demand | ;check for out of range

;selftest requested | ;perform FMEM action

| Do: ect\_koer\_check

| ;perform special tests

| ;for engine running

|

| --- ELSE ---

|

CCM\_EO\_ENA = 1 ---------------------| Do: ect\_failure\_check

;engine off on-demand | ;check for out of range

;selftest requested | ;perform FMEM action

| Do: ect\_koeo\_check

| ;perform special tests for engine off

|

| --- ELSE ---

|

| Normal engine operation

|

| Do: ect\_failure\_check

| ;check for out of range

| ;perform FMEM action

| Do: ect\_warm\_up\_test

| ;test for warm-up, calculate TCSTRT

| ;set component monitored flags

END: ect\_start\_up

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ENGINE INPUT PROCESSING, ENGINE COOLANT TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ect\_failure\_check

Check for "open/short" failures. Perform FMEM action if a failure is

detected. Set malfunction flag when a malfunction has been present for a

sufficient time. Otherwise, calculate ECT as a rolling average of ECT\_ENG.

ECT\_ENG > ECT\_HI\_ER ----------|

;temperature too high |

|

ECT\_ER\_TMR > ECT\_ER\_TM -------|

;failure present |AND -| CFMFLG := 1

;long enough | | FFG\_ECT := 1

| | ;set failure flags

CCM\_TST\_ENA = 1 --------| | | Do: malfunction(ccm,P0117)

| | | ECT\_FM\_TMR := 0

CCM\_EO\_ENA = 1 ---------|OR --| | Do: ect\_fmem

| | | ;perform FMEM action

CCM\_ER\_ENA = 1 ---------| |

| --- ELSE ---

|

ECT\_ENG > ECT\_HI\_ER ----------------| Do: ect\_fmem

;temperature too high | ;perform FMEM action

;not present long enough | FFG\_ECT := 1

;to set malfunction flag | ;set failure flag

|

| --- ELSE ---

ECT\_ENG < ECT\_LO\_ER ----------| |

;temperature too low | |

| |

ECT\_ER\_TMR > ECT\_ER\_TM -------|AND -| CFMFLG := 1

;failure present | | FFG\_ECT := 1

;long enough | | ;set failure flag

| | Do: malfunction(ccm,P0118)

CCM\_TST\_ENA = 1 --------| | | ECT\_FM\_TMR := 0

| | | Do: ect\_fmem

CCM\_EO\_ENA = 1 ---------|OR --| | ;perform FMEM action

| |

CCM\_ER\_ENA = 1 ---------| |

| --- ELSE ---

|

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ENGINE INPUT PROCESSING, ENGINE COOLANT TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

ECT\_ENG < ECT\_LO\_ER ----------------| Do: ect\_fmem

;temperature too low | ;perform FMEM action

;not present long enough | FFG\_ECT := 1

;to set malfunction flag | ;set failure flag

|

| --- ELSE ---

P0118MALF = 1 ----------| |

;currently in FMEM |OR --| |

| | |

P0117MALF = 1 ----------| |AND -| Do: ect\_fmem

| | ;remain in FMEM mode for at least

ECT\_FM\_TMR < ECT\_FM\_TM -------| | ;the minimum time even if the

;minimum time in FMEM | ;failure is no longer present

;once it is entered | FFG\_ECT := 1

| CFMFLG := 1

| ;set failure mode flag

|

| --- ELSE ---

|

ECT\_FRST\_FL = 0 --------------------| ECT := ECT\_ENG

;first ECT value | ;initial value for ECT

| ;rolling average filter

| ECT\_INST := ECT\_ENG

| ;unfiltered value of ECT

| ECT\_ER\_TMR := 0

| ;clear failure present timer

| ECT\_FRST\_FL := 1

| FFG\_ECT := 0

| ;no failure

|

| --- ELSE ---

|

| ECT := ROLAV\_TC(ECT\_ENG,ECT\_TC1)

| ;no failure detected, return

| ;value for normal use

| ECT\_INST := ECT\_ENG

| ;unfiltered value of ECT

| ECT\_ER\_TMR := 0

| ;clear failure present timer

| Do: clear\_malf(P0118)

| Do: clear\_malf(P0117)

| CFMFLG := 0

| FFG\_ECT := 0

| ;no failure

| ;clear failure flags

END: ect\_failure\_check

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ENGINE INPUT PROCESSING, ENGINE COOLANT TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ect\_fmem

In crank mode, use TOT in place of ECT. Otherwise, until a failure has been

present long enough to set a failure flag, use last good value of ECT. Once

the failure flag is set, ramp ECT to the value ECT\_FMEM.

TSTRAT <> 0 ------------------|

;TOT available |

|

CRKFLG = 1 -------------------|

;crank mode |

|

ECT\_FRST\_FL = 0 --------------|

|AND -| ECT := TOT\_ENG

FFG\_TOT = 0 ------------------| | ;substitute a good TOT value for

;TOT in range | | ;the bad ECT while in crank mode

| | ECT\_FRST\_FL := 1

TOT\_FRST\_FL = 1 --------------| | ;initial value

;TOT has been read | ECT\_INST := TOT\_ENG

| ;unfiltered value of ECT

|

| --- ELSE ---

TSTRAT <> 0 ------------------| |

;TOT available | |

| |

CRKFLG = 1 -------------------| |

;crank mode |AND -| ECT := ROLAV\_TC(TOT\_ENG,ECT\_TC1)

| | ;calculate ECT as the rolling

FFG\_TOT = 0 ------------------| | ;average of ECT\_old and TOT

;TOT in range | | ;while in crank mode

| | ECT\_INST := TOT\_ENG

TOT\_FRST\_FL = 1 --------------| |

;TOT has been read |

| --- ELSE ---

CRKFLG = 1 -------------------| |

;crank mode | |

|AND -| ECT := ACT\_ENG

ECT\_FRST\_FL = 0 --------------| | ;substitute a good ACT value for

| | ;the bad ECT while in crank mode

FFG\_ACT = 0 ------------------| | ;as TOT not available

;ACT in range |

| ECT\_FRST\_FL := 1

| ;initial value

| ECT\_INST := ACT\_ENG

|

| --- ELSE ---

CRKFLG = 1 -------------------| |

;crank mode |AND -| ECT := ROLAV\_TC(ACT\_ENG,ECT\_TC1)

| | ;calculate ECT as the rolling

FFG\_ACT = 0 ------------------| | ;average of ECT\_old and ACT

;ACT in range | ;while in crank mode as

| ;TOT not available

| ECT\_INST = ACT\_ENG

|

| --- ELSE ---

(continued on next page)

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ENGINE INPUT PROCESSING, ENGINE COOLANT TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

P0117MALF = 1 ----------------| |

|OR --| Do: ect\_ramp

P0118MALF = 1 ----------------| | ;ramp ECT to ECTFMM

|

| --- ELSE ---

|

| Do not update ECT

| ;use last good value

END: ect\_fmem

BEGIN: ect\_ramp

Decrement (or increment) ECT from the current value to ECT\_FMEM at the rate

of 2 deg (1 bit) every ECT\_RAMP\_TM seconds. Since ECT\_FMEM\_TMR is allowed to

run during normal operations, on the first call to this routine it will

probabably exceed ECT\_RAMP\_TM and ECT will increment or decrement 2 degrees.

ECT > ECT\_FMEM ---------------|

;ECT high |AND -| ECT := ECT - 2 deg F

| | ;ramp down towards ECT\_FMEM

ECT\_FMEM\_TMR > ECT\_RAMP\_TM ---| | ECT\_FMEM\_TMR := 0

;enough time to allow | ;clear timer, set up to wait

;a decrement | ;for next interval

|

| --- ELSE ---

ECT < ECT\_FMEM ---------------| |

;ECT low |AND -| ECT := ECT + 2 deg F

| | ;ramp up towards ECT\_FMEM

ECT\_FMEM\_TMR > ECT\_RAMP\_TM ---| | ECT\_FMEM\_TMR := 0

;enough time to allow | ;clear timer, set up to wait

;a decrement | ;for next interval

|

| --- ELSE ---

|

| Do not update ECT

| ;ECT is already ECT\_FMEM or

| ;insufficent time since last

| ;update

END: ect\_ramp

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ENGINE INPUT PROCESSING, ENGINE COOLANT TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ect\_koer\_check

Check against Key-on engine running limits. If an error is detected, set

P1116MALF flag.

FFG\_ECT = 1 ------------------------| ;continuous test detected

;ECT unreliable | ;failure, no need to test

| ;tighter KOER limits

|

| --- ELSE ---

ECT\_ENG > ECT\_HI\_KOER --------| |

|OR --| Do: store\_code(P1116)

ECT\_ENG < ECT\_LO\_KOER --------| | ;ECT out of selftest range

|

| --- ELSE ---

|

| Do: clear\_malf(P1116)

| ;no failure detected

END: ect\_koer\_check

BEGIN: ect\_koeo\_check

Check against Key-on engine off limits. If an error is detected, set

P1116MALF flag.

FFG\_ECT = 1 ------------------------| ;continuous test detected

;ECT unreliable | ;failure, no need to test

| ;tighter KOER limits

|

| --- ELSE ---

ECT\_ENG > ECT\_HI\_KOEO --------| |

|OR --| Do: store\_code(P1116)

ECT\_ENG < ECT\_LO\_KOEO --------| | ;ECT out of selftest range

|

| --- ELSE ---

|

| Do; clear\_malf(P1116)

| ;no failure detected

END: ect\_koeo\_check

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ENGINE INPUT PROCESSING, ENGINE COOLANT TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ect\_warm\_up\_test

OBD-II regulations require that the ECT sensor be monitored for achieving a

stabilized minimum temperature level. This is the level needed to achieve

closed-loop operation within a manufacturer-specified time interval, after

starting the engine. To pass this test, ECT must excede ECT\_WUT within the

time limit defined by FN654W(INFAMB\_KAM). After the time interval

FN654W(INFAMB\_KAM), the ECT sensor is considered to be monitored for this

trip.

TCSTRT (ECT at start) based on the first eight ECT readings is also

calculated here.

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ENGINE INPUT PROCESSING, ENGINE COOLANT TEMPERATURE SENSOR - CDAN2

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PUTMR > TKYON2 ---------------|

;avoid noise during |

;engine cranking |AND -| TCSTRT\_ACCUM := TCSTRT\_ACCUM + (ECT/8)

| | ;compute arithmetic average of

ECTCNT < 8 -------------------| | ;the first 8 ECT readings

;accumulate first eight |

| TCSTRT := ECT

| ;use current value until TCSTRT

| ;has been calculated

| ECTCNT := ECTCNT + 1

| ;increment ECTCNT, also used

| ;for ACT and TOT

|

| --- ELSE ---

|

ECTCNT < 8 -------------------------| TCSTRT := ECT

| ;use current value until TCSTRT

| ;has been calculated

|

| --- ELSE ---

ECT > ECT\_WUT ----------------| |

;stabilized ECT reached | |

| |

CCM\_ECT\_MON = 0 --------------|AND -| Do: clear\_malf(P0125)

;not yet monitored | | ;ECT stabilized

| | CCM\_ECT\_MON := 1

CCM\_TST\_ENA = 1 --------------| | ;ECT monitored for OBD-II trip

;CCM test enabled | TCSTRT := TCSTRT\_ACCUM

| ;load TCSTRT with arithmetic

| ;average of first 8 values

| ;after PUTMR > TKYON2

|

| --- ELSE ---

USPD\_RUN\_TMR > |

FN654W(INFAMB\_KAM) -----| |

;enough time for ECT to | |

;stabilize | |

| |

|AND -| Do: malfunction(ccm,P0125)

CCM\_ECT\_MON = 0 --------------| | ;set failure flag

;not yet monitored | | ;did not warm up in time

| | ;ECT or thermostat failure

CCM\_TST\_ENA = 1 --------------| |

;CCM test enabled | CCM\_ECT\_MON := 1

| ;ECT monitored for OBD-II trip

| TCSTRT := TCSTRT\_ACCUM

| ;load TCSTRT with arithmetic

| ;average of first 8 values

| ;after PUTMR > TKYON2

|

| --- ELSE ---

|

| TCSTRT := TCSTRT\_ACCUM

| ;load TCSTRT with arithmetic

| ;average of first 8 values

| ;after PUTMR > TKYON2

END: ect\_warm\_up\_test

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INPUT AND FAILURE MODE AND SELF TEST, OCTANE ADJUST INPUT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.7 OCTANE ADJUST INPUT TEST (CDAL0)

OVERVIEW

The OCTane ADJust pin is used in service to retard the spark for octane. The

normal state for the pin is to be shorted to ground, in which case service

spark retard is not required.

Providing octane adjust hardware is present, the purpose of the Octane Adjust

Input Test is to check the state of the octane adjust pin and output a self

test code if the pin is open circuit, thus indicating that spark retard has

been requested or that there is an open circuit fault.

DEFINITIONS

INPUTS

Bit Flags:

- CCM\_EO\_ENA = KOEO on-demand self test enabled.

- OCTADJ = Field octane adjust input; 1 -> Retard for octane adjustment is

desired, 0 -> No retard is desired.

- PxxxMALF = OBD-II malfunction flag for fault xxx; 1 -> a malfunction

currently exists for fault xxx, where Pxxx is a valid OBD-II code.

Calibration Constants:

- OCTADJHP = Octane adjust pin hardware present switch; 0 -> no OCTADJ pin

present, 1 -> an OCTADJ pin is present.

OUTPUTS

Bit Flags:

- PxxxMALF = See above

OTHER

- octadj\_codes = Set of {P1390}

- store\_code(Pxxx) = Stores the fault code specified by Pxxx.

- erase\_code(Pxxx) = Erases the fault code specified by Pxxx.

- P1390 = Octane adjust service pin in use/circuit open.

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INPUT AND FAILURE MODE AND SELF TEST, OCTANE ADJUST INPUT TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_OCTADJ\_OBDII\_COM1

OCTADJHP = 0 ---------------------------| (no action)

(Octane Adjust hardware |

not present) |

| --- ELSE ---

|

CCM\_EO\_ENA = 1 -------------------| |

(KOEO on-demand test) |AND -| store\_code(P1390)

| |

OCTADJ = 1 -----------------------| |

(Octane Adjust pin is |

open circuit) |

| --- ELSE ---

|

CCM\_EO\_ENA = 1 -------------------------| erase\_code(P1390)

|

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INPUT AND FAILURE MODE AND SELF TEST, PSPS INPUT AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.8 POWER STEERING PRESSURE SWITCH (PSPS) INPUT AND SELF TEST (CDAJ0)

OVERVIEW

PSPS is a switch which opens/closes based on the level of the power steering

pressure. If the pressure is greater tha or equal to that exerted by the

switchn the circuit is opened and the flag POWSFG is set to 1; if the switch

is closed (PSPS is greater than pressure) then a signal is output of 0.4

Volts direct current or less and POWSFG is set to zero.

In normal continuous mode, it is assumed that the power steering would have

been activated at least once by the time V\_PSPS\_CNT transitions from zero MPH

to a sustained cruise speed (V\_PSPSPD\_CTR) are made. If not, a failure code

is set.

NOTE: This code could be set if a vehicle is towed with the engine running.

For the KOEO on-demand test, POWSFG must be low to pass. For KOER, a failure

is assumed and when both on and off states have been seen, the KAM bit is

cleared.

DEFINITIONS

INPUTS

Registers:

- ER\_STATUS = State pointer that incicated current state of engine running

on-demand test.

- PSPS = Digital input.

- V\_PSPSPD\_CTR = Number of vehicle speed transitions from a speed of zero

to a speed of V\_ZTOSPD\_MPH that lasted at least V\_ZTOSPD\_TM seconds since

last PSPS on and off detected.

Bit Flags:

- CCM\_TST\_ENA = Continuous self test enabled.

- CCM\_EO\_ENA = KOEO on-demand self test enabled.

- PxxxMALF = OBD-II malfunction flag for fault xxx; 1-> a malfunction

currently exists for fault xxx, where Pxxx is a valid OBD-II code.

- POWSFG = Current state of PSPS input; 0 -> no PSPS load.

- OPER\_RSP\_CHK = PSPS KOER on-demand self test enabled, enabled at end of

KOER test.

- V\_POWS\_OFF = Off state has been seen since last reset.

- V\_POWS\_ON = On state has been seen since last reset.

31-41

INPUT AND FAILURE MODE AND SELF TEST, PSPS INPUT AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- ER\_INIT = Value for state of ER\_STATUS when engine running test first

inits.

- PSPSHP = Power steering pressure switch hardware present.

- V\_PSPS\_CNT = Number of speed transitions without both PSPS states to

assume a failure.

OUTPUTS

Registers:

- V\_PSPSPD\_CTR = See above.

Bit Flags:

- PxxxMALF = See above.

- POWSFG = See above.

- V\_POWS\_ON = See above.

- V\_POWS\_OFF = See above.

OTHER

- store\_code(Pxxx) = Stores the fault code specified by Pxxx.

- psps\_codes = SET OF {P1650,P1651}

- P1650 = PSPS indicates power steering applied during KOEO or no state

change in KOER.

- P1651 = PSPS did not change states in Continuous test.

31-42

INPUT AND FAILURE MODE AND SELF TEST, PSPS INPUT AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_PSPS\_COM1

PSPSHP = 0 ------------------------| do nothing

(PSPS hardware not present) |

| --- ELSE ---

PSPS\_LVL = 1 ----------------| |

|AND -| POWSFG = 1

PSPSHP = 1 ------------------| | (power steering load on)

(PSPS input hardware | V\_POWS\_ON = 1

present) | (ON state "seen")

|

| --- ELSE ---

|

| POWSFG = 0

| (Power steering not applied or

| hardware not present)

| V\_POWS\_OFF = 1

| (OFF state "seen")

ER\_STATUS = ER\_INIT ---------------| V\_POWS\_ON = 0

(engine running on-demand | V\_POWS\_OFF = 0

test starting now) | (restart flags to watch for response

| during on-demand test.)

|

| V\_PSPSPD\_CTR = 0

| (clear counter)

|

| --- ELSE ---

|

| no action.

PSTMR - POWER STEERING TIMER (SEC.)

This timer increments while the power steering is applied.

POWSFG = 1 ------------------| |

|AND -| Count up PSTMR

PSPSHP = 1 ------------------| |

|

| --- ELSE ---

|

| PSTMR = 0

31-43

INPUT AND FAILURE MODE AND SELF TEST, PSPS INPUT AND SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PSPSHP = 0 ------------------------| NO ACTION

(PSPS hardware not present) |

| --- ELSE ---

CCM\_TST\_ENA = 1 -------------| |

(Continuous Self Test | |

enabled) | |

| |

V\_POWS\_ON = 1 --------------|AND -| clear\_malf(P1651)

(ON state has been seen) | | (both states seen, PSPS works)

| | V\_POWS\_ON = 0

V\_POWS\_OFF = 1 --------------| | V\_POWS\_OFF = 0

(OFF state has been seen) | (reset flags to allow re-test)

| V\_PSPSPD\_CTR = 0

| (restart counter for re-test)

|

| --- ELSE ---

CCM\_TST\_ENA = 1 -------------| |

|AND -| store\_code(P1651)

V\_PSPSPD\_CTR > V\_PSPS\_CNT ---| | (failure assumed)

(Enough speed transitions |

without both PSPS states to |

assume failure) |

| --- ELSE ---

OPER\_RSP\_CHK = 1 ------------| |

(KOER PSPS Self Test ena.) | |

|AND -| store\_code(P1650)

V\_POWS\_ON = 0 --------| | | (malfunction)

(ON state has not | | |

been seen) |OR --| |

| |

V\_POWS\_OFF = 0 --------| |

(OFF state has not been seen) |

| --- ELSE ---

CCM\_EO\_ENA = 1 --------------| |

(KOEO on-demand test) |AND -| store\_code(P1650)

| | (malfunction)

POWSFG = 1 ------------------| |

(power steering load on) |

|

| --- ELSE ---

|

| (no action)

31-44

INPUT CONVERSIONS AND FILTERS, POWER STEERING PRESSURE SWITCH INPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.9 POWER STEERING PRESSURE SWITCH INPUT (CDAA0)

OVERVIEW

PSPS is a switch which opens/closes based on the level of the power steering

pressure. If the pressure is greater than, or equal to that exerted by the

switch the circuit is opened; if the switch is closed (PSPS is greater than

pressure) then a signal is output of 0.4 Volts direct current or less. NOTE:

If the PSPSHP is calibrated to indicate no PSPS, the POWSFG is held at zero.

DEFINITIONS

INPUTS

Registers:

- PSPS = Power steering pressure switch input.

Calibration Constants:

- PSPSHP = Power steering pressure switch "Hardware Present" indicator (0 =

NO, 1 = YES).

OUTPUTS

Bit Flags:

- POWSFG = Power steering flag.

31-45

INPUT CONVERSIONS AND FILTERS, POWER STEERING PRESSURE SWITCH INPUT - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_PSPS\_SWITCH\_COM1

PSPS LOW --------------------|

|OR --| POWSFG = 0

PSPSHP = 0 ------------------| | (no power steering load)

(PSPS hardware absent) |

| --- ELSE ---

|

| POWSFG = 1

| (power steering load)

31-46

ENGINE INPUT PROCESSING, START STOP COUNTER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.10 START STOP COUNTER FOR PSPS (CDAN0)

OVERVIEW

This module counts V\_PSPSPD\_CTR transitions from stopped to a sustained speed

V\_ZTOSPD\_MPH, in V\_ZTOSPD\_TM seconds. These counts are used in the PSPS test

to determine if sufficient vehicle movement has occurred to assume that the

power steering should have been used.

DEFINITIONS

Registers:

- V\_PSPSPD\_CTR = Number of vehicle speed transitions from a speed of zero

to a speed of V\_ZTOSPD\_MPH that lasted at least V\_ZTOSPD\_TM seconds since

last PSPS on and off detected.

- VSBAR = Rolling average of vehicle speed, mph.

- V\_ZTOSPD\_TMR = Non cumulative time VSBAR greater than V\_ZTOSPD\_MPH, sec.

Bit Flags:

- V\_SPDTOZ\_FLG = Flag to indicate that vehicle has been stopped.

Calibration Constants:

- V\_ZTOSPD\_MPH = Speed required to increment V\_PSPSPD\_CTR, mph.

- V\_ZTOSPD\_TM = Time at speed required to increment V\_PSPSPD\_CTR, sec

31-47

ENGINE INPUT PROCESSING, START STOP COUNTER - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_START\_STOP\_OBDII\_COM1

BEGIN: input\_start\_stop

This is called once per background loop from the CNVRT software module.

VSBAR = 0 --------------------------| V\_SPDTOZ\_FLG := 1

;vehicle stopped | ;set up to count next

| ;zero to speed transition

|

| V\_ZTOSPD\_TMR := 0

| ;not above required speed

| ;hold timer to zero

|

| --- ELSE ---

|

VSBAR <= V\_ZTOSPD\_MPH --------------| V\_ZTOSPD\_TMR := 0

| ;not above required speed

| ;hold timer to zero

|

| --- ELSE ---

V\_ZTOSPD\_TMR > V\_ZTOSPD\_TM ---| |

;sufficient time at speed |AND -| V\_PSPSPD\_CTR := V\_PSPSPD\_CTR + 1

| | ;zero to speed transition made

V\_SPDTOZ\_FLG = 1 -------------| | ;so increment counter

;first time conditions met | ;counter zeroed in PSPS

;since last zero speed |

| V\_SPDTOZ\_FLG := 0

| ;wait for next zero speed...

|

| --- ELSE ---

|

| No action

END: input\_start\_stop

31-48

ENGINE INPUT PROCESSING, TRANSMISSION OIL TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.11 TOT SENSOR INPUT AND SELFTEST (CDAM0)

OVERVIEW

Initial checks are made to determine if an on-demand mode is activated. If

no on-demand mode is active the software falls through and runs the standard

sequence. The A/D is read and the raw counts (TOT\_CNTS) are converted into

deg F. (TOT\_ENG). TOT\_ENG is the value used when performing any input

testing and is reported to the scan tool. Next, the TOT\_ENG value is tested

for "out of range" or other failure conditions. If the TOT sensor reading is

in range, TOT is set equal to TOT\_ENG. Otherwise, the last "good" value of

TOT (TOT\_LST) will be used for TOT until the failure is present for a

sufficient amount of time. At that time, the appropriate malfunction flag

(PxxxMALF) is set and the FMEM strategy will determine TOT as follows:

- ECT < warm engine TOT = ECT

- ECT >= warm engine TOT is ramped to TOT\_MAX.

If TOT was < warm\_engine before invalid

reading,the ramp starts at warm\_engine;

otherwise the ramp starts at TOT value

before invalid reading.

Ramp time is calibratible with maximum

time of 255 seconds; resolution of

1 second.

This allows cold engagement strategy to function and protects the

transmission when operating at higher temperatures.

If an on-demand mode is active. The KOER or KOEO range tests will be run

along with the standard Continuous tests and FMEM action.

DEFINITIONS

Registers:

- ECT = Engine Coolant Temperature, deg F.

- FFG\_TOT = OBD-II system FMEM flag for TOT; 1 -> TOT is currently

unreliable.

- INIT\_TOT = TOT at start-up; arithmetic average of the first eight TOT

readings.

- INIT\_TOT\_CNT = Number of times that the TOT sensor has been read.

- PUTMR = Time since power up, sec.

- TOT = Transmission oil temperature with FMEM corrections as required, deg

F.

- TOT\_CNTS = Raw A/D counts from sensor.

31-49

ENGINE INPUT PROCESSING, TRANSMISSION OIL TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TOT\_ENG = Transmission oil temperature before any FMEM action. Used for

FMEM testing and output to scan tool, deg F.

- TOT\_ER\_TMR = Timer that runs when a fault is present.

- TOT\_FM\_TMR = Timer that is reset when the failure conditions for FMEM

mode are met, sec.

- TOT\_LST = Last pass value of TOT, deg F.

- TOT\_PREV = Last valid TOT before out of range value, deg F.

- TOT\_TMR = Timer that is reset until FMEM logic calls for TOT to ramp to

TOT\_MAX, sec.

Bit Flags:

- CCM\_EO\_ENA = Indicates that engine off on-demand mode has been requested.

- CCM\_ER\_ENA = Indicates that engine running on-demand mode has been

requested.

- CCM\_TST\_ENA = Continuous CCM tests enabled.

- OBD\_PARM\_RST = Flag set whenever OBDII is reset, KAM is in error or

on-demand tests are entered or exited.

- PxxxMALF = OBD-II malfunction flag for fault xxx; 1-> a malfunction

currently exists for fault xxx, where Pxxx is a valid OBD-II code.

- TOT\_FM\_FLG = TOT failure mode flag; 1 -> TOT FMEM in progress.

- TOT\_FRST\_FL = First pass TOT reading flag; 0 -> First pass for TOT A/D

reading.

Calibration Constants:

- ECT\_WARM\_ENG = Value of ECT above which the powertrain will be considered

warm, deg F.

- FN703F(TOT\_CNTS) = Function to convert from A/D counts to deg F.

- TKYON2 = Time delay before Key on updates are permitted, sec.

- TOT\_ER\_TM = Time with failure present required to set code, sec.

- TOT\_FM\_TM = Minimum time in FMEM mode once initiated, sec.

- TOT\_HI\_ER = Maximum acceptable value for TOT, deg F.

- TOT\_HI\_KOEO = Maximum value to pass KOEO on-demand test, deg F.

- TOT\_HI\_KOER = Maximum value to pass KOER on-demand test, deg F.

- TOT\_LO\_ER = Minimum acceptable value for TOT, deg F.

- TOT\_LO\_KOEO = Minimum value to pass KOEO on-demand test, deg F.

31-50

ENGINE INPUT PROCESSING, TRANSMISSION OIL TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TOT\_LO\_KOER = Minimum value to pass KOER on-demand test, deg F.

- TOT\_MAX = TOT value during sensor FMEM once powertrain has warmed up.

- TOT\_RMP\_TIM = Length of time of FMEM TOT ramp, sec.

- TOT\_TC = Time constant for TOT, sec.

- TSTRAT = Transmission strategy switch; The TSTRAT software switch

controls which transmission control strategy is executed:

0 -> No transmission control (Manual trans., AOD, ATX, C6, C3, etc.)

1 -> SIL (Shift indicator light)

2 -> A4LD with 3-4 shift control and converter clutch control

3 -> AXOD

4 -> C64E (E4OD)

5 -> A4LDE

6 -> FAX-4

7 -> AOD-E (AOD-I)

8 -> 4EAT

9 -> CD4E

OTHER

- malfunction(ccm,Pxxx) = Logic process imported from the MIL control

module where Pxxx is a valid OBD-II code.

- store\_code(Pxxx) = Stores the fault code specified by Pxxx.

- P1711 = Transmission oil temperature (TOT) higher or Lower than expected

(KOER or KOEO)

- P0712 = Transmission oil temperature (TOT) sensor circuit below minimum

voltage / 254 F. indicated.

- P0713 = Transmission oil temperature (TOT) sensor circuit above maximum

voltage / -40 F. indicated.

- TOT\_CODES = Set of {P0712,P0713}

- TOT\_OTHER\_CODES = Set of {P1711}

31-51

ENGINE INPUT PROCESSING, TRANSMISSION OIL TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_TOT\_OBDII\_COM2

BEGIN: tot\_init

Initialize TOT\_ENG and TOT at power-up so a "reasonable" value is available

until the input can be read.

power-up initialization ------------| TOT\_ENG := 60

| TOT := 60

END: tot\_init

BEGIN: tot\_start\_up

Once per background the following logic is executed:

OBD\_PARM\_RST is set whenever OBDII is reset or KAM is in error or on-demand

tests are entered or exited. At this time the error timer needs to be

cleared to prevent codes being carried forward.

unconditionally --------------------| TOT\_LST := TOT

| ;save last value of TOT

31-52

ENGINE INPUT PROCESSING, TRANSMISSION OIL TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TSTRAT <= 3 ------------------------| Exit module

;manual/non-electric transmission |

| --- ELSE ---

CCM\_TST\_ENA = 0 --------| |

| |

CCM\_E0\_ENA = 0 ---------|AND -| |

| | |

CCM\_ER\_ENA = 0 ---------| |OR --| TOT\_ER\_TMR := 0

| | ;if test not asked for

OBD\_PARM\_RST = 1 -------------| | ;clear timer to zero

|

| TOT\_ENG := FN703F(TOT\_CNTS)

| ;convert A/D input to deg F

| DO: tot\_failure\_check

| ;check for out of range

| ;perform FMEM action

| Do: initial\_tot\_calculation

| ;compute arithmetic average of the

| ;first 8 consecutive TOT readings

|

| --- ELSE ---

|

CCM\_ER\_ENA = 1 ---------------------| TOT\_ENG := FN703F(TOT\_CNTS)

;engine running on-demand | ;convert A/D input to deg F

;selftest requested | Do: tot\_failure\_check

| ;check for out of range

| ;perform FMEM action

| Do: tot\_koer\_check

| ;perform special tests for

| ;engine running

|

| --- ELSE ---

|

CCM\_EO\_ENA = 1 ---------------------| TOT\_ENG := FN703F(TOT\_CNTS)

;engine off on-demand | ;convert A/D input to deg F

;self test requested | Do: tot\_failure\_check

| ;check for out of range

| ;perform FMEM action

| Do: tot\_koeo\_check

| ;perform special tests for

| ;engine off

|

| --- ELSE ---

|

| Normal engine operation

|

| TOT\_ENG := FN703F(TOT\_CNTS)

| ;convert A/D input to deg F

| DO: tot\_failure\_check

| ;check for out of range

| ;perform FMEM action

| Do: initial\_tot\_calculation

| ;compute arithmetic average of the

| ;first 8 consecutive TOT readings

|

END: tot\_start\_up

31-53

ENGINE INPUT PROCESSING, TRANSMISSION OIL TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: tot\_failure\_check

Check for "open/short" failures. Perform FMEM action if a failure is

detected. Set malfunction flag when a malfunction has been present for a

sufficient time. Otherwise, calculate TOT as a rolling average of TOT\_ENG.

TOT\_ENG > TOT\_HI\_ER ----------|

;value too high |

|

TOT\_ER\_TMR > TOT\_ER\_TM -------|

;failure present |AND -| FFG\_TOT := 1

;long enough | | TOT\_FM\_FLG := 1

| | ;set failure flags

CCM\_TST\_ENA = 1 --------| | | Do: store\_code(P0712)

| | | TOT\_FM\_TMR := 0

CCM\_ER\_ENA = 1 ---------|OR --| | Do: fmem\_tot\_calc

| | ;perform FMEM action

CCM\_EO\_ENA = 1 ---------| |

| --- ELSE ---

|

TOT\_ENG > TOT\_HI\_ER ----------------| TOT := TOT\_LST

;value too high | TOT\_FM\_TMR := 0

;not present long enough to | FFG\_TOT := 1

;set malfunction flag | ;set TOT to TOT\_LST

| ;until error present long

| ;enough to store a code

|

| --- ELSE ---

TOT\_ENG < TOT\_LO\_ER ----------| |

;value too low | |

| |

TOT\_ER\_TMR > TOT\_ER\_TM -------| |

;failure present |AND -| FFG\_TOT := 1

;long enough | | TOT\_FM\_FLG := 1

| | ;set failure flag

CCM\_TST\_ENA = 1 --------| | | Do: store\_code(P0713)

| | | TOT\_FM\_TMR := 0

CCM\_ER\_ENA = 1 ---------|OR --| | Do: fmem\_tot\_calc

| | ;perform FMEM action

CCM\_EO\_ENA = 1 ---------| |

|

| --- ELSE ---

|

TOT\_ENG < TOT\_LO\_ER ----------------| TOT := TOT\_LST

;value too low | TOT\_FM\_TMR := 0

;not present long enough to | FFG\_TOT := 1

;set malfunction flag | ;set TOT to TOT\_LST

| ;until error present long

| ;enough to store a code

|

| --- ELSE ---

(continued on next page)

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ENGINE INPUT PROCESSING, TRANSMISSION OIL TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

TOT\_FM\_FLG = 1 ---------------| |

;TOT FMEM in progress |AND -| Do: fmem\_tot\_calc

| | ;remain in FMEM mode for at least

TOT\_FM\_TMR < TOT\_FM\_TM -------| | ;the minimum time even if the

;minimum time in FMEM | ;failure is no longer present

;once it is entered | FFG\_TOT := 0

|

| --- ELSE ---

|

TOT\_FRST\_FL = 0 --------------------| TOT := TOT\_ENG

;valid TOT not seen before | ;first valid TOT value

| TOT\_ER\_TMR := 0

| ;clear failure present timer

| TOT\_FRST\_FL := 1

| FFG\_TOT := 0

|

| --- ELSE ---

|

| TOT := ROLAV\_TC(TOT\_ENG,TOT\_TC)

| ;no failure detected, return

| ;value for normal use

| TOT\_ER\_TMR := 0

| ;clear failure present timer

| Do: clear\_malf(P0713)

| Do: clear\_malf(P0712)

| FFG\_TOT := 0

| TOT\_FM\_FLG := 0

| ;clear failure flags

END: tot\_failure\_check

BEGIN: initial\_tot\_calculation

Compute an arithmetic average of the first eight consecutive TOT readings.

PUTMR > TKYON2 ---------------|

|AND -| INIT\_TOT\_CNT := INIT\_TOT\_CNT + 1

INIT\_TOT\_CNT < 8 -------------| | INIT\_TOT := INIT\_TOT + (TOT/8)

END: initial\_tot\_calculation

31-55

ENGINE INPUT PROCESSING, TRANSMISSION OIL TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: tot\_koer\_check

Check against Key-On engine running limits. If an error is detected, set

P1711MALF flag.

FFG\_TOT = 1 ------------------------| No action

;immediate TOT failure | ;continuous test detected

| ;failure, no need to test

| ;tighter KOER limits

|

| --- ELSE ---

TOT\_ENG > TOT\_HI\_KOER --------| |

|OR --| Do: store\_code(P1711)

TOT\_ENG < TOT\_LO\_KOER --------| | ;TOT out of selftest range

|

| --- ELSE ---

|

| Do: clear\_malf(P1711)

| ;no failure detected

END: tot\_koer\_check

BEGIN: tot\_koeo\_check

Check against Key-On engine off limits. If an error is detected, set

P1711MALF flag.

FFG\_TOT = 1 ------------------------| No action

;immediate TOT failure | ;continuous test detected

| ;failure, no need to test

| ;tighter KOER limits

|

| --- ELSE ---

TOT\_ENG > TOT\_HI\_KOEO --------| |

|OR --| Do: store\_code(P1711)

TOT\_ENG < TOT\_LO\_KOEO --------| | ;TOT out of selftest range

|

| --- ELSE ---

|

| Do: clear\_malf(P1711)

| ;no failure detected

END: tot\_koeo\_check

31-56

ENGINE INPUT PROCESSING, TRANSMISSION OIL TEMPERATURE SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: fmem\_tot\_calc

This logic determines TOT during sensor FMEM:

TOT\_FM\_FLG = 0 ---------------------| TOT := TOT\_LST

;error not present long enough | TOT\_PREV := TOT\_LST

;to store a code | TOT\_TMR := 0

| ;set TOT equal to last valid TOT

| ;reading, save TOT in TOT\_PREV

|

| --- ELSE ---

|

TOT >= TOT\_MAX ---------------------| TOT := TOT\_MAX

;after TOT ramps to desired |

;maximum, freeze TOT at TOT\_MAX |

| --- ELSE ---

|

ECT < ECT\_WARM\_ENG -----------------| TOT := ECT

;powertrain NOT warmed up | TOT\_TMR := 0

|

| --- ELSE ---

|

TOT\_PREV > ECT\_WARM\_ENG ------------| TOT := TOT\_PREV + [(TOT\_TMR) \*

;powertrain ALREADY warm, ramp | (TOT\_MAX - TOT\_PREV)/

;TOT from the value before | (TOT\_RMP\_TIM)]

;error occurred to TOT\_MAX |

| --- ELSE ---

|

;Powertrain was not warm prior | TOT := ECT\_WARM\_ENG + [(TOT\_TMR) \*

;to invalid reading; ramp from | (TOT\_MAX - ECT\_WARM\_ENG)/

;warm engine to TOT\_MAX | (TOT\_RMP\_TIM)]

END: fmem\_tot\_calc

31-57

ENGINE INPUT PROCESSING, IN-RANGE TP-LOAD TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.12 IN-RANGE TP-LOAD TEST (CDAM0)

OVERVIEW

This module detects inconsistency between the throttle position and air

charge. Possible causes for such an inconsistency are:

1. TP sensor faulty.

2. Air meter faulty.

3. Air leak between air meter and throttle body.

Note, this test will be aborted if a series throttle is present and traction

assist is active.

DEFINITIONS

Registers:

- CCM\_ER\_ENA = Engine running on-demand for CCM enabled.

- ECT = Engine coolant temperature, deg F.

- LOAD = Normalized cylinder air charge as calculated from mass air flow

meter reading, unitless.

- N = Engine speed (RPM).

- TP\_REL = Throttle position, counts.

- V\_TP\_ERR\_TMR = Length of time that error has been detected, sec.

Bit Flags

- CCM\_TST\_ENA = OBD-II Comprehensive component test enable flag; 1 -> test

enabled.

- MFMFLG = Flag indicating a MAF sensor failure; 1 -> failure, unitless.

- OBD\_PARM\_RST = Flag set whenever OBDII is reset, KAM is in error or

on-demand tests are entered or exited.

- TFMFLG = Flag indicating a TP sensor failure; 1 -> failure, unitless.

- TRAC\_ACTIVE = Flag indicating vehicle is in a traction assist event; 1 ->

T/A active.

Calibration Constants:

- TEMPFB = Engine coolant temperature below which error cannot be detected,

deg F.

- TRAC\_AIRSW = Traction control switch; 1 -> do airflow (series throttle)

control.

31-58

ENGINE INPUT PROCESSING, IN-RANGE TP-LOAD TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- V\_LOAD\_HI = LOAD above which TP-sensor-very-high cannot detected,

unitless.

- V\_LOAD\_LOW = LOAD below which TP-sensor-very-low cannot be detected,

unitless.

- V\_TP\_ERR\_MIN = Minimum time that inconsistency must be present in order

to set error code, sec.

- V\_TP\_LOW = Throttle position above which TP-sensor-very-low cannot be

detected, counts.

- V\_TP\_HIGH = Throttle position below which TP-sensor-very-high cannot be

detected, counts.

- V\_WOTNMIN = Engine speed below which error cannot be detected, rpm.

OTHER

- malfunction(ccm,Pxxx) = Logic process imported from the MIL control

module where Pxxx is a valid OBD-II code.

- P1121 = Fault code indicating throttle position sensor voltage is

inconsistent with MAF-based LOAD, unitless.

31-59

ENGINE INPUT PROCESSING, IN-RANGE TP-LOAD TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_TP\_MAF\_OBDII\_COM1

BEGIN: input\_tp\_maf\_main

;This process is executed once per background loop.

;OBD\_PARM\_RST is set whenever OBDII is reset or

;KAM is in error or on-demand tests are entered or exited.

;At this time the error timer needs to be cleared to

;prevent codes being carried forward.

CCM\_TST\_ENA = 1 ------------|

;continuous testing |

;enabled |OR --|

| |

CCM\_ER\_ENA = 1 -------------| |

;on-demand engine |

;running test enabled |

|

TFMFLG = 0 -----------------------|

;TP sensor OK |

|

MFMFLG = 0 -----------------------|AND -| Do: input\_tp\_maf\_test

;MAF sensor OK | | ;check for TP/MAF

| | ;consistency

OBD\_PARM\_RST = 0 -----------------| |

;no reset | | --- ELSE ---

| |

TRAC\_AIRSW = 1 -------| | | V\_TP\_ERR\_TMR := 0

;series throttle | | | ;not testing

;present |AND -| | | ;clear ER timer

| | |

TRAC\_ACTIVE = 0 ------| | |

;traction assist not |OR --|

;active |

|

TRAC\_AIRSW = 0 -------------|

; no series throttle |

END: input\_tp\_maf\_main

31-60

ENGINE INPUT PROCESSING, IN-RANGE TP-LOAD TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: input\_tp\_maf\_test

;This process is executed only when explicitly called.

TP\_REL < V\_TP\_LOW ----------|

;TP below lower |

;threshold |

|

LOAD > V\_LOAD\_LOW ----------|AND -|

;LOAD above lower | |

;threshold | |

| |

N > V\_WOTNMIN --------------| |

|OR --| No action

TP\_REL > V\_TP\_HIGH ---------| | | ;allow timer to increment,

;TP above upper | | | ;TP and MAF are inconsistent

;threshold | | |

| | |

LOAD < V\_LOAD\_HI -----------|AND -| |

;LOAD below upper | | --- ELSE ---

;threshold | |

| | V\_TP\_ERR\_TMR := 0

N > V\_WOTNMIN --------------| | ;no inconsistency detected

V\_TP\_ERR\_TMR > V\_TP\_ERR\_MIN ------|

;inconsistency present |

;long enough |AND -| Do: malfunction(ccm,P1121)

| | ;TP/MAF inconsistency

ECT > TEMPFB ---------------------| | ;error detected

;engine is warm |

| --- ELSE ---

|

| Do: clear\_malf(P1121)

| ;no error detected

END: input\_tp\_maf\_test

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ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.13 THROTTLE POSITION SENSOR INPUT AND SELFTEST (CDAN2)

OVERVIEW

First checks are made to determine if an on-demand mode is activated. If no

on-demand mode is active the software falls through and runs the standard

| sequence. TP\_ENG is supplied averaged from four reads in the A/D list.

| TP\_ENG is the value used when performing any input testing and is reported to

| the scan tool. Next, the TP\_ENG value is tested for "out of range" or other

| failure conditions. If the TP sensor reading is in range, TP is set equal to

| TP\_ENG. If TP\_ENG is out of range during crank mode TP is set to RATCH\_REP.

| Otherwise the last "good" value will be used for TP until the failure is

| present for a sufficient amount of time. At that time, the FMEM strategy

| will substitute a value based on air flow from FN096(AM) for TP and RATCH

| will be set to RATCH\_REP. This action permits recognition of the various

| throttle modes (Closed, Part or WOT).

If an on-demand mode is active. The KOER or KOEO range tests will be run

along with the standard continuous tests and FMEM action.

DEFINITIONS

Registers:

- AM = Air mass flow, lbm/min.

- APT = Throttle mode position; -1 -> closed throttle, 0 -> part throttle,

1 -> wide open throttle.

- j1979\_01\_11 = Absolute throttle position, 0-255 range, (TP\_ENG / 4).

- LOAD = Universal load as ratio of air charge over standard.

- N = Engine RPM.

- P0121\_FIL = TP at WOT or P/T during KOER.

- P0122\_FIL = TP-low fault filter.

- P0123\_FIL = TP-high fault filter.

- P1120\_FIL = TP lower than idle position fault filter.

- RATCH = Closed throttle position, counts.

| - RATCH\_REP = RATCH replacement value, either RATKAM or RATIV, counts.

- RATKAM = Closed throttle position stored in KAM, counts.

- TP = Throttle position, counts.

- TP\_DIF\_CTR = Number of samples that throttle position is within limit.

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ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| - TP\_ENG = Averaged or filtered value of TP\_CNTS, counts.

| - TP\_ENG\_LAST = Last background value of throttle position sensor, counts.

| - TPBAR\_MT = Filtered TP with TCRTP\_MT, used for RATCH in M/T, counts.

- TP\_REL = Relative TP, (TP - RATCH).

- TP\_REL\_H = Relative TP, (TP - RATCH), high byte only.

| - TSLPIP = Time since last PIP, millisecs.

Bit Flags:

- BIFLG = Current state of BOO input; 0 -> brake off, 1 -> brake on.

- CRKFLG = Crank mode flag.

- CCM\_ER\_ENA = Indicates that engine running on-demand mode has been

requested.

- CCM\_EO\_ENA = Indicates that engine off on-demand mode has been requested.

- CCM\_TST\_ENA = OBD-II comprehensive component test enable flag; 1 -> test

enabled.

- FFG\_MAF = OBD-II system FMEM flag for TP; 1 -> MAF is not currently

reliable.

- FFG\_PIP = OBD-II system FMEM flag for TP; 1 -> PIP is not currently

reliable.

- FFG\_TP = OBD-II system FMEM flag for TP; 1 -> TP is not currently

reliable.

| - KAM\_ERROR = Indicates keep alive RAM invalid.

- OBD\_PARM\_RST = Flag set whenever OBDII is reset, KAM is in error or

on-demand tests are entered or exited.

- PxxxMALF = OBD-II malfunction flag for fault xxx; 1 -> a malfunction

currently exists for fault xxx, where Pxxx is a valid OBD-II code.

- TFMFLG = Flag indicating that TP sensor has failed.

Calibration Constants:

| - BIHP = Brake hardware present switch; 1 = hardware present.

- DTPMAX = Maximum delta between TP input and RATCH to enable RATCH to

change value.

- FIL\_HYST = Hysteresis term to prevent spurious exit of failure mode

strategy.

- FN096 = TP counts above RATCH as a function of air mass, used for TP FMEM

value.

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ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- IDLMAF = Maximum AM at idle, lb/min.

- P0121\_LVL = Threshold level for recognition of TP at WOT or P/T during

KOER.

- P0121\_TC = Fault filter time constant for recognition of TP at WOT or P/T

during KOER.

- P0122\_LVL = Threshold level for recognition of TP-low failure.

- P0122\_TC = Fault filter time constant for recognition of TP-low failure.

- P0123\_LVL = Threshold level for recognition of TP-high failure.

- P0123\_TC = Fault filter time constant for recognition of TP-high failure.

- P1120\_LVL = TP lower than idle position threshold.

- P1120\_TC = TP lower than idle position fault filter time constant.

| - RAT\_KAM\_SW = Calibration switch to allow RATCH to be stored in KAM; 0 ->

| do not store RATCH in KAM, 1 -> store RATCH in KAM.

- RATADD = RATCH adder on power-up to allow initial ratcheting down.

| - RATCH\_MIN = RATCH minimum clip, counts.

- RATDIFF = Minimum difference between RATKAM and RATCH to allow KAM to

update, counts.

- RATIV = Inititializing value for RATCH typically 250 counts.

| - RATKAM\_MIN = Minimum RATCH value in KAM, below which is considered

| currupted, counts.

- RATUP\_LD = Allow RATCH update below this LOAD value.

- TCRTP = Time constant for RATCH, for negative downward movement, sec.

| - TCRTP\_MT = Time constant for TPBAR\_MT, used in M/T RATCH, sec.

- TCRTP\_UP = Time constant for RATCH, for positive upward movement, sec.

- TP\_CTR = Maximum sample count where throttle position is within limit.

- TP\_CTR\_MAX = Maximum sample count beyond which do not update RATCH.

- TP\_HI\_ER = Maximum valid TP value, counts.

- TP\_HI\_KOEO = Maximum value for KOEO on-demand selftest.

- TP\_HI\_KOER = Maximum value for KOER on-demand selftest.

- TP\_IDL\_ER = Minimum value of TP at closed throttle, counts.

- TP\_LO\_ER = Minimum valid TP value, counts.

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ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TP\_LO\_KOEO = Minimum value for KOEO on-demand selftest.

- TP\_LO\_KOER = Minimum value for KOER on-demand selftest.

| - TSTALL = Elapsed time necessary to indicate a stall.

OTHER

- malfunction(ccm,Pxxx) = Logic process imported from the MIL control

module, where Pxxx is a valid OBD-II code.

- store\_code(Pxxx) = Stores the fault code specified by Pxxx.

- P0121 = Throttle position (TP) sensor circuit range problem.

- P0122 = Throttle position (TP) sensor circuit below minimum voltage.

- P0123 = Throttle position (TP) sensor circuit above maximum voltage.

- P1120 = Throttle position (TP) sensor circuit below closed throttle

voltage.

- P1124 = Throttle position (TP) sensor circuit out of selftest range.

- tp\_codes = Set of {P1120,P0122,P0123}

- tp\_other\_codes = Set of {P1124,P0121}

31-65

ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_TP\_OBDII\_COM1

BEGIN: pid\_definitions

unconditionally --------------------| pid\_def(j1979\_01\_11, (TP\_ENG / 4))

| ;parameter required by scan tool

END: pid\_definitions

BEGIN: tp\_init

| This logic is executed once at each power-up within 'ram\_init'.

| On power-up, RATKAM plus RATADD is used to initialise RATCH and allow RATCH

| to ratchet down immediately. RATADD must be calibrated greater than RATDIFF.

| RAT\_KAM\_SW = 1 ---------------------| RATCH := RATKAM + RATADD

| ;RATCH stored in KAM | ;increment RATCH

| | TPBAR\_MT := RATCH

| | RATCH\_REP := RATKAM

| |

| | --- ELSE ---

| |

| | RATCH := RATIV

| | TPBAR\_MT := RATIV

| | RATCH\_REP := RATIV

END: tp\_init

| BEGIN: tp\_main

| This logic is executed once per background loop and is read top down.

| At a KAM error or if RATKAM falls below a reasonable value, the value of

| RATKAM, RATCH, TPBAR\_MT and the replacement value RATCH\_REP is set to the

| calibrateable value RATIV.

| KAM\_ERROR = 1 ----------------|

| ;KAM fault |OR --| RATKAM := RATIV + RATADD

| | | RATCH := RATIV

| RATKAM < RATKAM\_MIN ----------| | TPBAR\_MT := RATIV

| ;RATCH corrupted | RATCH\_REP := RATIV

| | ;use default value

| |

| | --- ELSE ---

| |

| | No action

| unconditionally --------------------| TP\_REL := TP - RATCH

| | TP\_REL\_H := high byte of TP\_REL

31-66

ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| If a reset is requested or the tests are not asked for filters need to be

| cleared to prevent codes being carried forward.

CCM\_TST\_ENA = 0 --------|

|

| CCM\_EO\_ENA = 0 ---------|AND -|

| |

CCM\_ER\_ENA = 0 ---------| |OR --| P0121\_FIL := 0

| | P0122\_FIL := 0

OBD\_PARM\_RST = 1 -------------| | P0123\_FIL := 0

| ;reset | P1120\_FIL := 0

| ;clear fault filters

| ;fault detection not enabled

| |

| Do: tp\_failure\_check

| ;check for out of range

| ;fault action

| |

| | --- ELSE ---

| |

| CCM\_ER\_ENA = 1 ---------------------| Do: tp\_failure\_check

| ;engine running on-demand | ;check for out of range

| ;demand selftest requested | ;fault action

| |

| | Do: check\_fault\_filters

| | ;check for continuous fault codes

| |

| | Do: tp\_koer\_check

| | ;perform special tests for

| | ;engine running

| |

| | --- ELSE ---

| |

| CCM\_EO\_ENA = 1 ---------------------| Do: tp\_failure\_check

| ;engine off on-demand | ;check for out of range

| ;selftest requested | ;fault action

| |

| | Do: check\_fault\_filters

| | ;check for continuous fault codes

| |

| | Do: tp\_koeo\_check

| | ;perform special tests for engine off

| |

| | --- ELSE ---

| |

| CCM\_TST\_ENA = 1 --------------------| Normal engine operation

|

| Do: tp\_failure\_check

| ;check for out of range

| | ;fault action

| |

| Do: check\_fault\_filters

| ;check for continuous fault codes

| |

| | --- ELSE ---

|

| | Do Nothing

| END: tp\_main

31-67

ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: tp\_failure\_check

Check for "open/short" failures. Perform FMEM action if a failure is

detected. Set malfunction flag when a malfunction has been present for a

sufficient time. Otherwise, calculate TP as a function of air mass.

TP\_ENG > TP\_HI\_ER ------------------| P0123\_FIL := ROLAV\_TC(1,P0123\_TC)

;value too high | ;upcount fault P0123

| P0122\_FIL := ROLAV\_TC(0,P0122\_TC)

| P1120\_FIL := ROLAV\_TC(0,P1120\_TC)

| ;down count faults P0122,P1120

| Do: tp\_fmem

| ;perform FMEM action

| FFG\_TP := 1

| ;set fault flag

|

| --- ELSE ---

|

TP\_ENG < TP\_LO\_ER ------------------| P0122\_FIL := ROLAV\_TC(1,P0122\_TC)

;value too low | ;upcount fault P0122

| P0123\_FIL := ROLAV\_TC(0,P0123\_TC)

| P1120\_FIL := ROLAV\_TC(0,P1120\_TC)

| ;down count faults P0123,P1120

| Do: tp\_fmem

| ;perform FMEM action

| FFG\_TP := 1

| ;set fault flag

|

| --- ELSE ---

|

TP\_ENG < TP\_IDL\_ER -----------------| P1120\_FIL := ROLAV\_TC(1,P1120\_TC)

;value below idle, assume RATCH | ;upcount fault P1120

;is corrupted, reset | P0122\_FIL := ROLAV\_TC(0,P0122\_TC)

| P0123\_FIL := ROLAV\_TC(0,P0123\_TC)

| ;down count faults P0122,P0123

| FFG\_TP := 1

| ;set fault flag

|

| | RATCH := RATCH\_REP

| ;reset corrupted RATCH

|

| Do: tp\_fmem

| ;perform FMEM action

|

| --- ELSE ---

(continued on next page)

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ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

| |

| P1120MALF = 1 ----------------| |

| | |

P0122MALF = 1 ----------------|OR --| Do: tp\_fmem

| | ;perform FMEM action

P0123MALF = 1 ----------------| | P0123\_FIL := ROLAV\_TC(0,P0123\_TC)

| P0122\_FIL := ROLAV\_TC(0,P0122\_TC)

| P1120\_FIL := ROLAV\_TC(0,P1120\_TC)

| ;down count faults

|

| | ;currently in FMEM mode, remain

| | ;until fault filters downcount

| | ;and MALF flags are clear

| |

| FFG\_TP := 1

| ;a malfunction detected

| ;set fault flag

|

| --- ELSE ---

|

| TP := TP\_ENG

| ;no failure detected, return

| ;value for normal use

| |

| FFG\_TP := 0

| ;clear fault flag

|

| P0123\_FIL := ROLAV\_TC(0,P0123\_TC)

| P0122\_FIL := ROLAV\_TC(0,P0122\_TC)

| P1120\_FIL := ROLAV\_TC(0,P1120\_TC)

| ;down count faults

|

| Do: ratch\_go

| ;ratchet RATCH if required

END: tp\_failure\_check

31-69

ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: check\_fault\_filters

P1120\_FIL > P1120\_LVL --------------| Do: malfunction(ccm,P1120)

|

| --- ELSE ---

|

P1120\_FIL < P1120\_LVL - FIL\_HYST ---| Do: clear\_malf(P1120)

P0122\_FIL > P0122\_LVL --------------| Do: malfunction(ccm,P0122)

|

| --- ELSE ---

|

P0122\_FIL < P0122\_LVL - FIL\_HYST ---| Do: clear\_malf(P0122)

P0123\_FIL > P0123\_LVL --------------| Do: malfunction(ccm,P0123)

|

| --- ELSE ---

|

P0123\_FIL < P0123\_LVL - FIL\_HYST ---| Do: clear\_malf(P0123)

TFMFLG is a 'filtered' fault flag, the FFG\_TP is an immediate fault flag.

P1120MALF = 1 ----------------|

;TP below closed throttle |

|

P0122MALF = 1 ----------------|OR --| TFMFLG := 1

;TP failed low | | ;a malfunction detected

| | ;set flag for the use of

P0123MALF = 1 ----------------| | ;the rest of the strategy

;TP failed high |

| --- ELSE ---

|

| TFMFLG := 0

| ;no malfunction active

END: check\_fault\_filters

31-70

ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

THROTTLE RATCH MECHANISM

The throttle position ratchet (RATCH) continuously seeks the shut throttle

position by searching for a greater or lesser value than its current closed

throttle position. Two separate time constants are used to allow a slower

change in the positive direction and a more rapid change in the negative

direction. RATCH update is allowed at any time except in a positive

| direction during CRANK, or in a positive direction when the brake is not

| applied. This is always provided that the throttle is steady and LOAD is low

| or TP is below RATCH. RATCH can change during closed throttle decelerations.

| For vehicles without BOO input (eg manual transmission), positive RATCH

| cannot be employed. In this case TP is filtered (TPBAR\_MT) and is used for

| the RATCH replacement, assuming conditions are suitable.

BEGIN: ratch\_go

| This routine is read top downwards.

TP < RATCH -------------------|

;throttle below ratch |

|

LOAD < RATUP\_LD --------------|OR --|

;closed throttle decel | |

| |

APT = -1 ---------------------| |

;closed throttle |

|

abs(TP\_ENG - TP\_ENG\_LAST) < DTPMAX -|

;throttle steady limit |

|AND -| TP\_DIF\_CTR := TP\_DIF\_CTR + 1

| FFG\_PIP = 0 ------------------------| | ;TP is stationary

| ;no PIP failure | | ;increment counter to

| | ;allow RATCH to update

FFG\_MAF = 0 ------------------------| |

| ;no MAF failure | |

| | |

| CRKFLG = 0 -------------------| | |

| ;not in crank |OR --| |

| | |

| TSLPIP >= TSTALL -------------| |

| ;engine stopped | --- ELSE ---

| |

| | TP\_DIF\_CTR := 0

| | ;clear counter

| ;no change to RATCH

| TP = RATCH -------------------------|

| |OR --| Exit ratch\_go

| TP\_DIF\_CTR < TP\_CTR ----------------| | ;no change to RATCH

| | ;insufficient steady time

| |

| | --- ELSE ---

| |

| | Do: ratch\_update

END: ratch\_go

31-71

ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ratch\_update

| This routine is read top downwards but is not entered if TP = RATCH or

| insufficient steady time has elapsed.

| BIHP = 0 ---------------------------------| TPBAR\_MT = ROLAV\_TC(TP,TCRTP\_MT)

| ;brake switch hardware not present |

| | --- ELSE ---

| |

| | No change to TPBAR\_MT

| BIHP = 0 ---------------------------|

| ;brake switch hardware not present |AND -| ratch := TPBAR\_MT

| | | ;ratch down

| TPBAR\_MT < RATCH -------------------| |

| ;time to update | Do: ratch\_to\_kam

| |

| | --- ELSE ---

| |

| TP < RATCH -------------------------------| ratch := TP

| | ratch := ROLAV\_TC(ratch,TCRTP)

| | ;ratch down

| |

| Do: ratch\_to\_kam

|

| --- ELSE ---

| TP\_DIF\_CTR <= TP\_CTR\_MAX -----------| |

| ;limit time in which to update | |

| |

| CRKFLG <> 1 ------------------------|AND -| ratch := TP

| ;not in crank mode | | ratch := ROLAV\_TC(ratch,TCRTP\_UP)

| | | ;ratch up

BIFLG = 1 --------------------------| |

| ;brake applied | Do: ratch\_to\_kam

| |

| | --- ELSE ---

| |

| | No action

| END: ratch\_update

31-72

ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ratch\_to\_kam

| RATCH is clipped between RATCH\_MIN and RATIV at the top of this routine.

RATCH is stored in KAM to provide a rapid and accurate TP measurement for use

during key-on and prevent the normal delay in learning RATCH. It is also

used as a replacement FMEM value. RATCH is only stored in KAM if it is

| different from RATKAM but above a defined tolerance (RATDIFF) and storage of

| RATCH in KAM is required, (RAT\_KAM\_SW = 1). The RATDIFF qualification is

| used to prevent excessive KAM updates with a suggested calibration between 2

| and 7 counts.

| unconditionally --------------------------| ratch := min(ratch,RATIV)

| | ratch := max(ratch,RATCH\_MIN)

| | ;clip ratch between

| | ;RATCH\_MIN and RATIV

| |

| | RATCH = ratch

| | ;and store away

| abs(RATCH - RATKAM) < RATDIFF ------|

| ;insufficient divergency |OR --| Do nothing

| | |

| RAT\_KAM\_SW = 0 ---------------------| | --- ELSE ---

| ;RATCH not stored in KAM |

| | RATKAM := RATCH

| | ;store RATCH in KAM

| |

| | RATCH\_REP := RATCH

| | ;use KAM value of RATCH

| | ;for replacement use

END: ratch\_to\_kam

31-73

ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: tp\_koer\_check

Check against Key-On engine running limits. If an error is detected, set

| P1124MALF flag. If, at any time part throttle or WOT is detected, set the

P0121MALF flag as this condition can cause the EGR test to lock indefinitely.

FFG\_TP = 1 -------------------------| Exit module

;TP sensor immediate failure | ;continuous test detected

| ;failure, no need to test

| ;tighter KOEO limits

|

| --- ELSE ---

TP\_ENG > TP\_HI\_KOER ----------| |

;TP above maximum for KOER |OR --| Do: store\_code(P1124)

| | ;TP out of selftest range

TP\_ENG < TP\_LO\_KOER ----------| |

;TP below minimum for KOER |

| --- ELSE ---

|

APT = 0 ----------------------| |

;part throttle |OR --| P0121\_FIL := ROLAV\_TC(1,P0121\_TC)

APT = 1 ----------------------| | ;upcount fault P0121

;WOT | ;TP at part throttle or WOT

|

| --- ELSE ---

|

| No failures detected

| Do: clear\_malf(P1124)

| P0121\_FIL := ROLAV\_TC(0,P0121\_TC)

| ;downcount fault P0121

P0121\_FIL > P0121\_LVL --------------| Do: store\_code(P0121)

|

| --- ELSE ---

|

P0121\_FIL < P0121\_LVL - FIL\_HYST ---| Do: clear\_malf(P0121)

END: tp\_koer\_check

31-74

ENGINE INPUT PROCESSING, THROTTLE POSITION SENSOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: tp\_koeo\_check

Check against Key-on engine off limits. If an error is detected, set

P1124MALF flag.

FFG\_TP = 1 -------------------------| ;continuous test detected

;TP sensor immediate failure | ;failure, no need to test

| ;tighter KOEO limits

|

| --- ELSE ---

TP\_ENG > TP\_HI\_KOEO ----------| |

;TP above KOEO limits |OR --| Do: store\_code(P1124)

| | ;TP out of selftest range

TP\_ENG < TP\_LO\_KOEO ----------| |

;TP below KOEO limits |

| --- ELSE ---

|

| Do: clear\_malf(P1124)

| ;no failure detected

END: tp\_koeo\_check

| BEGIN: tp\_fmem

| In crank mode or at idle air flow, use RATCH\_REP in place of TP. Otherwise,

| until a failure has been present long enough to set a failure flag, use the

| last good value of TP. Once the failure flag is set, infer TP from air mass,

| FN096(AM).

| CRKFLG = 1 -------------------|

| ;crank mode |OR --| TP := RATCH\_REP

| | |

| AM < IDLMAF ------------------| |

| | --- ELSE ---

| |

| TFMFLG = 1 -------------------------| RATCH := RATCH\_REP

| | TP := RATCH + FN096(AM)

| | ;TP sensor out of limits

| | ;but probably NOT due to

| | ;low battery voltage

| |

| | --- ELSE ---

| |

| | No change to TP

| | ;TP sensor data unreliable

| | ;Do NOT update until

| | ;confident data valid

| END: tp\_fmem

31-75

CONTINUOUS SELF TEST, VEHICLE MOVING DETECTOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.14 VEHICLE MOVING DETECTOR (CDAL0)

OVERVIEW

This module performs the inferred vehicle motion check used in all speed

sensor tests. The logic is based on the principle that if the vehicle is in

drive and the torque converter is full, it is then possible to infer whether

or not the vehicle is moving based on the vehicle operating conditions.

Inferred vehicle speed for an AODE transmission is based on the following;

vehicle speed (OK to test for OSS output), output shaft speed (OK to test for

VSS output), and WOT stall speed of the converter (used only to allow test

entry in the event that both VSS and OSS have failed).

In an attempt to improve robustness of inferred vehicle motion, logic has

been added which attempts to determine when the transmission is in gear (a

load is present on the engine).

The purpose of this logic is to prevent transmission failures which result in

no torque capacity (transmission is in neutral) when the transmission should

be in gear from causing false inferred vehicle motion.

This logic uses the transmission input torque calculation (engine combustion

torque minus torque used to accelerate the engine) to determine if a

transmission load is present.

DEFINITIONS

Registers:

- ATMR1 = Time since engine start.

- EIP\_TMR = Engagement in progress timer.

- I4X4L = 4X4 input; 1 -> 4X4 selected.

- IPDL = Unfiltered MLPS position.

- ITP = Instantaneous throttle angle, A/D counts.

- LOAD = Universal LOAD as ratio of air charge over standard.

- N = Engine speed, RPM.

- NEBART = Filtered engine RPM for transmission.

- NOBART = Filtered Output Shaft Speed in RPM.

- TQ\_BRK\_SBAR = Filtered engine combustion torque.

- TR\_LOAD\_FLG = Transmission load flag; 1 -> based on torque the

transmission is in gear.

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CONTINUOUS SELF TEST, VEHICLE MOVING DETECTOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TRANS\_TQ\_IN = Transmission input torque, engine combustion torque minus

torque used to accelerate the engine.

- VMOVING = 1 -> Vehicle is moving.

- VSBARV = Filtered vehicle speed for self test.

- VSSTMR = Vehicle speed sensor fault timer.

Bit Flags:

- MFMFLG = MAP/MAF FMEM flag.

- NDSFLG = NEUTRAL/DRIVE flag; 1 -> drive.

- TFMFLG = TP FMEM flag.

- TST\_ENA\_FLG = Transmission self test enable flag; 1 -> TOT dependent

transmission self test enabled.

Calibration Constants:

- NE\_VMOV\_MAX = Maximum engine speed at which MPH vehicle motion will be

inferred.

- OS\_MOV = Output shaft speed above which test will be executed.

- TQ\_CK\_SW = Calibration switch to enable/disable checking torque as part

of inferring vehicle motion; 1 -> torque logic enabled.

- TQ\_CK\_VMOV = Engine torque is high enough to infer the vehicle is moving.

- TQ\_VMOV = Transmission input torque is high enough to infer the vehicle

is moving.

- TRLOAD = Transmission Load;

0 -> Manual Transmission, no clutch or gear switches,

forced neutral state (NDSFLG = 0),

1 -> Manual Transmission, no clutch or gear switch,

2 -> Manual Transmission, one clutch or gear switch,

3 -> Manual Transmission, both clutch and gear switches,

4 -> Auto Transmission, non-electronic, neutral drive switch,

5 -> Auto Transmission, non-electronic, neutral pressure switch

(AXOD),

6 -> Auto Transmission, electronic, PRNDL sensor - park,

reverse, neutral, overdrive, manual 1, manual 2.

- V\_MOV\_DLY = Start up delay before allowing VMOVING flag to set to avoid

codes from partially filled converter.

- VSAMIN = Minimum engine speed to do VSS test with automatic

transmissions, RPM.

- VS\_MOV = Vehicle speed above which test will be executed.

- VSSTP = Minimum TP to enter VSS test.

31-77

CONTINUOUS SELF TEST, VEHICLE MOVING DETECTOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- V\_VSS\_LOAD = Minimum air charge ratio to do CVIP VSS test.

- V\_VSS\_MULT = Multiplier for FN689V when in 4X4.

- V\_VSS\_NRHI = High eng. speed for load range to infer vehicle movement.

- V\_VSS\_NRLO = Low engine speed for load range to infer vehicle movement.

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CONTINUOUS SELF TEST, VEHICLE MOVING DETECTOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_VMOVING\_COM4

TQ\_CK\_SW = 0 -----------------------|

;Checking torque for VMOVING |

;cal'ed out |

|OR --| TR\_LOAD\_FLG = 1

TQ\_BRK\_SBAR >= TQ\_CK\_VMOV ----| | | ;Transmission input torque

;Engine torque high enough | | | ;indicates a load is present.

| | | ;Used for both manual and

TRANS\_TQ\_IN >= TQ\_VMOV -------|AND -| | ;automatic transmission

;Trans input tq high enough | |

| |

NEBART < NE\_VMOV\_MAX ---------| |

;Engine speed low enough |

| --- ELSE ---

|

| TR\_LOAD\_FLG = 0

| ;Transmission is not in gear

31-79

CONTINUOUS SELF TEST, VEHICLE MOVING DETECTOR - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TRLOAD => 4 -------------------------|

;auto trans |

|

ATMR1 >= V\_MOV\_DLY ------------------|

;long enough since startup |

;to fill torque converter |

|

EIP\_TMR = 0 -------------------------|

;engagement completed |

|

IPDL <> 0 ---------------------------|

;PRNDL in range |

|

TST\_ENA\_FLG = 1 ---------------------|

;TOT dependent logic |

;enabled |

|

TFMFLG = 0 --------------------------|

;TP sensor OK |

|AND -|

NDSFLG = 1 --------------------------| |

;in drive | |

| |

I4X4L = 0 ---------------| | |

;not in 4X4 mode | | |

|AND -| | |

NEBART => VSAMIN --------| | | |

;high RPM |OR --| |

| | |

NEBART >= VSAMIN \* V\_VSS\_MULT--| | |

;min. rpm in 4X4 mode | |

| |

ITP => VSSTP ------------------------| |

| |

TR\_LOAD\_FLG = 1 ---------------------| |

|OR --| VMOVING := 1

TRLOAD <= 3 -------------------------| | | ;Conditions satisfied to

;manual trans | | | ;infer vehicle motion

| | |

MFMFLG = 0 --------------------------| | |

;MAP sensor OK | | |

|AND -| |

N <= V\_VSS\_NRHI ---------------------| | |

| | |

LOAD => V\_VSS\_LOAD ------------------| | |

| | |

N => V\_VSS\_NRLO ---------------------| | |

| | |

TR\_LOAD\_FLG = 1 ---------------------| | |

| |

VSBARV >= VS\_MOV --------------------------| |

| |

NOBART >= OS\_MOV --------------------------| |

| --- ELSE ---

|

| VMOVING := 0

| VSSTMR := 0

| ;clear timer

31-80

ENGINE INPUT PROCESSING, VEHICLE SPEED (DARC) AND SELFTEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.15 VEHICLE SPEED INPUT AND SELF TEST (CDAN0)

OVERVIEW

The variable reluctance type Vehicle Speed Sensor produces an AC signal with

frequency proportional to vehicle speed. Through appropriate gearing, the

sensor generates 8000 cycles/mile, for a frequency range of 0 HZ at 0 MPH to

283.3 Hz at 127.5 MPH. Interface hardware in the EEC converts the AC signal

to a digital signal for input to the CPU. The strategy updates unfiltered

vehicle speed (vs) once per background loop if at least one new rising edge

was received (MPHCNT > 0) during the previous loop. If, after 255

milleseconds, no new signals are received (< 1.75 MPH), vs is set to 0. This

ensures a zero vehicle speed if the vehicle is stopped or if the sensor

fails.

The vehicle speed sensor input processing is designed to calculate unfiltered

vehicle speed (VS\_HW), and the vehicle speed limiting parameter VS\_LIM\_BAR.

Once vehicle speed has been calculated the VSS diagnostic module will be

called to perform self test on the sensor.

DEFINITIONS

Registers:

- NOBART = Filtered Output Shaft Speed in RPM.

- RT\_NOVS = Ratio of actual N-over-V to base N-over-V stored.

- TSLMPH = Time since last rising vehicle speed edge was seen. Reset to

zero when edge is seen, counts up in background when no edge is seen.

- VS = Instantaneous vehicle speed.

- VS\_HW = Instantaneous vehicle speed, mph.

- VSBAR = Filtered vehicle speed.

- VSBARV = Filtered vehicle speed for Self Test.

- VS\_LIM\_BAR = High range of VSBAR used for vehicle speed limiting.

- VS\_PRD = VSS input DARC period, DARC ticks.

- VS\_PRD\_MIN\_1 = VSS input DARC period - previous, DARC ticks.

- VS\_PREV = Previous value of unfiltered vehicle speed vs.

Bit Flags:

- FIRST\_MPH = Counter that indicates when the first edge is seen.

- VSFMFLG = Vehicle speed sensor failure mode flag.

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ENGINE INPUT PROCESSING, VEHICLE SPEED (DARC) AND SELFTEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- NVBASE = Base "N-over-V" ratio.

- TCVS\_LIM\_BAR = Time constant for VS\_LIM\_BAR.

PROCESS

STRATEGY MODULE: INPUT\_VSS\_DARC\_COM2

BEGIN: pid\_definitions

Parameter Identification Declaration for j1979\_01\_0d, vehicle speed in

kilometers/hour.

pid\_def(j1979\_01\_0d, VSBAR\*1.609)

END: pid\_definitions

Once per background; the following logic is executed:

unconditionally --------------| VS\_PREV = VS\_HW

| Do: vehicle\_speed\_calculations

|

| Do: intrn\_vss\_test\_comx

| ;call VSS self test module

31-82

ENGINE INPUT PROCESSING, VEHICLE SPEED (DARC) AND SELFTEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: vehicle\_speed\_calculations

Calculate unfiltered vehicle speed vs.

new\_vs\_period ----------------| TSLMPH := 0

;at least one period seen |

;since the last update |

TSLMPH >= 0.255 --------------| FIRST\_MPH := 0

;timed out - reset |

| VS\_HW := 0

|

| VS := 0

|

| --- ELSE ---

|

FIRST\_MPH = 0 ----------------| FIRST\_MPH := 1

;one period seen |

| VS\_HW := min( 405,000 / VS\_PRD, 255.0)

|

| VS := min( VS\_HW, 127.5)

|

| --- ELSE ---

|

| ave\_vs\_prd := (VS\_PRD + VS\_PRD\_MIN\_1) / 2

|

| VS\_HW := min( 405,000 / ave\_vs\_prd, 255.0)

|

| VS := min( VS\_HW, 127.5)

NOTE: TSLMPH is a seconds timer with milliseconds resolution.

Calculate unfiltered vehicle speed VS:

VSFMFLG = 0 ------------------| VS\_LIM\_BAR := ROLAV(VS\_HW,TCVS\_LIM\_BAR)

|

| VSBAR := VSBARV

|

| --- ELSE ---

|

| VS\_LIM\_BAR := NOBART / (NVBASE \* RT\_NOVS)

|

| VSBAR := NOBART / (NVBASE \* RT\_NOVS)

END: vehicle\_speed\_calculations

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ENGINE INPUT PROCESSING, CLUTCH SWITCH - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.16 CLUTCH SWITCH INPUT AND SELFTEST (CDAL0)

OVERVIEW

This test uses the clutch-starter safety interlock, whereby the clutch pedal

must be depressed for the starter to function. This test looks for the first

time that the engine starts to turn and assumes that this is due to the

starter motor. If the clutch switch input indicates that the clutch pedal

has not been depressed, then this test stores the non-MIL code P0704.

Unlike most of the continuous tests, this test runs when the engine is

cranking.

Note that either of the following could result in the setting of a false code

P0704 when the clutch switch is functioning correctly:

1) The vehicle is push started with both the clutch

released (engaged) and the vehicle in gear,

i.e. the clutch is never depressed during the

push-start attempt.

2) A mechanic uses a "bump starter" to crank the engine

with the ignition on.

To avoid other situations which could result in a false code P0704, this test

is run no more than once per power-up.

CALIBRATION NOTES:

It is important to realise that a clutch switch may not be fitted or it may

be fitted in series with a gear switch. The calibration switches must be set

accordingly and any code output be viewed carefully.

PIP periods which are longer than 0.8 seconds are treated as

zero RPM (N = 0), therefore:

4 cylinder applications N < 37.50 RPM is treated as N = 0

6 cylinder applications N < 25.00 RPM is treated as N = 0

8 cylinder applications N < 18.75 RPM is treated as N = 0

Calibrating CPP\_NMIN or CPP\_NMAX below these values is the same as

calibrating AT these values.

31-84

ENGINE INPUT PROCESSING, CLUTCH SWITCH - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- INDS = Neutral/drive input.

- N = RPM.

Bit Flags:

- CPP\_DISABLE = Indicates clutch switch test disabled.

- FFG\_CPP = Clutch pedal switch unreliable.

Calibration Constants:

- CPP\_NMAX = Maximum RPM for continuous clutch switch test.

- CPP\_NMIN = Minimum RPM for continuous clutch switch test.

- CPP\_SEL = Calibration test select switch; 1 -> do test.

- NDS\_SWPT = NDS input switch point.

- TRLOAD = Transmission load switch;

0 -> Manual Transmission, no clutch or gear switches,

forced neutral state, NDSFLG = 0.

1 -> Manual Transmission, no clutch or gear switch.

2 -> Manual Transmission, one clutch or gear switch.

3 -> Manual Transmission, both clutch and gear switches.

4 -> Auto Transmission, non-electronic, neutral drive switch.

5 -> Auto Transmission, non-electronic, neutral pressure

switch, (AXOD).

6 -> Auto Transmission, electronic, PRNDL sensor - park,

reverse, neutral, overdrive, manual 1, manual 2.

7 -> Auto Transmission, electronic, multiple discrete switches

for manual lever position, (F4E).

OTHER

- CPP\_CODES = Set of {P0704}

- store\_code(Pxxx) = Stores the fault code specified by Pxxx.

- P0704 = Clutch switch input circuit malfunction.

31-85

ENGINE INPUT PROCESSING, CLUTCH SWITCH - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_CPP\_OBDII\_COM1

BEGIN: cpp\_test

CPP\_DISABLE = 1 ------------------|

;clutch test disabled |

;during this power up |

|

N =< CPP\_NMIN --------------------|

;engine is not cranking |OR --| Exit continuous

| | clutch switch test

CPP\_SEL <> 1 ---------------------| |

;clutch test is calibrated out | |

| |

TRLOAD >= 4 ----------------------| |

;automatic transmission |

| --- ELSE ---

N >= CPP\_NMAX --------------------| |

;engine is turning too | |

;fast to do test |OR --| CPP\_DISABLE := 1

| | ;disable this test for the

INDS >= NDS\_SWPT -----------------| | ;remainder of this power-up

;transmission is in neutral |

;and/or clutch is depressed |

| --- ELSE ---

|

| Do: store\_code(P0704)

| ;clutch switch not activated

| FFG\_CPP := 1

| ;set failure flag

| CPP\_DISABLE := 1

| ;disable this test for the

| ;remainder of this power-up

END: cpp\_test

31-86

INPUT AND FAILURE MODE AND SELF TEST, NOVS CALCULATION - CDAN2

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31.17 ENGINE SPEED OVER VEHICLE SPEED (NOVS) (CDAL0)

OVERVIEW

NOVS is the ratio of engine speed over vehicle speed. It is used to infer

the transmission gear ratio selected - both in automatic and manual

transmissions

DEFINITIONS

INPUTS

Registers:

- N = RPM - engine speed in revolutions per minute.

- VSBAR = Filtered vehicle speed.

OUTPUTS

Registers:

- NOVS = N/VSBAR to infer transmission gear, rpm/mph.

PROCESS

STRATEGY MODULE: INPUT\_NOVS\_COM1

always ---------------------------------| NOVS := N/VSBAR

| ;clip NOVS between 0 and 255

31-87

INPUT AND FAILURE MODE AND SELF TEST, BATTERY VOLLTAGE (ML2) - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.18 BATTERY VOLTAGE (VBAT) (CDAL0)

OVERVIEW

The VBAT calculation is a time-dependent rolling average filter of

instantaneous battery voltage. The VBAT time constant TCVBAT is not a

calibration constant and is set to produce a 0.1 second VBAT average time

constant.

DEFINITIONS

Registers:

- IIVPWR = Ignition key-on power, A/D counts.

- VBAT = Battery Voltage.

Calibration Constants:

- KSF = Keypower scaling factor reciprocal, unitless

- TCVBAT = Time constant for VBAT, (NON calibrateable) sec.

PROCESS

STRATEGY MODULE: INPUT\_VBAT\_COM2

Instantaneous battery voltage is calculated from:

| 5 VOLTS

unconditionally --------------| vbat := IIVPWR \* ----------- \* KSF

| 1023 COUNTS

unconditionally --------------| VBAT := ROLAV(vbat,TCVBAT)

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INPUT AND FAILURE MODE AND SELF TEST, CLOCK\_SEC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

31.19 CLOCK\_SEC (CDAL0)

OVERVIEW

CLOCK\_SEC is a register which contains a clock in engineering units. The

clock rolls over every 60 seconds and displays seconds with millisecond

accuracy. As with any other background calculation, the clock is updated

every background loop.

DEFINITIONS

INPUTS

Registers:

- BG\_TMR = Time to complete the previous background loop.

- CLOCK\_SEC = DAC able clock, seconds.

OUTPUTS

Registers:

- CLOCK\_SEC = See above.

PROCESS

STRATEGY MODULE: INPUT\_CLOCK\_SEC\_COM1

always ---------------------------------| CLOCK\_SEC := CLOCK\_SEC + BG\_TMR

| ;add current background loop

| ;to the clock

CLOCK\_SEC >= 60.000 --------------------| CLOCK\_SEC := CLOCK\_SEC - 60.000

| ;allows clock to roll over

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ENGINE INPUT PROCESSING, AIR CONDITION PRESSURE SWITCH - CDAN2

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31.20 AC PRESSURE (ACP) SWITCH INPUT SIGNAL PROCESSING (CDAN0)

OVERVIEW

This module is for processing the AC pressure switch input via an analogue

input pin. It contains an inversion as the input is normally high and is

pulled low when the pressure switch is tripped. The signal is sampled and

considered to indicate an "on-condition" when the input exceeds (IACPSW) 512

counts. The module also contains a check on ACPSW\_HP to ensure that the

input should be read as ACPSW and not something else. Note that in the logic

below, "IACPSW" refers to the CPU pin designated to be the AC pressure switch

input.

DEFINITIONS

Registers:

- ACPSW = AC pressure switch input; 1 -> AC pressure high.

- IACPSW = The analogue ACPSW input register.

Calibration Constants:

- ACPSW\_HP = AC pressure switch hardware present.

PROCESS

STRATEGY MODULE: INPUT\_ACPSW\_COM2

ACPSW\_HP = 1 ---------------------|

|AND -| ACPSW := 1

IACPSW <= 512 counts -------------| |

| --- ELSE ---

|

| ACPSW := 0

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INPUT ENGINE PROCESSING, THROTTLE POSITION MULTI SAMPLING - CDAN2

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31.21 THROTTLE POSITION MULTI SAMPLING (CDAN2)

| OVERVIEW

| To prevent noise corrupting the TP signal, the TP is sampled 4 times every

| background loop and averaged. This is acheived by placing the TP at the top

| and bottom of the A to D read list, with the other two splitting the list

| into thirds.

| DEFINITIONS

| Registers:

| - TP\_CNT1 = 1st input TP from A to D, counts.

| - TP\_CNT2 = 2nd input TP from A to D, counts.

| - TP\_CNT3 = 3rd input TP from A to D, counts.

| - TP\_CNT4 = 4th input TP from A to D, counts.

| - TP\_ENG1 = 1st TP sample, counts.

| - TP\_ENG2 = 2nd TP sample, counts.

| - TP\_ENG3 = 3rd TP sample, counts.

| - TP\_ENG4 = 4th TP sample, counts.

| - TP\_ENG = Averaged TP for error analysis, counts.

| - TP\_ENG\_LAST = Last background value of throttle position sensor, counts.

| PROCESS

| STRATEGY MODULE: INPUT\_TP\_BG\_COM1

| BEGIN: tp\_sample

| Sample the TP sensor four times during each A to D read, with the time

| intervals being spaced as equal as possible. TP\_ENG is supplied to the main

| TP routine.

| Every background loop:

| unconditionally -------| TP\_ENG1 := TP\_CNT1

| | TP\_ENG2 := TP\_CNT2

| | TP\_ENG3 := TP\_CNT3

| | TP\_ENG4 := TP\_CNT4

| unconditionally -------| TP\_ENG\_LAST := TP\_ENG

| | ;store current value before recalculating

| | TP\_ENG := (TP\_ENG1+TP\_ENG2+TP\_ENG3+TP\_ENG4)/4

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INPUT ENGINE PROCESSING, THROTTLE POSITION MULTI SAMPLING - CDAN2

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| END: tp\_sample

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CHAPTER 32

KEEP ALIVE MEMORY

32-1

KEEP ALIVE MEMORY - CDAN2

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32.1 KEEP ALIVE MEMORY (KAM) QUALIFICATION TEST (CDAM0)

OVERVIEW

Each time the vehicle is started, the data stored in KAM may not be valid.

Power interruptions, noise, etc., may have altered KAM contents. Or, the

computer may not be reading KAM registers correctly because of a hardware

fault. When the KAM registers are intialized, a special binary pattern is

written into three bytes of KAM. The KAM register names are KAMQA, KAMQB,

and KAMQC. During each background loop, the KAM registers are tested. The

KAM qualification test judges the validity of the KAM data by looking for the

proper binary pattern. The alternate courses of action are either:

1) If the proper pattern is present, the KAM data is considered OK for

use by the strategy.

2) If not present, the KAM data is suspect. The KAM is over-written to a

set of initial values. The inital values are also used in place of the

KAM data when the strategy references KAM.

The KAM registers KAMQA, KAMQB, and KAMQC are assigned to different areas of

the KAM. This will help protect for partial KAM failures. The assignments

are:

KAM KAM

Register Address

--------- -------

KAMQA LOWEST ADDRESS OF KAM

KAMQB MIDDLE ADDRESS OF KAM

KAMQC HIGHEST ADDRESS OF KAM

The KAM qualification test is normally performed each background loop when

the computer is running.

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KEEP ALIVE MEMORY - CDAN2

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DEFINITIONS

Registers:

- BP = Barometric pressure stored in KAM, " Hg.

- GR\_CM = Commanded gear for shift solenoids.

- GR\_CM\_KAM = KAM equivalent of GR\_CM for reinit protection.

- ISCKAM0 = Idle Speed KAM IPSIBR cell 0.

- ISCKAM1 = Idle Speed KAM IPSIBR cell 1.

- ISCKAM2 = Idle Speed KAM IPSIBR cell 2.

- ISCKAM3 = Idle Speed KAM IPSIBR cell 3.

- ISCKAM4 = Idle Speed KAM IPSIBR cell 4.

- ISCKAM5 = Idle Speed KAM IPSIBR cell 5.

- ISKSUM = Idle Adaptive airflow check sum.

- KAMQA = KAM Qualification test register 1.

- KAMQB = KAM Qualification test register 2.

- KAMQC = KAM Qualification test register 3.

- NOVCTR = NOV calculation sampling counter.

- RT\_NOVS\_KAM = NOV ratio in KAM.

- V\_MODE\_SETUP = VIP Throttle Adjust Mode enable flag; 1 -> enabled.

Bit Flags:

- FLG\_FRST\_NOV = First pass to store NOV in KAM flag: 0 -> RT\_NOVS\_KAM has

not been loaded; 1 -> RT\_NOVS\_KAM has been loaded.

- FLG\_NOV\_KAM = Flag indicating at least one update of RT\_NOVS\_KAM since

last KAM update.

- KAM\_ERROR = KAM error flag; 1 -> KAM data invalid.

- LEGOFG11 = Lack of HEGO11 switch.

- LEGOFG21 = Lack of HEGO21 switch.

- VIP\_KAM = Indicates KAM invalid for VIP.

Calibration Constants:

- BAPFMM = Default value for BP failure.

- BPMAX = Maximum allowable IBAP value, " Hg.

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KEEP ALIVE MEMORY - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- BPMIN = Minimum allowable IBAP value, " Hg.

- GRCMKIV = KAM initialization value for GR\_CM.

- RTNVMN = Minimum valid RT\_NOVS\_KAM.

- RTNVMX = Maximum value for RT\_NOVS\_KAM.

PROCESS

STRATEGY MODULE: KAM\_CC

KAM QUALIFICATION TEST LOGIC

(performed each background loop)

KAM\_ERROR = 1 ---------------------| KAMQA = 10101010 BINARY

| KAMQB = 11000110 BINARY

| KAMQC = 01110101 BINARY

| ;Write the special binary patterns

| ;to KAM:

| KAM\_ERROR = 0

|

| --- ELSE ---

KAMQA <> 10101010 BINARY ----| |

| |

KAMQB <> 11000110 BINARY ----| |

| |

KAMQC <> 01110101 BINARY ----|OR --| KAMQC = 0

| | KAM\_ERROR = 1

RT\_NOVS\_KAM < RTNVMN --------| | (Individual features will reset

| | parameters stored in KAM as required.

RT\_NOVS\_KAM > RTNVMX --------| | Note that this flag will be cleared

| during the next background loop and

| reset here the following loop (toggle)

| if a chronic error is present.)

|

| VIP\_KAM = 1

| (Send error flag to Self-Test.)

|

| ISCKAMn = 0.0

| ISKSUM = 0.0

| BP = BAPFMM

| GR\_CM\_KAM = GRCMKIV

| GR\_CM = GRCMKIV

| NOVCTR = 0

| RT\_NOVS\_KAM = 1.0

| FLG\_FRST\_NOV = 0

| FLG\_NOV\_KAM = 0

| LEGOFG11 = 0

| LEGOFG21 = 0

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KEEP ALIVE MEMORY - CDAN2

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ISCKAM QUALIFICATION

(Done during Power-up sequence)

|ISCKAM0 + ISCKAM1 + ISCKAM2

+ ISCKAM3 - ISKSUM| <= 1 Bit ----| Assume the ISCKAMs are valid.

| No action taken.

| ISKSUM = ISCKAM0 + ISCKAM1

| + ISCKAM2 + ISCKAM3

|

| --- ELSE ---

|

| Assume ISCKAMs Data are invalid.

| Re-initialize the ISCKAM

| ISCKAM0 = 0

| ISCKAM1 = 0

| ISCKAM2 = 0

| ISCKAM3 = 0

| ISKSUM = 0

VIP THROTTLE MODE SET

(Done each background loop while in running VIP)

V\_MODE\_SETUP = 1 ------------------| Re-initialize the ISCKAM

(VIP Throttle Adjust Mode) | ISCKAM0 = 0

| ISCKAM1 = 0

| ISCKAM2 = 0

| ISCKAM3 = 0

| ISKSUM = 0

During power-up sequence, check the range of BP.

BP <= BPMAX -----------------|

|AND -| BP is OK

BP >= BPMIN -----------------| |

| --- ELSE ---

|

| BP = BAPFMM

32-5

KAM, RAM, AND ROM SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

32.2 ON DEMAND SELF TEST FOR EEC MEMORY (KAM, RAM, ROM) (CDAK0)

OVERVIEW

This module is executed only when called by the diagnostic executive at the

beginning of the KOEO on demand test. This test consists of four parts, the

"Instruction", "RAM", "ROM Check Sum" and "KAM Test Bytes" tests.

First, the "Instruction" test is performed. The "Instruction test" takes the

CPU through a range of instructions (such as Add, Shift, Exclusive Or, And,

Or, Multiply, Divide, and Stack manipulation) testing the result at each

step. If the test fails, the MIL is turned on and the module is locked into

an infinite loop (strategy execution stops). A failure of this test

indicates that the CPU is unable to properly perform instructions.

If the "Instruction" test passes, then the "RAM" test is executed. Starting

at the beginning of external RAM, the contents of each location is first

saved, then the value AAAA Hex is written and read back. If the returned

value is AAAA Hex, 5555 Hex is written to and read from the register. If

5555 Hex is read back, the contents of the register is restored and the test

moves to the next register. As in the instruction test, if a failure is

detected, the MIL is turned on and the module is locked into an infinite loop

(strategy execution stops). By using the values AAAA Hex (1010... Binary)

and 5555 Hex (0101... Binary) each bit in external RAM is tested in both the

set and cleared states. A failure indicates that at least one bit can not be

changed and/or read correctly.

Next, a 16 bit addition of the contents of the ROM locations is performed. A

parameter (ROM\_TO) is set to a value that should cause the result of the

summation to be zero. If the value is not zero, then some value in ROM has

been corrupted. (Note, during development, the use of patched chips, RCONs,

etc. can cause this test to fail.) If a failure is detected, Code P0605 is

set and Self Test continues.

Finally, The parameter VIP\_KAM is checked, and if it has been set by the KAM

QUALIFICATION TEST LOGIC (a check of 3 memory locations failed) code P0603 is

set. This is usually an indication that the keep-alive power has been lost.

Note that on the first powerup following a battery disconnect, this code is

expected and would not necessarily indicate an EEC hardware failure.

32-6

KAM, RAM, AND ROM SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Bit Flags:

- DISABLE\_EOLT = Prevents re-entry into EOL test.

- VIP\_KAM = Indicates KAM invalid for Self Test.

OUTPUTS

Bit Flags:

- DISABLE\_EOLT = See above.

OTHER

- store\_code(Pxxx) = Logic process imported from the TBD module where Pxxx

is a valid Self Test code.

- eca\_other\_codes = SET OF {P0603,P0605}

- P0605 = ROM check sum test failed.

- P0603 = KAM test failure.

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KAM, RAM, AND ROM SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: KAM\_RAM\_ROM\_TEST\_COM1

EO\_STATUS = ECU\_EO\_INIT ----------------| Do: Module instruction test

| (test module for capability to

| perform instructions)

|

| Do: RAM Test

| (write / read patterns to

| external RAM)

|

| Do: ROM Test

| (ROM checksum test)

|

| Do: KAM Test

| (check to see if KAM reset)

|

| EO\_STATUS = ECU\_EO\_DONE

| (Done with test)

BEGIN: Module instruction test

when called ----------------------------| (Perform module instruction test

| per ELD specifications)

(fail module test) ---------------------| (Turn MIL on, remain in infinite

| loop here.)

END: Module Instruction Test

32-8

KAM, RAM, AND ROM SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: RAM Test

(after instruction test) ---------------| (Looping through external RAM:

| Save register contents,

| Write AAAA Hex to register,

| Read register,

| If contents <> AAAA do ram

| failure procedure below.

| Otherwise,

| Write 5555 Hex to register

| Read register,

| If contents <> 5555 do ram

| failure procedure below.

| Otherwise,

| Restore register contents,

| continue loop)

(ram failure) --------------------------| (Turn MIL on, remain in infinite

| loop here)

END: RAM Test

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KAM, RAM, AND ROM SELF TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ROM Test

(after register test) ------------------| (perform a 16 bit (word) addition

| of contents of all ROM locations

| retaining the 16 least significant

| bits of the result)

| (Note: The parameter ROM\_TO

| contains a checksum such that the

| sum of the ROM contents will equal

| zero)

(If sum <> 0) --------------------------| store\_code(P0605)

END: ROM Test

BEGIN: KAM Test

VIP\_KAM = 1 ----------------------------| store\_code(P0603)

(failed KAM qualification)

END: KAM Test

32-10

CHAPTER 33

ENGINE OFF SELF TEST

33-1

ENGINE OFF SELF TEST, EDIS MODULE TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

33.1 EDIS MODULE TEST (CDAB0)

OVERVIEW

This test outputs a KOEO service code 226 if the CPU OK signal (IDM pulse

width of 100 +/- 14 usec) from the E-DIS module is not present.

DEFINITIONS

Bit Flags:

- VKOEO\_CPUOK = Flag set in IDM up foreground that indicates a CPU ok pulse

from the E-DIS module has been received.

Calibration Constants:

- V\_CPUOK\_ENA = Test enable flag; 1 = enable.

PROCESS

STRATEGY MODULE: VO\_EDISMT\_COM1

V\_CPUOK\_ENA = 1 ------------------|

|AND -| Set service code 226

VKOEO\_CPUOK = 0 ------------------|

33-2

CHAPTER 34

ENGINE RUNNING SELF TEST

34-1

ENGINE RUNNING SELF TEST, TRANSMISSION CONTROL SWITCH TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

34.1 TRANSMISSION CONTROL SWITCH CIRCUIT TEST (CDAB0)

OVERVIEW

The KOER transmission control switch circuit test monitors the ITCS register

for both the open and closed states. If during the course of the KOER test

sequence both states are not recognized, a code 632 will be output during

KOER code output. This test requires the operator to depress the overdrive

cancel switch anytime during the KOER test sequence.

DEFINITIONS

Bit Flags:

- ITCS = Input register indicate current state of TCS, 1 = closed.

- TCS\_OPEN = Indicates open state of TCS has been recognized during the

KOER TCS test when equal to 1.

- TCS\_SHORT = Indicates closed state of TCS has been recognized during the

KOER TCS test when equal to 1.

Calibration Constants:

- V\_TCS\_ENA = TCS circuit test enable switch; 1 -> enable.

PROCESS

STRATEGY MODULE: VR\_TCS\_COM2

During KOER initialization, set code 632, TCS\_SHORT = 0, TCS\_OPEN = 0.

The following is performed in SEQUENCE\_2, VIP\_BRAKE\_TEST (once per background

loop):

ITCS = 1 -------------------------------| TCS\_SHORT = 1

|

| --- ELSE ---

|

| TCS\_OPEN = 1

The following is performed in SEQUENCE\_2, VIP\_EXECUTIVE:

V\_TCS\_ENA = 0 --------------------|

|OR --| Clear Code 632

TCS\_OPEN = 1 ---------------| |

|AND -|

TCS\_SHORT = 1 --------------|

34-2

CHAPTER 35

CONTINUOUS SELF TEST

35-1

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

35.1 MISFIRE DETECTION TEST (CDAN2)

OVERVIEW

The misfire detection logic determines that a cylinder is misfiring by

comparing accelerations. To determine if cylinder "x" is misfiring, the

acceleration associated with cylinder "x" is compared with the median of the

accelerations of the MEDIAN\_WIDTH cylinder events surrounding cylinder "x"

where MEDIAN\_WIDTH is a calibration parameter. The acceleration of cylinder

"x" is included in the list of accelerations used to generate the median. If

the acceleration of cylinder "x" is sufficiently less than the median value

of the MEDIAN\_WIDTH accelerations mentioned above and other criteria are met

(see logic), cylinder "x" is determined to have misfired. The threshold of

the difference between the median acceleration and the acceleration of

cylinder "x" for determining if cylinder "x" has misfired is a function of

the indicated torque of the engine at the time cylinder "x" was to have

fired.

The misfire detection test logic is divided into two main parts. The first

is performed during the PIP interrupt routine (PIP down if accelerations are

calculated from PIP and the PIP up edge if the rear "misfire sensor" is

used). This is where the accelerations are calculated and MEDIAN\_WIDTH

accelerations stored. The indicated torques associated with the cylinders

("x") to be analysed are also calculated and stored. Two firing data

registers are maintained for each cylinder during the PIP routine. One

indicating the number of total firings for that cylinder since the last

misfire test background logic execution and the other indicating the number

of misfires for that cylinder since the last misfire test background logic

execution. The second part is performed during the background sequence.

Here, conditions are checked to determine if assessment of data gathered

during the PIP interrupts since the last background may be used to determine

if misfires have taken place. Misfire rates are maintained and the two

firing data registers for each cylinder are cleared for tallying the next

series of cylinder events. Also, OBDII requirements such as "trip"

indicators for the misfire detection test are controlled.

This version of the Misfire Detection test is capable of using profile

correction factors. Profile refers to the crank shaft angle comprising a pip

period. For any engine using this logic the nominal angle is 360/ENGCYL.

The number of correction factors therefore is ENGCYL, one for each pip period

in a rotation. The correction factors are applied to the velocity

calculation correcting for deviations in the profile from the nominal

360/ENGCYL degrees. The calibrator has the choice of using either adapted

correction factors which are generated by the Profile Correction algorithm,

or using only the initial values of the profile correction factors CFx\_INIT

(x refers to the 1 thru ENGCYL factors) which are calibration values.

35-2

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- ACCEL\_LST[] = Array of (2 \* NUMCYL - 1) registers containing pip down to

down acceleration data.

- ACCEL\_POINTR = Indicates position of newest acceleration in ACCEL\_LST [].

- ACCEL\_SAVE = Acceleration used to calculate decel.

- ACCS\_OLD = State of A/C during previous background loop.

- ACT = Air charge temperature, degrees.

- ATMR1 = Time since engine start.

- BANK1\_EXPLIC = Misfire rate on bank 1, updates occur each 200 rotations

of the engine.

- BANK1\_EXPON = Misfire rate on bank 1, calculated on a rolling ave basis.

- BANK2\_EXPLIC = Misfire rate on bank 2, updates occur each 200 rotations

of the engine.

- BANK2\_EXPON = Misfire rate on bank 2, calculated on a rolling ave basis.

- BG\_TMR = Background loop timer.

- CF1 = adapted correction factor for profile # 1.

- CF2 = adapted correction factor for profile # 2.

- CF3 = adapted correction factor for profile # 3.

- CF4 = adapted correction factor for profile # 4.

- CMISLEVEL = Misfire test individual cylinder failure threshold.

- CMIS1FIL = Misfire test cylinder 1 rolling average fault filter.

- CMIS2FIL = Misfire test cylinder 2 rolling average fault filter.

- CMIS3FIL = Misfire test cylinder 3 rolling average fault filter.

- CMIS4FIL = Misfire test cylinder 4 rolling average fault filter.

- CMIS5FIL = Misfire test cylinder 5 rolling average fault filter.

- CMIS6FIL = Misfire test cylinder 6 rolling average fault filter.

- CMIS7FIL = Misfire test cylinder 7 rolling average fault filter.

- CMIS8FIL = Misfire test cylinder 8 rolling average fault filter.

- CSUMFIL = Sum of individual cylinder misfire fault filters.

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CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- DACCEL\_36 = Result of MEDIAN - a(0) in misfire test.

- DACCEL\_HGHT = Expected DACCEL\_36 level under misfire.

- ECT = Engine coolant temp.

- FN1615\_DATA = Misfire test current net torque.

Range = 0 to 1022.984375; Resolution = 0.015625;Units = LB-FT

- FNMISOK\_DATA = current value from FNMISOK table.

- INJ\_ON = Number of injectors to be left on as determined by torque

control.

| - ISCFLG = ISC mode indicator flag; -1 -> Dashpot Mode, 0 -> Dashpot

| Preposition Mode, 1 -> closed Loop RPM Control Mode, 2 -> Closed Loop RPM

| Control (Lock\_out entry to RPM control).

- LOAD = Universal LOAD as ratio of air charge over standard.

- MAX\_PCT\_MIS = Contains most recent value from the table FNMAXISPCT.

- MISBYPSCTR = Cumulative cylinder events bypassed by the misfire test

foreground logic.

- MIS\_CF = current profile correction factor is assigned to this register

which is then applied to the velocity.

- MISECTDLY = Number of seconds to delay Misfire monitoring based on ECT,

after power-up.

- MISFDELTAERR = Misfire Comm. error indicator.

- MISACTDLY = Number of seconds to delay Misfire monitoring based on ACT,

after power-up.

- MIS\_PROFILE = profile associated with current pip period in the misfire

test.

- MIS\_SYNC\_CTR = Calculated value of sync\_ctr used by misfire detection.

- MISFIRES1000 = Accumulated misfires over 1000 revolutions.

- MISFIRES200 = Accumulated misfires over 200 revolutions.

- MISNOCALLFIL = 1st Order filter of nocall by the misfire detection logic.

- MIS\_EVENTS = Cumulative foreground executions of the misfire detection

test.

- MIS\_NOCALL = Cumulative instances of a no-call by the misfire test.

- MISPOTCALL = Cumulative instances of potential failures in the misfire

test.

- MISTOTDLY = Total amount of time, in seconds, misfire monitor will be

bypassed after power-up.

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CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- N = Engine speed, RPM.

- NOISE\_COUNT = When non-zero no assessment of misfire due to signal noise.

- NUMMIS = Cumulative instances of misfire detected by the misfire test.

- NUMMIS1 = Cumulative instances of misfire detected by the misfire test

from cylinder 1.

- NUMMIS2 = Cumulative instances of misfire detected by the misfire test

from cylinder 2.

- NUMMIS3 = Cumulative instances of misfire detected by the misfire test

from cylinder 3.

- NUMMIS4 = Cumulative instances of misfire detected by the misfire test

from cylinder 4.

- NUMMIS5 = Cumulative instances of misfire detected by the misfire test

from cylinder 5.

- NUMMIS6 = Cumulative instances of misfire detected by the misfire test

from cylinder 6.

- NUMMIS7 = Cumulative instances of misfire detected by the misfire test

from cylinder 7.

- NUMMIS8 = Cumulative instances of misfire detected by the misfire test

from cylinder 8.

- PIP\_DWN\_DEL = Period between two most recent PIP down edges.

- PIPTSTFIL = PIP circuit failure fault filter.

- SPK\_LAMBSE = Value of LAMBSE to be used in spark calculation.

- SYNC\_CTR = Sequence counter incremented every PIP rising edge that is

used to identify the cycle and position.

- TRQLST[TQ\_POINTER] = NUMCYL registers containing indicated torque at

associated pip down-to-down.

- TQ\_BRAKE\_S = Actual net torque produced by engine.

- TR\_SPK\_DELTA = current torque ration from spark advance

- TOTBGTOBG = Total cylinder events between misfire test background logic

executions.

- TOTEVENTS = Cumulative cylinder events total carried over from previous

background logic executions.

- TOTMISBGTOBG = Total number of misfires between misfire test background

logic executions.

- TOTMISFIL = Overall misfire fault rolling average fault filter .

35-5

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TOTMISLEVEL = Misfire test overall failure threshold for catalyst damage.

- TOTNOCALLOLD = Cumulative nocalls total carries over from previous

background logic execution.

- TQ\_POINTER = Indicates position of oldest torque in list.

- TYPE\_A\_MIS = Indicates to executive which misfire criteria.

- USPD\_RUN\_TMR = Time in underspeed or run mode.

- V\_CYL1\_MIS = Number of misfires of cylinder 1 since last misfire test

background.

- V\_CYL1\_TOT = Number of cylinder 1 events since last misfire test

background.

- V\_CYL2\_MIS = Number of misfires of cylinder 2 since last misfire test

background.

- V\_CYL2\_TOT = Number of cylinder 2 events since last misfire test

background.

- V\_CYL3\_MIS = Number of misfires of cylinder 3 since last misfire test

background.

- V\_CYL3\_TOT = Number of cylinder 3 events since last misfire test

background.

- V\_CYL4\_MIS = Number of misfires of cylinder 4 since last misfire test

background.

- V\_CYL4\_TOT = Number of cylinder 4 events since last misfire test

background.

- V\_CYL5\_MIS = Number of misfires of cylinder 5 since last misfire test

background.

- V\_CYL5\_TOT = Number of cylinder 5 events since last misfire test

background.

- V\_CYL6\_MIS = Number of misfires of cylinder 6 since last misfire test

background.

- V\_CYL6\_TOT = Number of cylinder 6 events since last misfire test

background.

- V\_CYL7\_MIS = Number of misfires of cylinder 7 since last misfire test

background.

- V\_CYL7\_TOT = Number of cylinder 7 events since last misfire test

background.

- V\_CYL8\_MIS = Number of misfires of cylinder 8 since last misfire test

background.

- V\_CYL8\_TOT = Number of cylinder 8 events since last misfire test

background.

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CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- V\_LST\_DPT = Saved value of angular velocity for next acceleration

calculation.

- V\_MIS1000\_1 = Total misfires of cylinder 1 for 1000 rotations criteria in

misfire test.

- V\_MIS1000\_2 = Total misfires of cylinder 2 for 1000 rotations criteria in

misfire test.

- V\_MIS1000\_3 = Total misfires of cylinder 3 for 1000 rotations criteria in

misfire test.

- V\_MIS1000\_4 = Total misfires of cylinder 4 for 1000 rotations criteria in

misfire test.

- V\_MIS1000\_5 = Total misfires of cylinder 5 for 1000 rotations criteria in

misfire test.

- V\_MIS1000\_6 = Total misfires of cylinder 6 for 1000 rotations criteria in

misfire test.

- V\_MIS1000\_7 = Total misfires of cylinder 7 for 1000 rotations criteria in

misfire test.

- V\_MIS1000\_8 = Total misfires of cylinder 8 for 1000 rotations criteria in

misfire test.

- V\_MIS200\_1 = Total misfires of cylinder 1 for 200 rotations criteria in

misfire test.

- V\_MIS200\_2 = Total misfires of cylinder 2 for 200 rotations criteria in

misfire test.

- V\_MIS200\_3 = Total misfires of cylinder 3 for 200 rotations criteria in

misfire test.

- V\_MIS200\_4 = Total misfires of cylinder 4 for 200 rotations criteria in

misfire test.

- V\_MIS200\_5 = Total misfires of cylinder 5 for 200 rotations criteria in

misfire test.

- V\_MIS200\_6 = Total misfires of cylinder 6 for 200 rotations criteria in

misfire test.

- V\_MIS200\_7 = Total misfires of cylinder 7 for 200 rotations criteria in

misfire test.

- V\_MIS200\_8 = Total misfires of cylinder 8 for 200 rotations criteria in

misfire test.

- V\_MIS\_LOOPS = Number of pip periods remaining before data is valid.

- V\_MIS\_THR1 = Calculated threshold above which DACCEL\_36 is considered a

misfire.

- V\_MIS\_THR2 = Calculated threshold below which DACCEL\_36 is considered

noise.

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CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- V\_MIS\_TSTCNT = Register containing number of misfire test testable

events.

- VMIS\_TOT1000 = Total cylinder events for 1000 rotations criteria in

misfire test.

- VMIS\_TOT200 = Total cylinder events for 200 roatations criteria in

misfire test

Bit Flags:

- ACCFLG = A/C clutch demand status; 1 -> A/C clutch commanded on.

- CF\_KAM\_MTR = 1 -> KAM contains mature correction factors.

- CF\_KAM\_MTRO = Value of CF\_KAM\_MTR during the last bg loop. Initial(on

power-up) value is equal to CF\_KAM\_MTR.

- DIS\_FMEM = 1 -> FMEM action in progress for coil/misfire malfunction.

- FFG\_ECT = when one indicated ect currently not reliable.

- FFG\_MISFIRE = OBDII system FMEM flag form engine misfire; 1 -> currently

misfiring.

- MIL\_200\_1 = Misfire on cylinder 1, catalyst temp criteria, for MIL

- MIL\_200\_2 = Misfire on cylinder 2, catalyst temp criteria, for MIL

- MIL\_200\_3 = Misfire on cylinder 3, catalyst temp criteria, for MIL

- MIL\_200\_4 = Misfire on cylinder 4, catalyst temp criteria, for MIL

- MIL\_200\_5 = Misfire on cylinder 5, catalyst temp criteria, for MIL

- MIL\_200\_6 = Misfire on cylinder 6, catalyst temp criteria, for MIL

- MIL\_200\_7 = Misfire on cylinder 7, catalyst temp criteria, for MIL

- MIL\_200\_8 = Misfire on cylinder 8, catalyst temp criteria, for MIL

- MIL\_1000\_1 = Misfire on cylinder 1, emissions criteria.

- MIL\_1000\_2 = Misfire on cylinder 2, emissions criteria.

- MIL\_1000\_3 = Misfire on cylinder 3, emissions criteria.

- MIL\_1000\_4 = Misfire on cylinder 4, emissions criteria.

- MIL\_1000\_5 = Misfire on cylinder 5, emissions criteria.

- MIL\_1000\_6 = Misfire on cylinder 6, emissions criteria.

- MIL\_1000\_7 = Misfire on cylinder 7, emissions criteria.

- MIL\_1000\_8 = Misfire on cylinder 8, emissions criteria.

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CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- MIS200FLG\_1 = Misfire on cylinder 1, catalyst temperature criteria.

- MIS200FLG\_2 = Misfire on cylinder 2, catalyst temperature criteria.

- MIS200FLG\_3 = Misfire on cylinder 3, catalyst temperature criteria.

- MIS200FLG\_4 = Misfire on cylinder 4, catalyst temperature criteria.

- MIS200FLG\_5 = Misfire on cylinder 5, catalyst temperature criteria.

- MIS200FLG\_6 = Misfire on cylinder 6, catalyst temperature criteria.

- MIS200FLG\_7 = Misfire on cylinder 7, catalyst temperature criteria.

- MIS200FLG\_8 = Misfire on cylinder 8, catalyst temperature criteria.

- MISBG\_BYPS = Misfire test flag indicating conditions present to bypass

test.

- MISDLYFLG = When set (=1), indicates that MISTOTDLY has been calculated.

- MIS\_ENA\_FRST = indicated first background of misfire after enable has

taken place.

- MIS\_ENA\_OLD = Misfire monitor; previous BG value of MIS\_TST\_ENA.

- MIS\_ER\_ENA = Flag enables misfire test during KOER on demand testing.

- MIS\_FCO\_FLG = Flag indicating FMEM action is being taken during type A

misfire.

- MISFIRING = Flag indicates when a misfire malfunction is being detected.

- MIS\_MON = 1 -> test performed sufficient to recognize a failure.

- MIS\_MON\_KAM = Same as MIS\_MON but stored in KAM.

- MIS\_TST\_ENA = OBD=II misfire test enable flag ( 1=> test enabled).

- MIS\_TST\_RDY = When equal to 1 indicated misfire test is available.

- POTN\_FAIL[] = Array of flags holding preliminary misfire status of a

cylinder event.

- PxxxFAULT = Service code xxx KAM bit.

- VPIPFLG = 1 -> indicates an intermittant PIP with DP.

- V\_SYNCFLG = 1 -> cylinder determination possible.

Calibration Constants:

- AICE\_SETR1\_B = AICE setup reg. "B" value.

- ALPHAMIS = Filter constant for misfire test rolling average fault

filters.

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CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- ALPHANOCALL = Filter constant for misfire test MISNOCALLFIL filter.

- BYPS\_BRKPNT = Threshold of value returned from FNMISOK for decision to

test or not for misfire.

- CF1\_INIT = initial profile correction factor for profile #1.

- CF2\_INIT = initial profile correction factor for profile #2.

- CF3\_INIT = initial profile correction factor for profile #3.

- CF4\_INIT = initial profile correction factor for profile #4.

- CF\_KAM\_IGNR = 1 -> misfire logic ignores the state of CF\_KAM\_MTR flag.

- DACCEL\_CALIB = Adjusts DACCEL\_HGHT to the level of expected DACCEL\_36

under misfire.

- DACCEL\_THRES = Percent of DACCEL\_HGHT above which DACCEL\_36's will be

considered misfires.

- ENGCYL = Number of PIP's per engine revolution 2 -> 4 cyl eng (2

PIP/REV), 3 -> 6 cyl eng (e PIP/REV).

- FAST\_MIS\_LVL = Selects method of updating misfire malfunction threshold:

0 -> always filter, 1 -> filter up, jump down.

- FN1327(injector\_out, null) = A one row (9 x 1) table that maps 'injector

number' to a numerical indication of its associated engine bank.

- FN1329(INJ\_BANK, NULL) = An 8x1 table that translates the sequence number

into the correct cylinder number.

- FN1615A(FN070C, FN034A) = Misfire table to represent misfire specific

indicated engine torque, X = normalized engine speed in RPM, Y =

normalized load.

Range = 0 to 510;Resolution = 2; Units = LB-FT

- FN1615M(FN070M, FN034M) = Misfire table to represent misfire specific

indicated engine torque, X = normalized engine speed in RPM, Y =

normalized load.

Range = 0 to 510;Resolution = 2; Units = LB-FT

- FN1615M\_MULT(FN070M, FN034M) = Misfire multiplier table, allows the user

to increase the resolution of FN1615\_DATA.

Range = 0 to 3.984375; Resolution = 0.015625;Units = Unitless

- FN1615M\_CAL := When set to 1, misfire-specific torque table,

FN1615M(N,LOAD), and the mulitplication table FN1615M\_MULT are used.

When set to 0, FN1615A(N,LOAD) torque table is used.

- FN623(SPK\_LAMBSE) = Fuel multiplier used in torque calculation.

- FNMAXMISPCT(FN070C,FN034A) = Maximum misfire rate allowed before

malfunction.

- FNMISECT(ECT) = A function, it takes ECT temp as input and returns time,

seconds.

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CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FNMISACT(ACT) = A function, it takes ACT temp as input and returns time,

seconds.

- FNMISOK(FN070M, FN034M) = Table of N, LOAD regions where testing for

misfire allowed, 1 = testing allowed.

- MEDIAN\_WIDTH = In misfire test, number of events used to calculate median

acceleration.

- MIS\_ECTMAX = maximum ECT to activate misfire detection monitor.

- MIS\_ECTMIN = minimum ECT to activate misfire detection monitor.

- MISLVLEXP = Misfire rate threshold for control of FFG\_MISFIRE.

- MIS\_AC\_SW = 1 -> bypass misfire test for A/C cycling.

- MIS\_CAT\_CONF = Catalyst configuration for misfire detection purposes. 0

-> both cylinder banks into one catalyst; 1 -> one bank into one

catalyst.

- MIS\_FIL\_SEL = Select filtering method for misfire test; 0 -> geometric

rolling average, 1 -> blocks of rotations.

| - MIS\_ISCF\_SW = Switch which enables the Idle Speed Control indicator

| (ISCFLG) to be included in the misfire test ready logic. If this switch

| is set to 1, then misfire will be disabled during a tip out condition

| when ISCFLG = -1 (dashpot mode). Set this switch to 0 to disable this

| option.

- MIS\_STRT\_DLY = Minimum time since exiting crank mode before misfire

monitor will be ready.

- MIS\_MIN\_TQ = Minimum net torque to allow testing for misfire.

- MIS\_USE\_CF = in misfire test when equal to 1 use adapted profile

correction factors, when 0 use initial values of profile correction

factors.

- MISLEVEL1000 = Percent misfire threshold for emissions.

- MISLEVELSMLR = Percent misfire threshold for a similar conditions check.

- MISTHRESPCT = Multiplier (normally < 1) for lower (noise) deviant

acceleration threshold.

- NUMCYL = Number of cylinders in the engine.

- VMIS\_NOISBND = Number of firing events between a noisy event and an event

that may be evaluated.

- V\_MIS\_BGMAX = BG loop time above which misfire test foreground is

bypassed for chronometrics.

- V\_MIS\_MONCNT = Number of firing events consecutively tested to qualify as

a monitoring of misfire.

35-11

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- V\_MIS\_NMAX = RPM above which misfire test background is bypassed.

- V\_MIS\_NMIN = RPM below which misfire test backround is bypassed.

OTHER

- mis\_codes = Set of (P0300, P0301, P0302, P0303, P0304, P0305, P0306,

P0307, P0308).

- P0300 = Misfire failure fault code, more than one cylinder or cylinder

cannot be determined due to lack of syncronization.

- P0301 = Cylinder 1 misfire failure fault code.

- P0302 = Cylinder 2 misfire failure fault code.

- P0303 = Cylinder 3 misfire failure fault code.

- P0304 = Cylinder 4 misfire failure fault code.

- P0305 = Cylinder 5 misfire failure fault code.

- P0306 = Cylinder 6 misfire failure fault code.

- P0307 = Cylinder 7 misfire failure fault code.

- P0308 = Cylinder 8 misfire failure fault code.

35-12

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VC\_MISFIRE\_DETEC\_COM4

BEGIN: MISFIRE\_DETECTION\_FOREGROUND\_MAIN

(performed during PIP interrupt as follows:

1. if the cal parameter AICE\_SETR1\_B (bit3) = 1, PIP input is used to

calculate accelerations, perform "MISFIRE\_DETECTION\_FOREGROUND\_MAIN" during

the PIP down interrupt after update of EEC registers containing AICE data.

2. if the cal parameter AICE\_SETR1\_B (bit3) = 0, rear "misfire sensor" input

is used to calculate accelerations, perform

"MISFIRE\_DETECTION\_FOREGROUND\_MAIN" during the PIP up interrupt, prior to

update of SYNC\_CTR and prior to the update of the EEC registers that contain

AICE data.)

AICE\_SETR1\_B (bit3) = 1 --| perform "MISFIRE\_DETECTION\_FOREGROUND\_MAIN"

| during the PIP down interrupt after update

| of EEC registers containing AICE data

|

| --- ELSE ---

|

| perform "MISFIRE\_DETECTION\_FOREGROUND\_MAIN"

| during the PIP up interrupt, prior to

| update of SYNC\_CTR and prior to the update of

| the EEC registers that contain AICE data

35-13

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

This is the main misfire detection logic procedure contained in the PIP

routine. All other misfire detection procedures contained in the PIP routine

are either called by MISFIRE\_DETECTION\_FOREGROUND\_MAIN or are called by

procedures called by MISFIRE\_DETECTION\_FOREGROUND\_MAIN.

MISBG\_BYPS = 1 --| MISBYPSCTR := MISBYPSCTR + 1

(background is | (for development only)

indicating to |

bypass test) |

| --- ELSE ---

|

V\_MIS\_LOOPS = 0 -| Do: MIS\_SYNC\_CTR\_CALC

(accel\_lst[] | Do: ACCEL\_CALC

and | Do: MAINTAIN\_ACCEL\_LST

trqlst[] | Do: MAINTAIN\_TORQUE\_LIST

filled with | Do: MAINTAIN\_POTN\_FAIL\_FLG\_QUE

good data, | Do: CALCULATE\_MEDIAN\_ACCELERATION

however | Do: POINTER\_CONTROL

potn\_fail[0] | MIS\_EVENTS := MIS\_EVENTS + 1

cannot be | (for development only)

considered | DACCEL\_HGHT := DACCEL\_CALIB \* TRQLST[TQ\_POINTER]

to contain | (expected daccel level under misfire)

valid data | V\_MIS\_THR1 := DACCEL\_HGHT \* DACCEL\_THRES

until | (deviant accels above this value

noise\_level=0) | are potential misfires)

| V\_MIS\_THR2 := V\_MIS\_THR1 \* MISTHRESPCT \* -1

| (deviant accels below this value are noise)

| DACCEL\_36 := accel\_stat - ACCEL\_LST[a0]

| (deviant acceleration)

| ACCEL\_SAVE := ACCEL\_LST[a0]

| (accel used to calculate daccel)

| Do: MIS\_DETECTION

|

| --- ELSE ---

|

| Do: MIS\_SYNC\_CTR\_CALC

| Do: ACCEL\_CALC

| Do: MAINTAIN\_ACCEL\_LST

| Do: MAINTAIN\_TORQUE\_LIST

| Do: MAINTAIN\_POTN\_FAIL\_FLG\_QUE

| V\_MIS\_LOOPS := V\_MIS\_LOOPS - 1

| (when decremented to zero,

| accel\_lst[] and trqlst[]

| have valid data)

| MISBYPSCTR := MISBYSCTR + 1

| (for development only)

END: MISFIRE\_DETECTION\_FOREGROUND\_MAIN

35-14

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ACCEL\_CALC

This procedure calculates the velocity and acceleration of the PIP period

ending at this PIP down event (or the previous PIP down event if using a rear

"misfire sensor" resulting in performance of this logic on the PIP up).

Do: DETERMINE\_WHICH\_PROFILE\_CF\_TO\_USE ; what profile is generating

; this pip period

Do: GENERATE\_CORRECTION\_FACTOR ; assign MIS\_CF a value based on

; current profile and whether to

; use adapted CF values or base

; cal values of CFs

dpt1 := [360/(ENGCYL \* PIP\_DWN\_DEL)] \* MIS\_CF

(corrected velocity) ; angular velocity of the most

; recent pip down-to-down

; corrected for profile. (PIP\_DWN\_DEL

; may be generated

; by the rear "misfire sensor")

calculated acceleration := (dpt1 - V\_LST\_DPT)/PIP\_DWN\_DEL

; change in velocity from last

; pip down-to-down

; to this pip down-to-down

V\_LST\_DPT := dpt1 ; save current angular velocity

; for next acceleration

; calculation.

END: ACCEL\_CALC

BEGIN: MAINTAIN\_ACCEL\_LST

ACCEL\_POINTR + 1 = MEDIAN\_WIDTH + 1 -| ACCEL\_POINTR := 1

| ACCEL\_LST[ACCEL\_POINTR] :=

| calculated\_acceleration

|

| --- ELSE ---

|

| ACCEL\_POINTR := ACCEL\_POINTR + 1

| ACCEL\_LST[ACCEL\_POINTR] :=

| calculated\_acceleration

END: MAINTAIN\_ACCEL\_LST

35-15

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: DETERMINE\_WHICH\_PROFILE\_CF\_TO\_USE

The appropriate SYNC\_CTR (MIS\_SYNC\_CTR) comparisons are made by calling

the procedure associated with the number of cylinder.

ENGCYL = 4 -------------------| Do: DETERMINE\_8CYL\_CF

|

| --- ELSE ---

|

ENGCYL = 3 -------------------| Do: DETERMINE\_6CYL\_CF

|

| --- ELSE ---

|

ENGCYL = 2 -------------------| Do: DETERMINE\_4CYL\_CF

END: DETERMINE\_WHICH\_PROFILE\_CF\_TO\_USE

BEGIN: MIS\_SYNC\_CTR\_CALC

If using the rear misfire sensor (AICE\_SET1\_B(bit3) = 0) then the current

pip down to down is associated with the current value of SYNC\_CTR - 1.

AICE\_SET1\_B (bit3) = 1 ---| MIS\_SYNC\_CTR := SYNC\_CTR

| (using front (PIP) sensor)

|

| --- ELSE ---

|

| MIS\_SYNC\_CTR := SYNC\_CTR - 1

| Do: ADJUST\_MIS\_SYNC\_CTR

(using rear misfire sensor)

END: MIS\_SYNC\_CTR\_CALC

BEGIN: ADJUST\_MIS\_SYNC\_CTR

ENGCYL = 4 ---------|

|AND -| MIS\_SYNC\_CTR := 7

MIS\_SYNC\_CTR = -1 --| |

| --- ELSE ---

ENGCYL = 3 ---------| |

|AND -| MIS\_SYNC\_CTR := 5

MIS\_SYNC\_CTR = -1 --| |

| --- ELSE ---

ENGCYL = 2 ---------| |

|AND -| MIS\_SYNC\_CTR := 3

MIS\_SYNC\_CTR = -1 --|

END: ADJUST\_MIS\_SYNC\_CTR

35-16

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: DETERMINE\_8CYL\_CF

MIS\_SYNC\_CTR is used to determine which profile applies during this

interrupt for 8 cylinder engines.

MIS\_SYNC\_CTR = 3 --|

|OR --| MIS\_PROFILE := 4

MIS\_SYNC\_CTR = 7 --| |

| --- ELSE ---

MIS\_SYNC\_CTR = 0 --| |

|OR --| MIS\_PROFILE := 1

MIS\_SYNC\_CTR = 4 --| |

| --- ELSE ---

MIS\_SYNC\_CTR = 1 --| |

|OR --| MIS\_PROFILE := 2

MIS\_SYNC\_CTR = 5 --| |

| --- ELSE ---

MIS\_SYNC\_CTR = 2 --| |

|OR --| MIS\_PROFILE := 3

MIS\_SYNC\_CTR = 6 --|

END: DETERMINE\_8CYL\_CF

BEGIN: DETERMINE\_6CYL\_CF

MIS\_SYNC\_CTR is used to determine which profile applies during this

interrupt for 6 cylinder engines

MIS\_SYNC\_CTR = 3 --|

|OR --| MIS\_PROFILE := 1

MIS\_SYNC\_CTR = 0 --| |

| --- ELSE ---

MIS\_SYNC\_CTR = 1 --| |

|OR --| MIS\_PROFILE := 2

MIS\_SYNC\_CTR = 4 --| |

| --- ELSE ---

MIS\_SYNC\_CTR = 2 --| |

|OR --| MIS\_PROFILE := 3

MIS\_SYNC\_CTR = 5 --|

END: DETERMINE\_6CYL\_CF

BEGIN: DETERMINE\_4CYL\_CF

MIS\_SYNC\_CTR is used to determine which profile applies during this

interrupt for 4 cylinder engines.

MIS\_SYNC\_CTR = 1 --|

|OR --| MIS\_PROFILE := 2

MIS\_SYNC\_CTR = 3 --| |

| --- ELSE ---

MIS\_SYNC\_CTR = 2 --| |

|OR --| MIS\_PROFILE := 1

MIS\_SYNC\_CTR = 0 --|

END: DETERMINE\_4CYL\_CF

35-17

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: GENERATE\_CORRECTION\_FACTOR

Assign MIS\_CF a value based on current profile and (via MIS\_USE\_CF)

whether to use adapted CF values or base cal values of CFs.

MIS\_PROFILE = 1 -|

|AND -| MIS\_CF := CF1

MIS\_USE\_CF = 1 --| |

(use adapted CFs) |

| --- ELSE ---

|

MIS\_PROFILE = 1 -------| MIS\_CF := CF1\_INIT

| (uncorrected or best guess cal

| of what profile 1 CF should be)

|

| --- ELSE ---

MIS\_PROFILE = 2 -| |

|AND -| MIS\_CF := CF2

MIS\_USE\_CF = 1 --| |

(use adapted CFs) |

| --- ELSE ---

|

MIS\_PROFILE = 2 -------| MIS\_CF := CF2\_INIT

| (uncorrected or best guess cal

| of what profile 2 CF should be)

|

| --- ELSE ---

MIS\_PROFILE = 3 -| |

|AND -| MIS\_CF := CF3

MIS\_USE\_CF = 1 --| |

(use adapted CFs) |

| --- ELSE ---

|

MIS\_PROFILE = 3 -------| MIS\_CF := CF3\_INIT

| (uncorrected or best guess cal

| of what profile 3 CF should be)

|

| --- ELSE ---

MIS\_PROFILE = 4 -| |

|AND -| MIS\_CF := CF4

MIS\_USE\_CF = 1 --| |

(use adapted CFs) |

| --- ELSE ---

|

MIS\_PROFILE = 4 -------| MIS\_CF := CF4\_INIT

| (uncorrected or best guess cal

| of what profile 4 CF should be)

END: GENERATE\_CORRECTION\_FACTOR

35-18

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MAINTAIN\_TORQUE\_LIST

;assign current value of torque to list. At this point

;TQ\_POINTER is pointing to the oldest member of the list,

;which will be written over and then will be pointing to

;the newest member of the list.

unconditionally -----------| TRQLST[TQ\_POINTER] := FN1615\_DATA

In the following logic, TQ\_POINTER is incremented and now will once again

point to the oldest member of the list. This is the member of the list

which will be used to calculate DACCEL\_HGHT during this interrupt.

TQ\_POINTER + 1 = (MEDIAN\_WIDTH + 1) / 2 -| TQ\_POINTER := 0

(list rollover) |

| --- ELSE ---

|

| TQ\_POINTER := TQ\_POINTER + 1

END: MAINTAIN\_TORQUE\_LIST

35-19

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MAINTAIN\_POTN\_FAIL\_FLG\_QUE

Shift the POTN\_FAIL[] array losing the oldest value in preparation for

adding the most recent value.

b0 := VMIS\_NOISBND + 1 ; b0 is index of most current

POTN\_FAIL[] element

POTN\_FAIL[0] := POTN\_FAIL[1]

POTN\_FAIL[1] := POTN\_FAIL[2]

POTN\_FAIL[2] := POTN\_FAIL[3]

.

.

.

POTN\_FAIL[b0 - 1] := POTN\_FAIL[b0]

END: MAINTAIN\_POTN\_FAIL\_FLG\_QUE

BEGIN: CALCULATE\_MEDIAN\_ACCELERATION

Set accel\_sort[] array := ACCEL\_LST[] array

Sort accel\_sort[] array (1 to MEDIAN\_WIDTH)

;find the median of accel\_sort[] and assign it to accel\_stat

accel\_stat := accel\_sort [(MEDIAN\_WIDTH + 1)/2]

END: CALCULATE\_MEDIAN\_ACCELERATION

BEGIN: POINTER\_CONTROL

a0 := ACCEL\_POINTR + (MEDIAN\_WIDTH + 1)/2

a0 >= MEDIAN\_WIDTH + 1 ---| a0 := a0 - MEDIAN\_WIDTH

END: POINTER\_CONTROL

35-20

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MIS\_DETECTION

Firing events pointed to by ACCEL\_LST[a0] are assessed for misfire, the

result is held in the POTN\_FAIL[] array until possible noise surrounding the

event can be determined. If noise exists in events near the event

represented by POTN\_FAIL elements, a misfire indicated by the POTN\_FAIL

element will be disregarded as due to noise.

DACCEL\_36 > V\_MIS\_THR1 ------------------| POTN\_FAIL[b0] := 1

(potential misfire recognized, if no | MISPOTCALL := MISPOTCALL + 1

noise appears in the VMIS\_NOISBND | (for development only)

firings on either side of the event | Do: MIS\_EVENTS\_TALLY

pointed to by accel\_lst[a0], |

this event will become classified |

as an actual misfire) |

| --- ELSE ---

|

DACCEL\_36 < V\_MIS\_THR2 ------------------| POTN\_FAIL[b0] := 0

(noisy signal has been recognized, | NOISE\_COUNT := VMIS\_NOISBND \*

NOISE\_COUNT register reset to protect | 2 + 1

against wrongfully calling | MIS\_NOCALL := MIS\_NOCALL + 1

neighboring cylinder events misfires) | (for development only)

|

| --- ELSE ---

|

| POTN\_FAIL[b0] := 0

| Do: MIS\_EVENTS\_TALLY

END: MIS\_DETECTION

35-21

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MIS\_EVENTS\_TALLY

Final determination of misfire is made here.

NOISE\_COUNT = 0 -----------| Do: DETERMINE\_CYLINDER\_BEING\_EVALUATED

(no noise) | Do: POTNFAIL\_TO\_ACTUALFAIL

| (potn\_fail flag for next cylinder to be

| evaluated is checked)

| Do: INC\_EVENTS\_CNTR

| (document that an event for the cylinder

| determined by "determine\_cylinder\_being\_

| evaluated" has taken place)

| V\_MIS\_TSTCNT := V\_MIS\_TSTCNT + 1

| (tally consecutive firing events with

| test active)

|

| --- ELSE ---

|

| MIS\_NOCALL := MIS\_NOCALL + 1

| (for development only)

| NOISE\_COUNT := NOISE\_COUNT - 1

| (noisy environment is subsiding)

END: MIS\_EVENTS\_TALLY

35-22

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: POTNFAIL\_TO\_ACTUALFAIL

POTN\_FAIL[0] = 1 ----------| Do: INC\_MIS\_CNTR

| (document a misfire for cylinder determined

| by "determine\_cylinder\_being\_evaluated")

| NUMMIS := NUMMIS + 1

| (for development only)

END: POTNFAIL\_TO\_ACTUALFAIL

BEGIN: DETERMINE\_CYLINDER\_BEING\_EVALUATED

med\_dist := (MEDIAN\_WIDTH - 1) / 2

nois\_dist := VMIS\_NOISBND + 1

temp := MIS\_SYNC\_CTR - med\_dist - nois\_dist

(offset between current value of MIS\_SYNC\_CTR and

MIS\_SYNC\_CTR of the cylinder under evaluation)

Do: MODULO\_ARITHMETIC

Do: CONVERT\_SYNC\_CTR\_TO\_CYLINDER\_NUMBER

END: DETERMINE\_CYLINDER\_BEING\_EVALUATED

BEGIN: MODULO\_ARITHMETIC

At the end of this process, temp will contain the MIS\_SYNC\_CTR number

for the cylinder being evaluated (on 8 cylinder engines temp contains

MIS\_SYNC\_CTR + 1).

temp <= 0 -------------| temp := temp + NUMCYL

| Do: MODULO\_ARITHMETIC ; loop

END: MODULO\_ARITHMETIC

BEGIN: CONVERT\_SYNC\_CTR\_TO\_CYLINDER\_NUMBER

temp := temp - 1 ; input to FN1329 requires value 0 thru 7

temp := FN1329(temp)

END: CONVERT\_SYNC\_CTR\_TO\_CYLINDER\_NUMBER

35-23

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: INC\_MIS\_CNTR

The counters associated with the misfiring cylinder are incremented.

temp = 1 -----------| V\_CYL1\_MIS := V\_CYL1\_MIS + 1

|

| --- ELSE ---

|

temp = 2 -----------| V\_CYL2\_MIS := V\_CYL2\_MIS + 1

|

| --- ELSE ---

|

temp = 3 -----------| V\_CYL3\_MIS := V\_CYL3\_MIS + 1

|

| --- ELSE ---

|

temp = 4 -----------| V\_CYL4\_MIS := V\_CYL4\_MIS + 1

|

| --- ELSE ---

|

temp = 5 -----------| V\_CYL5\_MIS := V\_CYL5\_MIS + 1

|

| --- ELSE ---

|

temp = 6 -----------| V\_CYL6\_MIS := V\_CYL6\_MIS + 1

|

| --- ELSE ---

|

temp = 7 -----------| V\_CYL7\_MIS := V\_CYL7\_MIS + 1

|

| --- ELSE ---

|

temp = 8 -----------| V\_CYL8\_MIS := V\_CYL8\_MIS + 1

END: INC\_MIS\_CNTR

35-24

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: INC\_EVENTS\_CNTR

The counter associated with the current cylinder, when valid

test conditions are present,is incremented.

temp = 1 -----------| V\_CYL1\_TOT := V\_CYL1\_TOT + 1

|

| --- ELSE ---

|

temp = 2 -----------| V\_CYL2\_TOT := V\_CYL1\_TOT + 1

|

| --- ELSE ---

|

temp = 3 -----------| V\_CYL3\_TOT := V\_CYL3\_TOT + 1

|

| --- ELSE ---

|

temp = 4 -----------| V\_CYL4\_TOT := V\_CYL4\_TOT + 1

|

| --- ELSE ---

|

temp = 5 -----------| V\_CYL5\_TOT := V\_CYL5\_TOT + 1

|

| --- ELSE ---

|

temp = 6 -----------| V\_CYL6\_TOT := V\_CYL6\_TOT + 1

|

| --- ELSE ---

|

temp = 7 -----------| V\_CYL7\_TOT := V\_CYL7\_TOT + 1

|

| --- ELSE ---

|

temp = 8 -----------| V\_CYL8\_TOT := V\_CYL8\_TOT + 1

END: INC\_EVENTS\_CNTR

end pip period processing

35-25

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MISFIRE BACKGROUND MAIN

;execute once per bg loop

unconditionally ----| Do: CLEAR\_MISFIRE\_KAM\_REGS

| Do: SYNC\_CHK

| ;clear individual cylinder regs if not in sync.

| Do: ACCESSORY\_CHECK

| ;accessory state changes that may appear as

| ;misfires are detected

| Do: MISFIRE\_ENA\_FLG\_TRANSITION\_CHK

| ;information for control of misfire ready

| ;flag based on transition of the OBDII

| ;executive misfire enable flag

| Do: BYPASS\_TABLE

| Do: MIS\_START\_DLYTM\_CALC

| ;calc time to delay misfire monitor

| Do: MIS\_TST\_READY\_CHK

| ;indicate whether misfire test may be performed

| Do: MISBG\_BYPS

| ;perform misfire testing if possible

END: MISFIRE BACKGROUND MAIN

BEGIN: CLEAR\_MISFIRE\_KAM\_REGS

MIS\_TST\_ENA = 1 -----------|

|AND -| | NUMMIS1 := 0

MIS\_ENA\_FRST = 0 ----------| | | NUMMIS2 := 0

|OR --| NUMMIS3 := 0

| | NUMMIS4 := 0

CF\_KAM\_MTRO = 0 -----------| | | NUMMIS5 := 0

|AND -| | NUMMIS6 := 0

CF\_KAM\_IGNR = 0 -----------| | NUMMIS7 := 0

| NUMMIS8 := 0

| NUMMIS := 0

| MIS\_MON\_KAM := 0

| MIS\_NOCALL := 0

| TOTEVENTS := 0

| MIS\_ENA\_FRST := 1

END: CLEAR\_MISFIRE\_KAM\_REGS

35-26

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: SYNC\_CHK

V\_SYNCFLG = 0 --------| V\_MIS200\_1 := 0

| V\_MIS200\_2 := 0

| V\_MIS200\_3 := 0

| V\_MIS200\_4 := 0

| V\_MIS200\_5 := 0

| V\_MIS200\_6 := 0

| V\_MIS200\_7 := 0

| V\_MIS200\_8 := 0

| V\_MIS1000\_1 := 0

| V\_MIS1000\_2 := 0

| V\_MIS1000\_3 := 0

| V\_MIS1000\_4 := 0

| V\_MIS1000\_5 := 0

| V\_MIS1000\_6 := 0

| V\_MIS1000\_7 := 0

| V\_MIS1000\_8 := 0

END: SYNC\_CHK

BEGIN: ACCESSORY\_CHECK

Any accessory which may cause sudden changes in parasitic torque

and which may affect the misfire detection algorithm are documented.

Also any strategy intended action which may cause or appear as a

misfire (e.g. injector cutout for torque truncation) is documented.

ACCS\_OLD <> ACCFLG ---------|

(A/C state change) |AND -|

| |

MIS\_AC\_SW = 1 --------------| |

(bypass for A/C state change) |OR --| access\_flg := 1

| | ACCS\_OLD := ACCFLG

INJ\_ON <> NUMCYL -----------------| | (save current ACCFLG)

(one or more injectors commanded |

off) |

| --- ELSE ---

|

| access\_flg := 0

| ACCS\_OLD := ACCFLG

END: ACCESSORY\_CHECK

35-27

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MISFIRE\_ENA\_FLG\_TRANSITION\_CHK

MIS\_TST\_ENA = 0 ------------------|

(current ena state) |AND -| ena\_transition\_to\_off := 1

| | (enable transition to off

MIS\_ENA\_OLD = 1 ------------------| | has occurred)

(previous ena state) | MIS\_ENA\_OLD := MIS\_TST\_ENA

|

| --- ELSE ---

|

| ena\_transition\_to\_off := 0

| (no on to off transition

| this time)

| MIS\_ENA\_OLD := MIS\_TST\_ENA

END: MISFIRE\_ENA\_FLG\_TRANSITION\_CHK

BEGIN: MIS\_START\_DLYTM\_CALC

;execute when called

MISDLYFLG = 0 -----------------| MISECTDLY := FNMISECT(ECT)

| MISACTDLY := FNMISACT(ACT)

| MISTOTDLY := MISECTDLY + MISACTDLY +

MIS\_STRT\_DLY

| MISDLYFLG := 1

END: MIS\_START\_DLYTM\_CALC

35-28

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MIS\_TST\_READY\_CHK

When the following logic is true, the misfire test is available for misfire

assessment. The MIS\_TST\_RDY flag is controlled.

AICE\_SETR1\_B(bit3)

= 0 --|

|AND -|

MISFDELTAERR = 0 -----| |

;rear snsr & no aice err |OR --|

| |

AICE\_SETR1\_B(bit3) | |

= 1 --| | |

|AND -| |

PIPTSTFIL = 0 --| | |

|OR --| |

VPIPFLG = 0 ----| |

;front snsr & no pip err |

|

| ISCFLG <> -1 ---------------| |

| |OR --|

| MIS\_ISCF\_SW = 0 ------------| |

| |

BG\_TMR <= V\_MIS\_BGMAX ------------|

|

FFG\_ECT = 0 ----------------------|

|

ECT > MIS\_ECTMIN -----------------|

(ect range to test) |

|

ECT < MIS\_ECTMAX -----------------|

|

N > V\_MIS\_NMIN -------------------|

(rpm range to test) |

|

N < V\_MIS\_NMAX -------------------|

|

access\_flg = 0 -------------------|

|AND -| MIS\_TST\_RDY := 1

TQ\_BRAKE\_S > MIS\_MIN\_TQ ----------| |

| |

mis\_byps\_tbl = 1 -----------------| |

| |

ena\_transition\_to\_off = 0 --------| |

| |

USPD\_RUN\_TMR >= MISTOTDLY --------| |

| |

(continued on next page)

35-29

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

| |

MIS\_ER\_ENA = 1 -------------| | |

(do not bypass while in | | |

fmem if engine-running | | |

test in progress) | | |

| | |

DIS\_FMEM = 0 ---------------| | |

| | |

DIS\_FMEM = 1 ---------| |OR --| |

| | |

P0300MALF = 0 --------| | |

| | |

P0301MALF = 0 --------| | |

| | |

P0302MALF = 0 --------| | |

| | |

P0303MALF = 0 --------|AND -| |

| |

P0304MALF = 0 --------| |

| |

P0305MALF = 0 --------| |

| |

P0306MALF = 0 --------| |

| |

P0307MALF = 0 --------| |

| |

P0308MALF = 0 --------| |

(coil failure caused FMEM action. |

misfire detection continues until |

it recognizes the misfire due to |

coil malfunction) |

| --- ELSE ---

|

| MIS\_TST\_RDY := 0

END: MIS\_TST\_READY\_CHK

35-30

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MISBG\_BYPS

MIS\_TST\_RDY = 1 --------------|

|

MIS\_TST\_ENA = 1 --------| |

|OR --|AND -| MISBG\_BYPS := 0

MIS\_ER\_ENA = 1 ---------| | | (misfire test is performed)

| | Do: TORQUE\_CALCULATION

MIS\_CAT\_CONF = 0 -------------| | Do: MIS\_MONITOR\_FLAG

(cat exposed to all cylinders) | Do: MISFIRE\_PARAMETER\_CALCULATIONS

| Do: MISFIRE\_FAILURE\_INDICATION\_CONTROL

| \_BY\_ENGINE

| Do: CLEAR\_MALF\_FLAGS

| Do: NOCALL\_FILTER\_CONTROL

| Do: ZERO\_MIS\_REGISTERS

|

| --- ELSE ---

MIS\_TST\_RDY = 1 --------------| |

| |

MIS\_TST\_ENA = 1 --------| | |

|OR --|AND -| MISBG\_BYPS := 0

MIS\_ER\_ENA = 1 ---------| | | (misfire test is performed)

| | Do: TORQUE\_CALCULATION

MIS\_CAT\_CONF = 1 -------------| | Do: MIS\_MONITOR\_FLAG

(cat exposed to a bank only) | Do: MISFIRE\_PARAMETER\_CALCULATIONS

| Do: MIS\_RATE\_BY\_BANK\_INIT

| Do: MISFIRE\_FAILURE\_INDICATION\_CONTROL

| \_BY\_BANK

| Do: CLEAR\_MALF\_FLAGS

| Do: NOCALL\_FILTER\_CONTROL

| Do: ZERO\_MIS\_REGISTERS

|

| --- ELSE ---

(continued on next page)

35-31

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

VPIPFLG = 1 ------------------| |

(pip failure) | |

PIPTSTFIL > 0 ----------------| |

| |

MISFDELTAERR = 1 -------------| |

(aice data error) | |

| |

FFG\_ECT = 1 ------------------| |

(ect currently not reliable) | |

| |

MIS\_TST\_ENA = 0 --------| | |

(obdII enable flag) |AND -| |

| |OR --| MISBG\_BYPS := 1

MIS\_ER\_ENA = 0 ---------| | | (misfire test is to be bypassed

| | filter registers are cleared)

DIS\_FMEM = 1 -----------| | | V\_MIS\_LOOPS := MEDIAN\_WIDTH - 1

| | | NOISE\_COUNT := VMIS\_NOISBND \* 2 + 1

P0300MALF = 1 ----| | | | ACCEL\_POINTR := 0

| | | | TQ\_POINTER := 0

P0301MALF = 1 ----| |AND -| | Do: MIS\_FIL\_ZERO

| | | Do: NOCALL\_FILTER\_CONTROL

P0302MALF = 1 ----| | | Do: ZERO\_MIS\_REGISTERS

| | |

P0303MALF = 1 ----|OR --| |

| |

P0304MALF = 1 ----| |

| |

P0305MALF = 1 ----| |

| |

P0306MALF = 1 ----| |

| |

P0307MALF = 1 ----| |

| |

P0308MALF = 1 ----| |

| --- ELSE ---

|

| MISBG\_BYPS := 1

| (misfire test is to be bypassed

| filters are maintained at the

| current level)

| V\_MIS\_LOOPS := MEDIAN\_WIDTH - 1

| NOISE\_COUNT := VMIS\_NOISBND \* 2 + 1

| ACCEL\_POINTR := 0

| TQ\_POINTER := 0

| Do: NOCALL\_FILTER\_CONTROL

| Do: ZERO\_MIS\_REGISTERS

END: MISBG\_BYPS

35-32

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: TORQUE\_CALCULATION

FN1615M\_CAL = 0 --| FN1615\_DATA := FN1615A(N,LOAD) \* TR\_SPK\_DELTA

| \* FN623(SPK\_LAMBSE)

|

| --- ELSE ----

|

| FN1615\_DATA := FN1615M(N,LOAD) \* TR\_SPK\_DELTA

| \* FN623(SPK\_LAMBSE) \* FN1615M\_MULT(N,LOAD)

END: TORQUE\_CALCULATION

BEGIN: BYPASS\_TABLE

Each cell of the table FNMISOK will contain "1" if when operating in that

cell, misfires will be allowed to be determined. If the cell contains "0"

misfire detection will be bypassed. The calibration parameter BYPS\_BRKPNT

allows for 4 point interpolation calculation.

FNMISOK\_DATA := FNMISOK(N,LOAD)

FNMISOK\_DATA >= BYPS\_BRKPNT -----| mis\_byps\_tbl := 1

| (misfire detection not bypassed)

|

| --- ELSE ---

|

| mis\_byps\_tbl := 0

| (misfire detection is bypassed)

END: BYPASS\_TABLE

35-33

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MISFIRE\_PARAMETER\_CALCULATIONS

unconditionally --| Do: MIS\_KAM\_CALCS

| Do: MIS\_FILTER\_UPDATE\_EXPON

| ;misfire rate filters are updated

| Do: MIS\_PROFILE\_CFMTR\_CHK

| Do: MIS\_EXPORT\_DATA\_CONTROL

| ;control od data not used bu misfire

| Do: CALCULATE\_EXPLICIT\_MISFIRE\_RATE

| ;misfire rates based on groups

| ;of engine rotations are calculated

NOISE\_COUNT = 0 --| Do: MIS\_THRESHOLD\_CONTROL

| ;current misfire threshold is calculated only when

| ;misfire malfunctions filters are updated i.e. when

| ;noise\_count = 0

END: MISFIRE\_PARAMETER\_CALCULATIONS

BEGIN: MIS\_KAM\_CALCS

unconditionally --| NUMMIS1 := NUMMIS1 + V\_CYL1\_MIS

| NUMMIS2 := NUMMIS2 + V\_CYL2\_MIS

| NUMMIS3 := NUMMIS3 + V\_CYL3\_MIS

| NUMMIS4 := NUMMIS4 + V\_CYL4\_MIS

| NUMMIS5 := NUMMIS5 + V\_CYL5\_MIS

| NUMMIS6 := NUMMIS6 + V\_CYL6\_MIS

| NUMMIS7 := NUMMIS7 + V\_CYL7\_MIS

| NUMMIS8 := NUMMIS8 + V\_CYL8\_MIS

END: MIS\_KAM\_CALCS

BEGIN: MIS\_PROFILE\_CFMTR\_CHK

;If profile correction logic indicates that the Correction Factors (CFs)

;in the KAM aren't mature (CF\_KAM\_MTR = 0) and if the cal constant

;CF\_KAM\_IGNR indicates to check CF's status (CF\_KAM\_IGNR = 0) then

;exit misfire background logic.

CF\_KAM\_MTR = 0 ------------|

|AND -| (exit misfire background)

CF\_KAM\_IGNR = 0 -----------| | ;cfs aren't mature and cf

;cf mature chk cal'd in | ;maturity is cal'd in.

|

| --- ELSE ---

|

CF\_KAM\_MTRO = 0 -----------| |

|AND -| Do: ZERO\_MIS\_REGISTERS

CF\_KAM\_IGNR = 0 -----------| | Do: MIS\_FIL\_ZERO

| Do: CLEAR\_MISFIRE\_KAM\_REGS

| CF\_KAM\_MTRO := 1

END: MIS\_PROFILE\_CFMTR\_CHK

35-34

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MIS\_FILTER\_UPDATE\_EXPON

TOTMISBGTOBG := V\_CYL1\_MIS + V\_CYL2\_MIS + V\_CYL3\_MIS + V\_CYL4\_MIS +

V\_CYL5\_MIS + V\_CYL6\_MIS + V\_CYL7\_MIS + V\_CYL8\_MIS

(total misfires since last misfire test BG

execution)

TOTBGTOBG := V\_CYL1\_TOT + V\_CYL2\_TOT + V\_CYL3\_TOT + V\_CYL4\_TOT +

V\_CYL5\_TOT + V\_CYL6\_TOT + V\_CYL7\_TOT + V\_CYL8\_TOT

(total cylinder events since last misfire test BG

execution)

TOTBGTOBG <> 0 --| TOTMISFIL := [(1 - ALPHAMIS \* TOTBGTOBG) \* TOTMISFIL]

| + (ALPHAMIS \* TOTMISBGTOBG)

| (update overall misfire filter)

CF\_KAM\_MTR = 1 --|

|OR -| Do:INDIVIDUAL\_CYLINDER\_FILTER\_UPDATE\_EXPON

CF\_KAM\_IGNR = 1 -| | ;update each individual cylinder misfire filter

END: MIS\_FILTER\_UPDATE\_EXPON

BEGIN: MIS\_EXPORT\_DATA\_CONTROL

TOTMISFIL > MISLVLEXP ------------------| FFG\_MISFIRE := 1

|

| --- ELSE ---

|

| FFG\_MISFIRE := 0

END: MIS\_EXPORT\_DATA\_CONTROL

35-35

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MIS\_RATE\_BY\_BANK\_INIT

The following variables are initialized for use by MIS\_RATE\_BY\_BANK.

cyl\_num := 1

BANK1\_EXPON :=0

BANK2\_EXPON :=0

BANK1\_EXPLIC :=0

BANK2\_EXPLIC :=0

Do: MIS\_RATE\_BY\_BANK

END: MIS\_RATE\_BY\_BANK\_INIT

BEGIN: MIS\_RATE\_BY\_BANK

This procedure calculated the misfire rate occurring on each bank of

cylinders of the engine. If a catalyst configuration is one catalyst on each

bank, then the misfire rate affecting that catalyst temperature must be based

only on the bank associated with that catalyst.

This procedure loops to itself for each cylinder of the engine summing the

misfire rates for the bank associated with the current cylinder number.

bank\_num := FN1327(cyl\_num) ; bank associated with cyl\_num is assigned to

; bank\_num.

cyl\_num <= NUMCYL ------|

|AND -| Do: SUM\_BANK\_1

bank\_num = 0 -----------| | (current cylinder number is in bank 1

| the misfire rate for bank 1 will be

| incremented by the misfire rate of

| the current cyl\_num adjusted by ENGCYL)

| cyl\_num := cyl\_num + 1

| Do: MIS\_RATE\_BY\_BANK (loop)

| (continue to call until all cylinders have

| been accounted for)

|

| --- ELSE ---

cyl\_num <= NUMCYL ------| |

|AND -| Do: SUM\_BANK\_2

bank\_num = 2 -----------| | (current cylinder number is in bank 2)

| the misfire rate for bank 2 will be

| incremented by the misfire rate of

| the current cyl\_num adjusted by ENGCYL)

| cyl\_num := cyl\_num + 1

| Do: MIS\_RATE\_BY\_BANK (loop)

| (continue to call until all cylinders have

| been accounted for)

END: MIS\_RATE\_BY\_BANK

35-36

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: SUM\_BANK\_1

cyl\_num = 1 --------| BANK1\_EXPLIC := BANK1\_EXPLIC + mis\_rate200\_1

| BANK1\_EXPON := BANK1\_EXPON + CMIS1FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 2 --------| BANK1\_EXPLIC := BANK1\_EXPLIC + mis\_rate200\_2

| BANK1\_EXPON := BANK1\_EXPON + CMIS2FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 3 --------| BANK1\_EXPLIC := BANK1\_EXPLIC + mis\_rate200\_3

| BANK1\_EXPON := BANK1\_EXPON + CMIS3FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 4 --------| BANK1\_EXPLIC := BANK1\_EXPLIC + mis\_rate200\_4

| BANK1\_EXPON := BANK1\_EXPON + CMIS4FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 5 --------| BANK1\_EXPLIC := BANK1\_EXPLIC + mis\_rate200\_5

| BANK1\_EXPON := BANK1\_EXPON + CMIS5FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 6 --------| BANK1\_EXPLIC := BANK1\_EXPLIC + mis\_rate200\_6

| BANK1\_EXPON := BANK1\_EXPON + CMIS6FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 7 --------| BANK1\_EXPLIC := BANK1\_EXPLIC + mis\_rate200\_7

| BANK1\_EXPON := BANK1\_EXPON + CMIS7FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 8 --------| BANK1\_EXPLIC := BANK1\_EXPLIC + mis\_rate200\_8

| BANK1\_EXPON := BANK1\_EXPON + CMIS8FIL/ENGCYL

END: SUM\_BANK\_1

35-37

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: SUM\_BANK\_2

cyl\_num = 1 --------| BANK2\_EXPLIC := BANK2\_EXPLIC + mis\_rate200\_1

| BANK2\_EXPON := BANK2\_EXPON + CMIS1FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 2 --------| BANK2\_EXPLIC := BANK2\_EXPLIC + mis\_rate200\_2

| BANK2\_EXPON := BANK2\_EXPON + CMIS2FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 3 --------| BANK2\_EXPLIC := BANK2\_EXPLIC + mis\_rate200\_3

| BANK2\_EXPON := BANK2\_EXPON + CMIS3FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 4 --------| BANK2\_EXPLIC := BANK2\_EXPLIC + mis\_rate200\_4

| BANK2\_EXPON := BANK2\_EXPON + CMIS4FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 5 --------| BANK2\_EXPLIC := BANK2\_EXPLIC + mis\_rate200\_5

| BANK2\_EXPON := BANK2\_EXPON + CMIS5FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 6 --------| BANK2\_EXPLIC := BANK2\_EXPLIC + mis\_rate200\_6

| BANK2\_EXPON := BANK2\_EXPON + CMIS6FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 7 --------| BANK2\_EXPLIC := BANK2\_EXPLIC + mis\_rate200\_7

| BANK2\_EXPON := BANK2\_EXPON + CMIS7FIL/ENGCYL

|

| --- ELSE ---

|

cyl\_num = 8 --------| BANK2\_EXPLIC := BANK2\_EXPLIC + mis\_rate200\_8

| BANK2\_EXPON := BANK2\_EXPON + CMIS8FIL/ENGCYL

END: SUM\_BANK\_2

35-38

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MISFIRE\_FAILURE\_INDICATION\_CONTROL\_BY\_ENGINE

TOTMISFIL > TOTMISLEVEL -------|

(engine is misfiring) |AND -| Do: MIS\_CODE\_SET\_EXPON

| | (determine which cylinders

MIS\_FIL\_SEL = 0 ---------------| | should be considered as

(use filters for rate of misfire) | misfiring)

| MISFIRING := 1

| (indicate misfire currently

| taking place)

|

| --- ELSE ---

VMIS\_TOT200 >= ENGCYL \* 200 ---| |

(mis\_rate200 is updated) | |

| | TYPE\_A\_MIS := 1

mis\_rate200 > TOTMISLEVEL -----|AND -| Do: MIS\_CODE\_SET\_EXPLICIT\_200

(misfiring over 200 revs) | | (determine which cylinders

| | should be considered as

MIS\_FIL\_SEL = 1 ---------------| | misfiring)

(use explicit misfire rate calc) | MISFIRING := 1

| (indicate misfire currently

| taking place)

|

| --- ELSE ---

mis\_rate1000 > MISLEVEL1000 ---| |

(misfiring over 1000 revs) | |

| | TYPE\_A\_MIS := 0

VMIS\_TOT1000 >= ENGCYL \* 1000 -|AND -| Do: MIS\_CODE\_SET\_EXPLICIT\_1000

(mis\_rate1000 is updated) | | (determine which cylinders

| | should be considered as

MIS\_FIL\_SEL = 1 ---------------| | misfiring)

(use explicit misfire rate calc) | MISFIRING := 1

| (indicate misfire currently

| taking place)

|

| --- ELSE ---

|

VMIS\_TOT1000 >= ENGCYL \* 1000 -| | TYPE\_A\_MIS := 0

(mis\_rate1000 is updated) |AND -| Do: MIS\_SIMILAR\_CONDS\_HYST\_CHK

| | ;check similar conditions

MIS\_FIL\_SEL = 1 ---------------| |

(use explicit misfire rate calc) |

| --- ELSE ---

|

MIS\_FIL\_SEL = 0 ---------------------| MISFIRING := 0

(using filters) | (indicate misfire is not

| currently taking place)

Do: CYL\_DETERMINATION\_INTEGRITY\_CHK ; determine if cylinder

; identification is possible

END: MISFIRE\_FAILURE\_INDICATION\_CONTROL\_BY\_ENGINE

35-39

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MISFIRE\_FAILURE\_INDICATION\_CONTROL\_BY\_BANK

BANK1\_EXPON > TOTMISLEVEL/2 --|

;bank misfire rates |OR --|

| |

BANK2\_EXPON > TOTMISLEVEL/2 --| |AND -| Do: MIS\_CODE\_SET\_EXPON

| | ;determine which cylinders

MIS\_FIL\_SEL = 0 --------------------| | ;should be considered as

;use filters for rate of misfire | ;misfiring

| MISFIRING := 1

| ;indicate misfire currently

| ;taking place

|

| --- ELSE ---

VMIS\_TOT200 >= ENGCYL \* 200 --------| |

;mis\_rate200 is updated | |

| |

BANK1\_EXPLIC > TOTMISLEVEL/2 -| | | TYPE\_A\_MIS := 1

;bank misfire ovr 200 rev |OR --|AND -| Do: MIS\_CODE\_SET\_EXPLICIT\_200

| | | ;determine which cylinders

BANK2\_EXPLIC > TOTMISLEVEL/2 -| | | ;should be considered as

| | ;misfiring

MIS\_FIL\_SEL = 1 --------------------| | MISFIRING := 1

;use explicit misfire rate calc | ;indicate misfire currently

| ;taking place

|

| --- ELSE ---

mis\_rate1000 > MISLEVEL1000 --------| |

;misfiring over 1000 revs | |

| | TYPE\_A\_MIS := 0

VMIS\_TOT1000 >= ENGCYL \* 1000 ------|AND -| Do: MIS\_CODE\_SET\_EXPLICIT\_1000

;mis\_rate1000 is updated | | ;determine which cylinders

| | ;should be considered as

MIS\_FIL\_SEL = 1 --------------------| | ;misfiring

;use explicit misfire rate calc | MISFIRING := 1

| ;indicate misfire currently

| ;taking place

|

| --- ELSE ---

VMIS\_TOT1000 >= ENGCYL \* 1000 ------| |

;mis\_rate1000 is updated |AND -| TYPE\_A\_MIS := 0

| | Do: MIS\_SIMILAR\_CONDS\_HYST\_CHK

MIS\_FIL\_SEL = 1 --------------------| | ;check similar conditions

;use explicit misfire rate calc |

|

| --- ELSE ---

|

MIS\_FIL\_SEL = 0 --------------------------| MISFIRING := 0

;using filters | ;indicate misfire is not

| ;currently taking place

Do: CYL\_DETERMINATION\_INTEGRITY\_CHK ; determine if cylinder

; identification is possible

END: MISFIRE\_FAILURE\_INDICATION\_CONTROL\_BY\_BANK

35-40

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MIS\_SIMILAR\_CONDS\_HYST\_CHK

;execute only when called

mis\_rate1000 >= MISLEVELSMLR -----------| MISFIRING := 1

|

| --- ELSE ---

|

| MISFIRING := 0

| ;indicate misfire has not

| ;taken place in 1000 revolutions

| Do: CHECK\_MIS\_CONDS

| ;public process - call to check

| ;if similar conditions exist

END: MIS\_SIMILAR\_CONDS\_HYST\_CHK

BEGIN: MIS\_MONITOR\_FLAG

The number of consecutive cylinder events while testing for

misfire, as specified by the OBDII regulation, to meet

the misfire test monitor criteria is checked.

V\_MIS\_TSTCNT >= V\_MIS\_MONCNT -|

|

CF\_KAM\_MTR = 1 ---------| |AND -| MIS\_MON := 1

|OR --| | MIS\_MON\_KAM := 1

CF\_KAM\_IGNR = 1 --------| | ;met OBDII monitor requirement

END: MIS\_MONITOR\_FLAG

35-41

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MIS\_THRESHOLD\_CONTROL

This procedure updates the maximum tolerable misfire rate

malfunction threshold (TOTMISLEVEL). The values for the

threshold are a function of N and LOAD and are contained in the

table FNMAXMISPCT. The calibration constant FAST\_MIS\_LVL selects

the method by which TOTMISLEVEL is updated; 0 = new threshold is

filtered whether increasing or decreasing. 1 = new threshold is

filtered when decreasing but jumps to the new level if the

threshold is increasing. 2 = always jump to new threshold.

FNMAXMISPCT is defined as the maximum misfire rate per catalyst.

For a dual bank system, the strategy calculates the misfire rate

accordingly. To gather data, misfires induced should be

distributed at a set rate across all cylinders until the catalyst

temperature for damage is exceeeded. This threshold rate can be

entered into FNMAXMISPCT table for single or dual bank catalyst

without any adjustments.

max\_pct\_mis\_old := MAX\_PCT\_MIS

MAX\_PCT\_MIS := FNMAXMISPCT(N,LOAD)

FAST\_MIS\_LVL = 2 ---------------------|

(always jump to new threshold) |

|OR --| TOTMISLEVEL := MAX\_PCT\_MIS

MAX\_PCT\_MIS >= max\_pct\_mis\_old -| | | (jump to new threshold)

(new threshold greater) |AND -| | CMISLEVEL := NUMCYL \*

| | TOTMISLEVEL

FAST\_MIS\_LVL = 1 ---------------| | (calculate indivudual cylinder

(jump to higher threshold) | misfire threshold for

| exponential filters)

|

| --- ELSE ---

|

| TOTMISLEVEL :=

| (1 - ALPHAMIS) \* TOTMISLEVEL

| + ALPHAMIS \* MAX\_PCT\_MIS

| (filter to new threshold

| level)

| CMISLEVEL := NUMCYL \*

| TOTMISLEVEL

| (calculate indivudual cylinder

| misfire threshold for

| exponential filters)

END: MIS\_THRESHOLD\_CONTROL

35-42

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CALCULATE\_EXPLICIT\_MISFIRE\_RATE

VMIS\_TOT200 := VMIS\_TOT200 + TOTBGTOBG

(total testable cylinder events for calculation

of catalyst temp criteria misfire rate)

VMIS\_TOT1000 := VMIS\_TOT1000 + TOTBGTOBG

(total testable cylinder events for calculation

of emission criteria misfire rate)

MISFIRES200 := MISFIRES200 + TOTMISBGTOBG

(accumulating total misfires over 200 revolutions)

MISFIRES1000 := MISFIRES1000 + TOTMISBGTOBG

(accumulating total misfires over 1000 revolutions)

V\_MIS200\_1 := V\_MIS200\_1 + V\_CYL1\_MIS

V\_MIS200\_2 := V\_MIS200\_2 + V\_CYL2\_MIS

V\_MIS200\_3 := V\_MIS200\_3 + V\_CYL3\_MIS

V\_MIS200\_4 := V\_MIS200\_4 + V\_CYL4\_MIS

V\_MIS200\_5 := V\_MIS200\_5 + V\_CYL5\_MIS

V\_MIS200\_6 := V\_MIS200\_6 + V\_CYL6\_MIS

V\_MIS200\_7 := V\_MIS200\_7 + V\_CYL7\_MIS

V\_MIS200\_8 := V\_MIS200\_8 + V\_CYL8\_MIS

V\_MIS1000\_1 := V\_MIS1000\_1 + V\_CYL1\_MIS

V\_MIS1000\_2 := V\_MIS1000\_2 + V\_CYL2\_MIS

V\_MIS1000\_3 := V\_MIS1000\_3 + V\_CYL3\_MIS

V\_MIS1000\_4 := V\_MIS1000\_4 + V\_CYL4\_MIS

V\_MIS1000\_5 := V\_MIS1000\_5 + V\_CYL5\_MIS

V\_MIS1000\_6 := V\_MIS1000\_6 + V\_CYL6\_MIS

V\_MIS1000\_7 := V\_MIS1000\_7 + V\_CYL7\_MIS

V\_MIS1000\_8 := V\_MIS1000\_8 + V\_CYL8\_MIS

35-43

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Individual cylinder misfire rates over 1000 rotations of the enging are

calculated below. These rates are relative rates based on a comparison of

misfires for that cylinder total events for that of the engine as a whole.

This mean that if cylinder 1 is always misfiring, its filter will contain

0.125 (12.5%) on an eight cylinder engine, 0.167 (16.7%) on a six cylinder

engine and 0.25 (25%) on a four cylinder engine. To observe absolute misfire

rate by cylinder use the exponential filter for each cylinder (CMISnFIL

n=1..8).

Also the overall misfire rate for the engine over 1000 rotations is

calculated.

VMIS\_TOT1000 >= ENGCYL \* 1000 --| mis\_rate1000 := MISFIRES1000 /

| VMIS\_TOT1000

| mis\_rate1000\_1 := V\_MIS1000\_1 /

| VMIS\_TOT1000

| mis\_rate1000\_2 := V\_MIS1000\_2 /

| VMIS\_TOT1000

| mis\_rate1000\_3 := V\_MIS1000\_3 /

| VMIS\_TOT1000

| mis\_rate1000\_4 := V\_MIS1000\_4 /

| VMIS\_TOT1000

| mis\_rate1000\_5 := V\_MIS1000\_5 /

| VMIS\_TOT1000

| mis\_rate1000\_6 := V\_MIS1000\_6 /

| VMIS\_TOT1000

| mis\_rate1000\_7 := V\_MIS1000\_7 /

| VMIS\_TOT1000

| mis\_rate1000\_8 := V\_MIS1000\_8 /

| VMIS\_TOT1000

VMIS\_TOT1000 >= ENGCYL \* 1000 --|

|AND -| MIL\_1000\_1 := 0

mis\_rate1000 <= MISLEVELSMLR ---| | MIL\_1000\_2 := 0

| MIL\_1000\_3 := 0

| MIL\_1000\_4 := 0

| MIL\_1000\_5 := 0

| MIL\_1000\_6 := 0

| MIL\_1000\_7 := 0

| MIL\_1000\_8 := 0

35-44

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Individual cylinder misfire rates over 200 rotations of the enging are

calculated below. These rates are relative rates based on a comparison of

misfires for that cylinder total events for that of the engine as a whole.

This mean that if cylinder 1 is always misfiring, its filter will contain

0.125 (12.5%) on an eight cylinder engine, 0.167 (16.7%) on a six cylinder

engine and 0.25 (25%) on a four cylinder engine. To observe absolute misfire

rate by cylinder use the exponential filter for each cylinder (CMISnFIL

n=1..8).

Also the overall misfire rate for the engine over 200 rotations is

calculated.

VMIS\_TOT200 >= ENGCYL \* 200 ---| mis\_rate200 := MISFIRES200 / VMIS\_TOT200

| mis\_rate200\_1 := V\_MIS200\_1 /

| VMIS\_TOT200

| mis\_rate200\_2 := V\_MIS200\_2 /

| VMIS\_TOT200

| mis\_rate200\_3 := V\_MIS200\_3 /

| VMIS\_TOT200

| mis\_rate200\_4 := V\_MIS200\_4 /

| VMIS\_TOT200

| mis\_rate200\_5 := V\_MIS200\_5 /

| VMIS\_TOT200

| mis\_rate200\_6 := V\_MIS200\_6 /

| VMIS\_TOT200

| mis\_rate200\_7 := V\_MIS200\_7 /

| VMIS\_TOT200

| mis\_rate200\_8 := V\_MIS200\_8 /

| VMIS\_TOT200

| MIL\_200\_1:= 0

| MIL\_200\_2:= 0

| MIL\_200\_3:= 0

| MIL\_200\_4:= 0

| MIL\_200\_5:= 0

| MIL\_200\_6:= 0

| MIL\_200\_7:= 0

| MIL\_200\_8:= 0

END: CALCULATE\_EXPLICIT\_MISFIRE\_RATE

35-45

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: INDIVIDUAL\_CYLINDER\_FILTER\_UPDATE\_EXPON

Individual cylinder misfire rates are calculated below. These rates are

absolute rates based on a comparison of misfires and total events for that

cylinder only. This mean that if cylinder #1 is always misfiring, its filter

will approach 1 (100%) regardless of the number of cylinders in the engine.

(filter constant modified for rate of events for individual cylinders)

unconditionally ---| alphamis\_cyl := NUMCYL / [NUMCYL + (1 / ALPHAMIS) - 1]

| cmisfil\_tot := 0

For all cylinders calculate CMISxFIL and cmisxfil\_tot:

(begin for loop)

For x = 1 to NUMCYL

V\_CYLx\_TOT <> 0 ---| CMISxFIL := [(1 - alphamis\_cyl \* V\_CYLx\_TOT) \*

| CMISxFIL] + (alphamis\_cyl \* V\_CYLx\_MIS)

| cmisfil\_tot := cmisfil\_tot + CMISxFIL

(end for loop)

unconditionally ---| CSUMFIL := cmisxfil\_tot/NUMCYL

| (overall misfire rate calculated)

(the following logic is required for scp mode06 reporting purposes)

ENGCYL = 2 --------| CMIS5FIL := FFFFh

| CMIS6FIL := FFFFh

| CMIS7FIL := FFFFh

| CMIS8FIL := FFFFh

|

| --- ELSE ---

|

ENGCYL = 3 --------| CMIS7FIL := FFFFh

| CMIS8FIL := FFFFh

END: INDIVIDUAL\_CYLINDER\_FILTER\_UPDATE\_EXPON

35-46

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MIS\_CODE\_SET\_EXPON

Set service code when its filter exceeds its threshold.

misfillvlflg := 0

CMIS1FIL > CMISLEVEL --| Do: malfunction(mis,P0301)

| (call to MIL control procedure)

| misfillvlflg := 1

CMIS2FIL > CMISLEVEL --| Do: malfunction(mis,P0302)

| (call to MIL control procedure)

| misfillvlflg := 1

CMIS3FIL > CMISLEVEL --| Do: malfunction(mis,P0303)

| (call to MIL control procedure)

| misfillvlflg := 1

CMIS4FIL > CMISLEVEL --| Do: malfunction(mis,P0304)

| (call to MIL control procedure)

| misfillvlflg := 1

CMIS5FIL > CMISLEVEL --| Do: malfunction(mis,P0305)

| (call to MIL control procedure)

| misfillvlflg := 1

CMIS6FIL > CMISLEVEL --| Do: malfunction(mis,P0306)

| (call to MIL control procedure)

| misfillvlflg := 1

CMIS7FIL > CMISLEVEL --| Do: malfunction(mis,P0307)

| (call to MIL control procedure)

| misfillvlflg := 1

CMIS8FIL > CMISLEVEL --| Do: malfunction(mis,P0308)

| (call to MIL control procedure)

| misfillvlflg := 1

misfillvlflg = 0 ------| Do: malfunction(mis,P0300)

| (call MIL control procedure

END: MIS\_CODE\_SET\_EXPON

35-47

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MIS\_CODE\_SET\_EXPLICIT\_1000

misfillvlflg := 0

mis\_rate1000\_1 > MISLEVEL1000 ------| Do: malfunction(mis,P0301)

| (call to MIL control procedure)

| misfillvlflg := 1

| MIL\_1000\_1 := 1

mis\_rate1000\_2 > MISLEVEL1000 ------| Do: malfunction(mis,P0302)

| (call to MIL control procedure)

| misfillvlflg := 1

| MIL\_1000\_2 := 1

mis\_rate1000\_3 > MISLEVEL1000 ------| Do: malfunction(mis,P0303)

| (call to MIL control procedure)

| misfillvlflg := 1

| MIL\_1000\_3 := 1

mis\_rate1000\_4 > MISLEVEL1000 ------| Do: malfunction(mis,P0304)

| (call to MIL control procedure)

| misfillvlflg := 1

| MIL\_1000\_4 := 1

mis\_rate1000\_5 > MISLEVEL1000 ------| Do: malfunction(mis,P0305)

| (call to MIL control procedure)

| misfillvlflg := 1

| MIL\_1000\_5 := 1

mis\_rate1000\_6 > MISLEVEL1000 ------| Do: malfunction(mis,P0306)

| (call to MIL control procedure)

| misfillvlflg := 1

| MIL\_1000\_6 := 1

mis\_rate1000\_7 > MISLEVEL1000 ------| Do: malfunction(mis,P0307)

| (call to MIL control procedure)

| misfillvlflg := 1

| MIL\_1000\_7 := 1

mis\_rate1000\_8 > MISLEVEL1000 ------| Do: malfunction(mis,P0308)

| (call to MIL control procedure)

| misfillvlflg := 1

| MIL\_1000\_8 := 1

misfillvlflg = 0 -------------------| Do: malfunction(mis,P0300)

| (call MIL control procedure)

END: MIS\_CODE\_SET\_EXPLICIT\_1000

35-48

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MIS\_CODE\_SET\_EXPLICIT\_200

always -----------------------------------| misfillvlflg := 0

mis\_rate200\_1 > TOTMISLEVEL ---|

|AND -|

MIS\_CAT\_CONF = 0 --------------| |

|OR --| Do: malfunction(mis,P0301)

mis\_rate200\_1 > TOTMISLEVEL/2 -| | | ;call to MIL control procedure

|AND -| | misfillvlflg := 1

MIS\_CAT\_CONF = 1 --------------| | MIS200FLG\_1 := 1

| MIL\_200\_1 := 1

|

| --- ELSE ---

|

| MIS200FLG\_1 := 0

mis\_rate200\_2 > TOTMISLEVEL ---|

|AND -|

MIS\_CAT\_CONF = 0 --------------| |

|OR --| Do: malfunction(mis,P0302)

mis\_rate200\_2 > TOTMISLEVEL/2 -| | | ;call to MIL control procedure

|AND -| | misfillvlflg := 1

MIS\_CAT\_CONF = 1 --------------| | MIS200FLG\_2 := 1

| MIL\_200\_2 := 1

|

| --- ELSE ---

|

| MIS200FLG\_2 := 0

mis\_rate200\_3 > TOTMISLEVEL ---|

|AND -|

MIS\_CAT\_CONF = 0 --------------| |

|OR --| Do: malfunction(mis,P0303)

mis\_rate200\_3 > TOTMISLEVEL/2 -| | | ;call to MIL control procedure

|AND -| | misfillvlflg := 1

MIS\_CAT\_CONF = 1 --------------| | MIS200FLG\_3 := 1

| MIL\_200\_3 := 1

|

| --- ELSE ---

|

| MIS200FLG\_3 := 0

mis\_rate200\_4 > TOTMISLEVEL ---|

|AND -|

MIS\_CAT\_CONF = 0 --------------| |

|OR --| Do: malfunction(mis,P0304)

mis\_rate200\_4 > TOTMISLEVEL/2 -| | | ;call to MIL control procedure

|AND -| | misfillvlflg := 1

MIS\_CAT\_CONF = 1 --------------| | MIS200FLG\_4 := 1

| MIL\_200\_4 := 1

|

| --- ELSE ---

|

| MIS200FLG\_4 := 0

35-49

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

mis\_rate200\_5 > TOTMISLEVEL ---|

|AND -|

MIS\_CAT\_CONF = 0 --------------| |

|OR --| Do: malfunction(mis,P0305)

mis\_rate200\_5 > TOTMISLEVEL/2 -| | | ;call to MIL control procedure

|AND -| | misfillvlflg := 1

MIS\_CAT\_CONF = 1 --------------| | MIS200FLG\_5 := 1

| MIL\_200\_5 := 1

|

| --- ELSE ---

|

| MIS200FLG\_5 := 0

mis\_rate200\_6 > TOTMISLEVEL ---|

|AND -|

MIS\_CAT\_CONF = 0 --------------| |

|OR --| Do: malfunction(mis,P0306)

mis\_rate200\_6 > TOTMISLEVEL/2 -| | | ;call to MIL control procedure

|AND -| | misfillvlflg := 1

MIS\_CAT\_CONF = 1 --------------| | MIS200FLG\_6 := 1

| MIL\_200\_6 := 1

|

| --- ELSE ---

|

| MIS200FLG\_6 := 0

mis\_rate200\_7 > TOTMISLEVEL ---|

|AND -|

MIS\_CAT\_CONF = 0 --------------| |

|OR --| Do: malfunction(mis,P0307)

mis\_rate200\_7 > TOTMISLEVEL/2 -| | | ;call to MIL control procedure

|AND -| | misfillvlflg := 1

MIS\_CAT\_CONF = 1 --------------| | MIS200FLG\_7 := 1

| MIL\_200\_7 := 1

|

| --- ELSE ---

|

| MIS200FLG\_7 := 0

mis\_rate200\_8 > TOTMISLEVEL ---|

|AND -|

MIS\_CAT\_CONF = 0 --------------| |

|OR --| Do: malfunction(mis,P0308)

mis\_rate200\_8 > TOTMISLEVEL/2 -| | | ;call to MIL control procedure

|AND -| | misfillvlflg := 1

MIS\_CAT\_CONF = 1 --------------| | MIS200FLG\_8 := 1

| MIL\_200\_8 := 1

|

| --- ELSE ---

|

| MIS200FLG\_8 := 0

35-50

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

misfillvlflg = 0 -------------------| Do: malfunction(mis,P0300)

| ;call MIL control procedure

| MIS\_FCO\_FLG := 0

|

| --- ELSE ---

|

| MIS\_FCO\_FLG := 1

| ;informs MIL output that misfire

| ;FMEM action is active. Note that

| ;the flags TYPE\_A\_MIS and MISFIRING

| ;must also be observed to indicate

| ;state of misfire FMEM

END: MIS\_CODE\_SET\_EXPLICIT\_200

35-51

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CYL\_DETERMINATION\_INTEGRITY\_CHK

V\_SYNCFLG = 0 indicates that proper cylinder identification is not possible.

Therefore any misfire service code that has been set will get converted to

code 0300 which indicates that a misfire has taken place but the cylinder is

unknown.

If V\_SYNCFLG = 1 indicating proper cylinder identification is possible, and a

cylinder specific misfire service code is set, then the general misfire

service code is cleared.

V\_SYNCFLG = 0 ---------|

|

P0301FAULT = 1 --| |

| |

P0302FAULT = 1 --| |AND -| Do: unknown\_misfire(P0300)

| | | (replace specific cylinder

P0303FAULT = 1 --| | | misfire code with

| | | service code P0300)

P0304FAULT = 1 --| | |

|OR --| | Do: CLEAR\_FMEM/MIL\_RELATED\_FLAGS

P0305FAULT = 1 --| |

| |

P0306FAULT = 1 --| |

| |

P0307FAULT = 1 --| |

| |

P0308FAULT = 1 --| |

| --- ELSE ---

P0301FAULT = 1 --------| |

| |

P0302FAULT = 1 --------| |

| |

P0303FAULT = 1 --------| |

| |

P0304FAULT = 1 --------| |

|OR --| Do: known\_misfire(P0300)

P0305FAULT = 1 --------| (replace code P0300 with

| specific cylinder misfire

P0306FAULT = 1 --------| service code)

|

P0307FAULT = 1 --------|

|

P0308FAULT = 1 --------|

END: CYL\_DETERMINATION\_INTEGRITY\_CHK

35-52

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ZERO\_MIS\_REGISTERS

Clear foreground event registers for the next misfire test

background pass.

V\_CYL1\_MIS := 0

V\_CYL2\_MIS := 0

V\_CYL3\_MIS := 0

V\_CYL4\_MIS := 0

V\_CYL5\_MIS := 0

V\_CYL6\_MIS := 0

V\_CYL7\_MIS := 0

V\_CYL8\_MIS := 0

V\_CYL1\_TOT := 0

V\_CYL2\_TOT := 0

V\_CYL3\_TOT := 0

V\_CYL4\_TOT := 0

V\_CYL5\_TOT := 0

V\_CYL6\_TOT := 0

V\_CYL7\_TOT := 0

V\_CYL8\_TOT := 0

VMIS\_TOT1000 >= ENGCYL \* 1000 --| VMIS\_TOT1000 := 0

| MISFIRES1000 := 0

| V\_MIS1000\_1 := 0

| V\_MIS1000\_2 := 0 (1000 rotations of the

| V\_MIS1000\_3 := 0 engine has occurred.

| V\_MIS1000\_4 := 0 Clear registers for

| V\_MIS1000\_5 := 0 emissions criteria

| V\_MIS1000\_6 := 0 misfire assessment of

| V\_MIS1000\_7 := 0 the next 1000 rotations

| V\_MIS1000\_8 := 0 of the engine.)

VMIS\_TOT200 >= ENGCYL \* 200 ----| VMIS\_TOT200 := 0

| MISFIRES200 := 0

| V\_MIS200\_1 := 0

| V\_MIS200\_2 := 0 (200 rotations of the

| V\_MIS200\_3 := 0 engine has occurred.

| V\_MIS200\_4 := 0 Clear registers for

| V\_MIS200\_5 := 0 catalyst overtemp

| V\_MIS200\_6 := 0 misfire assessment of

| V\_MIS200\_7 := 0 the next 200 rotations

| V\_MIS200\_8 := 0 of the engine.)

END: ZERO\_MIS\_REGISTERS

35-53

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MIS\_FIL\_ZERO

Fault filters will be cleared for the next time the test conditions become

true. Also clear the register V\_MIS\_TSTCNT which is used to indicate that

misfire has been monitored.

CMIS1FIL := 0

CMIS2FIL := 0

CMIS3FIL := 0

CMIS4FIL := 0

CMIS5FIL := 0

CMIS6FIL := 0

CMIS7FIL := 0

CMIS8FIL := 0

TOTMISFIL := 0

VMIS\_TOT200 := 0

MISFIRES200 := 0

VMIS\_TOT1000 := 0

MISFIRES1000 := 0

V\_MIS200\_1 := 0

V\_MIS200\_2 := 0

V\_MIS200\_3 := 0

V\_MIS200\_4 := 0

V\_MIS200\_5 := 0

V\_MIS200\_6 := 0

V\_MIS200\_7 := 0

V\_MIS200\_8 := 0

V\_MIS1000\_1 := 0

V\_MIS1000\_2 := 0

V\_MIS1000\_3 := 0

V\_MIS1000\_4 := 0

V\_MIS1000\_5 := 0

V\_MIS1000\_6 := 0

V\_MIS1000\_7 := 0

V\_MIS1000\_8 := 0

V\_MIS\_TSTCNT := 0

END: MIS\_FIL\_ZERO

BEGIN: NOCALL\_FILTER\_CONTROL

MIS\_ENA\_FRST = 1 --| totnocall := MIS\_NOCALL + MISBYPSCTR - TOTNOCALLOLD

| TOTNOCALLOLD := TOTNOCALLOLD + totnocall

| totevents\_t := MIS\_EVENTS + MISBYPSCTR - TOTEVENTS

| TOTEVENTS := TOTEVENTS + totevents\_t

| MISNOCALLFIL := [(1 - ALPHANOCALL \* totevents\_t)

| \* MISNOCALLFIL]

| + (ALPHANOCALL \* totnocall)

END: NOCALL\_FILTER\_CONTROL

35-54

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CLEAR\_FMEM/MIL\_RELATED\_FLAGS

MIL\_200\_1 := 0

MIL\_200\_2 := 0

MIL\_200\_3 := 0

MIL\_200\_4 := 0

MIL\_200\_5 := 0

MIL\_200\_6 := 0

MIL\_200\_7 := 0

MIL\_200\_8 := 0

MIS200FLG\_1 := 0

MIS200FLG\_2 := 0

MIS200FLG\_3 := 0

MIS200FLG\_4 := 0

MIS200FLG\_5 := 0

MIS200FLG\_6 := 0

MIS200FLG\_7 := 0

MIS200FLG\_8 := 0

MIL\_1000\_1 := 0

MIL\_1000\_2 := 0

MIL\_1000\_3 := 0

MIL\_1000\_4 := 0

MIL\_1000\_5 := 0

MIL\_1000\_6 := 0

MIL\_1000\_7 := 0

MIL\_1000\_8 := 0

END: CLEAR\_FMEM/MIL\_RELATED\_FLAGS

35-55

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CLEAR\_MALF\_FLAGS

MIL\_200\_1 = 0 --------|

|AND -| clear\_malf(P0301)

MIL\_1000\_1 = 0 -------|

MIL\_200\_2 = 0 --------|

|AND -| clear\_malf(P0302)

MIL\_1000\_2 = 0 -------|

MIL\_200\_3 = 0 --------|

|AND -| clear\_malf(P0303)

MIL\_1000\_3 = 0 -------|

MIL\_200\_4 = 0 --------|

|AND -| clear\_malf(P0304)

MIL\_1000\_4 = 0 -------|

MIL\_200\_5 = 0 --------|

|AND -| clear\_malf(P0305)

MIL\_1000\_5 = 0 -------|

MIL\_200\_6 = 0 --------|

|AND -| clear\_malf(P0306)

MIL\_1000\_6 = 0 -------|

MIL\_200\_7 = 0 --------|

|AND -| clear\_malf(P0307)

MIL\_1000\_7 = 0 -------|

MIL\_200\_8 = 0 --------|

|AND -| clear\_malf(P0308)

MIL\_1000\_8 = 0 -------|

35-56

CONTINUOUS SELF TEST, MISFIRE DETECTION TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MISFIRING = 0 --------|

|

P0301MALF = 1 --------|

|

P0302MALF = 1 --------|

|

P0303MALF = 1 --------|

|

P0304MALF = 1 --------|OR --| clear\_malf(P0300)

|

P0305MALF = 1 --------|

|

P0306MALF = 1 --------|

|

P0307MALF = 1 --------|

|

P0308MALF = 1 --------|

END: CLEAR\_MALF\_FLAGS

35-57

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

35.2 DISTRIBUTORLESS IGNITION SYSTEM TEST (CDAN0)

OVERVIEW

The Continuous DIS Test is actually a number of tests and processes.

Tests performed (by the EEC processor) are as follows:

PIP circuit; code P0320

IDM circuit; code P1351

CID circuit; code P0340 (not a device used by the ignition system

however the nature of its signal and how

it is processed make it natural to test

within this group)

EDIS module test; code 1367

Individual coil driver circuits, primary side of the coils;

coil A primary circuit; code P0351

coil B primary circuit; code P0352

coil C primary circuit; code P0353

coil D primary circuit; code P0354

EEC/EDIS communication interface:

The positive pulsewidth of the IDM signal is used by the EDIS to transmit

information to the EEC. The EEC measures the IDM positive pulsewidth and

takes the appropriate action based on the measured width. Pulsewidths for

the following may be output:

- EDIS module operating properly and the engine is not turning

- EDIS detects no failures and the engine is turning

Testing is performed by the EEC that detects an IDM positive pulse width that

is not defined. If this test is calibrated in, a service code 1357 will

result.

If there is no pulse from the EDIS is present during Engine Off on demand

self-test, a service code 1358 will be set.

PIP test overview:

The PIP circuit test is divided into hard fault (i.e. complete loss of

signal) and intermittents. Hard faults are tested by comparing the time

since the last PIP edge has occurred. If this time exceeds a maximum, a

failure is indicated. Stalls etc. are protected against. Intermittents are

tested by comparing three consecutive PIP periods. Under the assumption of

constant excelleration over the three periods, a relation of the three

periods can determine if an intermittent failure has occurred. See the PIP

down interrupt logic of these tests for the relationship.

35-58

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

IDM test overview:

The IDM signal when coming from an EDIS processor is governed by two factors;

1) the positive pulsewidth is determined by the message the EDIS is sending

to the EEC. 2) an IDM rising edge is output only when a spark event actually

occurs. During the IDM up interrupt a flag named V\_SPK\_FLG is set indicating

that a spark event has taken place. When the PIP down interrupt occurs,

V\_SPK\_FLG is tested. Since, under normal circumstances (no IDM circuit

failures, missed sparks) there will be one and only one spark event between

PIP down edges, V\_SPK\_FLG = 0 indicates that the IDM interrupt did not occur.

This may be the result of loss of spark or an IDM circuit failure. To

distinguish between the two, an IDM failure will not be considered until

VNREVIDM rotations of the engine have occured with no IDM events being

experienced. This distinguishes an IDM circuit failure from missed spark

events since loss of a coil will result in at least one spark event during a

complete rotation of the engine. However loss of all coils (or B+ to the

coil pack) will result in the same signal pattern (no IDMs) as a failed IDM

circuit. The difference is that the engine will run normally with a failed

IDM circuit, loss of the coils will result in an engine stall. Rapid

intermittent IDM is tested knowing that there is a one to one correspondence

between PIP and IDM (when considering the PIP down edge). The register

PIPIDM is incremented on each PIP down interrupt and decremented on each IDM

up interrupt. Given the one to one correspondence between PIP and IDM and

also given that PIP is known to be a good signal, than if the PIPIDM register

becomes less than -1, more IDM events than PIP events have occurred

indicating an intermittent IDM circuit.

CID circuit test overview:

For every NUMCYL PIP down events there is one and only one CID event (CID

down for VRS CID sensors and CID up for hall CID sensors). Therefore if PIP

is known to be valid and exactly one CID event did not occur after NUMCYL PIP

events a CID circuit failure is indicated.

Coil primary circuit test overview:

Simply, during the PIP down interrupt When V\_SPK\_FLG = 0 indicating that a

spark event has been missed, a register is incremented that is associated

with the coil which missed the spark. This information is used by the

background test logic in determining whether to set a coil service code.

PIPs while engine not turning overview:

The EDIS module outputs a specific IDM positive pulsewidth when it determine

via its 36-1 tooth crank sensor that the engine is not turning. If a PIP is

encountered while this pulsewidth is received a service code 1356 can be

output if this test is turned on.

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- CCM\_EO\_ENA = Engine off on demand test for CCM enabled.

- CCM\_TST\_ENA = OBD-II Comprehensive Component Test enable flag; 1 -> test

enabled.

- CIDTSTFIL = CID circuit failure fault filter.

- COILAPFIL = Coil A primary failure fault filter.

- COILBPFIL = Coil B primary failure fault filter.

- COILCPFIL = Coil C primary failure fault filter.

- COILDPFIL = Coil D primary failure fault filter.

- COILUFIL = Unknown Coil failure fault filter.

- DATA\_TIME = 3 byte time of transition.

- DT12S = The period of time between two adjacent rising edges of PIP,

ticks/pip.

- DT23S = Last DT12S time.

- DT34S = Last DT23S time (Used in HDR EDIS Test).

- ERROR\_CNTR = Number of undefined pulsewidths received from EDIS.

- ERROR\_TMR = Invalid IDM positive pw test timer.

- IDMFIL = IDM circuit failure fault filter.

- IDM\_PW = IDM pulse width for previous PIP period.

- IDM\_PW\_STARTM = Last time IDM changed high, clock ticks.

- N = Engine speed RPM.

- PIPIDM = Counter incremented on each PIP low and decremented on each IDM

high.

- PIPTSTFIL = PIP circuit failure fault filter.

- PUTMR = Time after CPU power up.

- SYNC\_CTR = Sequence counter incremented every PIP rising edge that is

used to indentify the cycle and position.

- TSLIDM = Time since last IDM interrupt.

- TSLPIP = Time since last PIP.

- V\_CL\_BRK\_TMR = Driver action procedure timer; timer zeroed when brake or

clutch depressed.

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- VCIDCNT = Counter incremented on each CID high (hall sensor) or CID low

(VRS sensor).

- VCIDERRCNT = Number of CID failure indications between background

executions.

- VCIDPASCNT = Number of CID non failure indications between background

executions.

- V\_COILOK\_CTR = Number of consecutive valid spark events.

- V\_CPU\_OK\_TMR = PIP with engine not turning test timer

- V\_IDM\_CTR = Number of undetermined IDM faults.

- VIDMERRCNT = Number of IDM failure indications between background

executions.

- VIDMPASCNT = Number of IDM non failure indications between background

executions.

- V\_PAC\_A\_CTR = Number of coil A primary fault occurrences.

- V\_PAC\_B\_CTR = Number of coil B primary fault occurrences.

- V\_PAC\_C\_CTR = Number of coil C primary fault occurrences.

- V\_PAC\_D\_CTR = Number of coil D primary fault occurrences.

- V\_PAC\_U\_CTR = Number of unknown coil fault occurrences.

- VPIPCNT = Counter incremented on each PIP low.

- VPIPERRCNT = Number of PIP failure indications between background

executions.

- VPIPPASCNT = Number of PIP nonfailure indications between background

executions.

Bit Flags:

- BIFLG = Brake ON/OFF indicator; 0 -> ON, 1 -> OFF.

- BIHP = Brake input 'hardware present' indicator; 0 -> no, 1 -> yes.

- FFG\_CPP = OBD-II system flag for Clutch Pedal Position (CPP)switch. 1 ->

CPP is currently unreliable.

- CODE\_1356\_FLG = PIPs received with engine not turning FG flag.

- CODE\_1357\_FLG = Invalid IDM PW received FG flag.

- CPU\_OK\_1 = When set first cpu ok IDM PW received from EDIS.

- CRKFLG = Crank flag.

- FFG\_CID = OBDII system FMEM flag for CID; 1 -> CID is not currently

reliable.

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FFG\_PIP = OBDII system FMEM flag for PIP; 1 -> PIP is not currently

reliable.

- IDM\_BYPASS = When set causes IDM test to be bypassed due to PIP failure.

- IDM\_RLBL\_FLG = When 1, indicated that IDM signal is currently reliable.

- PxxxMALF = Malfunction flag for code Pxxx; 1 -> a malfunction currently

exists for fault Pxxx.

- UNDSP = Underspeed flag.

- VCID\_BYPS = 1 -> the CID test background is bypassed.

- VCIDFLG = 1 -> CID fault (VIP error flag).

- V\_IDM\_FLG = When set to 1 indicates that the first missed IDM after valid

IDMs has passed.

- VKOEO\_CPUOK = Flag when set indicates to KOEO self test that EDIS module

OK.

- VPIPFLG = PIP failure flag set in FG.

- V\_PRE\_CPP = Previous state of FFG\_CPP.

- V\_SPK\_FLG = When set indicates IDM (spark) event occurred since last PIP

falling edge.

- V\_SYNCFLG = When set to zero indicated engine is not in sync.

Calibration Constants:

- CIDLVLEXP = CID failure fault filter threshold for export use.

- CIDTSTLVL = CID failure fault filter threshold.

- CIDUP = CID failure fault filter increment.

- CPUOK\_PW = valid IDM high pulsewidth for KOEO condition, clock tics.

- CPRIMLVL = Coil primary failure fault filter threshold.

- CPRIMUP = Coil primary failure fault filter increment.

- ENGCYL = Number of PIP'S per engine revolution; 2 -> 4 cyl. engine (2

PIP/rev), 3 -> 6 cyl. engine (3 PIP/rev), 4 -> 8 cyl. engine (4

PIP/rev).

- HP\_CIDSEL = CID sensor hardware select switch set; 0 -> Hall Effect

sensor, 1 -> VR sensor if a CID sensor.

- IDMLVL = IDM failure fault filter threshold.

- IDMUP = IDM failure fault filter increment.

- IDM\_VBATMIN = Minimum VBAT level required before IDM signal can be

considered reliable.

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- IDM\_VBATMAX = Maximum VBAT level below which IDM signal is considered

reliable.

- IDM\_NMAX = Minimum N (RPM) required before IDM signal can be considered

reliable.

- IGNR\_CPP = 1 -> ignore clutch pedal position switch test input.

- MAX\_ERROR = Maximum number of erroneous FG IDM high pw fault

transmissions before setting EDIS transmission fault code.

- MAX\_TIME = Maximum time window in which to recognize erroneous FG IDM

high pw transmissions and set EDIS transmission fault code.

- OKIDM\_PW = Valid IDM high pulsewidth for KOER with no failures reported,

clock tics.

- PIPERR = PIP error level to set PIP fault, unitless ratio of clock tics.

- PIPLVLEXP = PIP failure fault filter threshold for export use.

- PIPTSTLVL = PIP failure fault filter threshold.

- PIPUP = PIP failure fault filter increment.

- PW\_EPSILON2 = IDM FG high pulsewidth tolerance, clock tics.

- TRLOAD = Transmission load switch.

- V\_CL\_BRK\_TM = Time to delay after driver uses brake or declutches.

- VCIDSW = CID test enable switch.

- VDLY6 = Time to wait after PIP has been restored after failure before

testing IDM.

- V\_1PAC\_ERR = Coil pack FG fault counter threshold before uncounting BG

fault filter.

- V\_CIDN\_MAX = CID sensor not tested above this value.

- V\_CIDN\_MIN = CID sensor not tested below this value.

- V\_CPU\_OK\_DUR = Time delay before an erroneous PIP can be tested during

KOEO condition, sec.

- V\_CPUOK\_ENA = KOEO EDIS module test enable switch. 1 -> do test; 0 ->

skip test

- V\_CPU\_OK\_PTM = Maximum time window in which to detect an erronewous PIP

occuring during the KOEO condition.

- V\_IDM\_NOISE = Number of PIP periods without an IDM event considered an

IDM failure.

- VNREVIDM = Number of revolutions of the engine without a valid IDM

considered an IDM fault.

35-63

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- V\_PIP\_HARD = TSLPIP greater than this value is considered a loss of PIP

signal.

- VPMAX = Maximum PIP period for PIP test background execution.

OTHER

- P0320 = Fault code, PIP circuit failure.

- P0340 = Fault code, CID circuit failure.

- P0350 = Fault code, undetermined coil primary failure.

- P0351 = Fault code, Coil A primary failure.

- P0352 = Fault code, Coil B primary failure.

- P0353 = Fault code, coil C primary failure.

- P0354 = Fault code, Coil D primary failure.

- P0703 = Change in brake state not seen in continuous test.

- P0704 = Clutch switch failure malfunction code.

- P1351 = Fault code, IDM circuit failure.

- P1356 = Fault code, PIP received while engine not turning.

- P1357 = Fault code, unexpected IDM signal received.

- P1358 = Fault code, no KOEO CPU OK (IDM) pulse from EDIS.

35-64

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OVERVIEW

The IDM interrupt provides information that the PIP and IDM test require to

determine the nature of the fault.

The IDM interrupt also is used to receive input from the E-DIS computer

(IDM\_PW). The appropriate action is taken based on the value of IDM\_PW.

Also V\_SPK\_FLG is set to indicate an IDM occurred during the current PIP

period.

PROCESS

STRATEGY MODULE: VC\_DIS\_COM6

BEGIN: IDM\_PRCS

;execute in the IDM up interrupt routine

The following modifies the PIPIDM register documenting this IDM up event.

It also documents that this interrupt occurred for use by the PIP down

interrupt via V\_SPK\_FLG.

PIPIDM = -128 ------------| V\_SPK\_FLG := 1

(PIPIDM lower clip) | (indicates to the DIS test PIP down logic

| that an IDM (spark) has occurred since the

| previous PIP down)

| IDM\_PW\_STARTM := DATA\_TIME

| (time of this edge saved, see DIS test IDM

| down interrupt logic for use of this time)

| Do: IDM\_PW\_ACTION\_SELECT

| (selects action based on positive pulse

| width of IDM)

|

| --- ELSE ---

|

| PIPIDM := PIPIDM - 1

| V\_SPK\_FLG := 1

| (indicates to the DIS test PIP down logic

| that an IDM (spark) has occurred since the

| previous PIP down)

| IDM\_PW\_STARTM := DATA\_TIME

| (time of this edge saved, see DIS test IDM

| down interrupt logic for use of this time)

| Do: IDM\_PW\_ACTION\_SELECT

| (selects action based on positive pulse

| width of IDM)

END: IDM\_PRCS

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - IDM Up Interrupt Logic

BEGIN: IDM\_PW\_ACTION\_SELECT

;execute when called from IDM\_PRCS

Select the appropriate process to perform based on IDM\_PW generated by the

E-DIS module.

(OKIDM\_PW - PW\_EPSILON2) <= IDM\_PW <= ------| Do: EDIS\_NOFAIL

(OKIDM\_PW + PW\_EPSILON2) |

(E-DIS indicates engine is turning and no |

failure present) |

| --- ELSE ---

|

(CPUOK\_PW - PW\_EPSILON2) <= IDM\_PW <= -------| Do: EDIS\_CPUOK

(CPUOK\_PW + PW\_EPSILON2) |

(E-DIS indicates engine is not turning) |

| --- ELSE ---

|

| Do: IDM\_PW\_ERROR

END: IDM\_PW\_ACTION\_SELECT

35-66

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - IDM Up Interrupt Logic

BEGIN: IDM\_PW\_ERROR

;execute when called from IDM\_PRCS

This process is executed when a IDM pulsewidth is received that is not

expected, e.g. any undefined PW or a PW previously defined but EDIS has

opted not to utilize it. In the second example the calibratable enable

register CODEx\_ENA will equal -1, where x is 1 thru 6.

When the first error is detected (ERROR\_CNTR = 1) the timer ERROR\_TMR is set

to zero. This timer will be used to determine the "time density" of the

unexpected IDM\_PW's received. If this density exceeds the calibratable limit

MAX\_ERROR in MAX\_TIME an error code 1357 will be set.

This test can be disabled by the following calibration:

MAX\_ERROR := 65535

MAX\_TIME := 0

unconditionally -----------------| ERROR\_CNTR := ERROR\_CNTR + 1

| (tally number of errors detected)

ERROR\_CNTR = 1 ------------------| ERROR\_TMR := 0

(this is the first error, zero the timer)

ERROR\_CNTR >= MAX\_ERROR ---|

|

ERROR\_TMR < MAX\_TIME ------|

(density exceeded, failure |AND -| CODE\_1357\_FLG := 1

is indicated) | | (set flag for BG processing)

| | ERROR\_CNTR := 0

CCM\_TST\_ENA = 1 -----------| | (clear counter)

|

| --- ELSE ---

|

ERROR\_CNTR >= MAX\_ERROR ---------| ERROR\_CNTR := 0

(no failure after MAX\_ERROR | (clear counter for detection of

events has occurred) | the next episode)

END: IDM\_PW\_ERROR

BEGIN: DIS\_CLEAR\_FILTERS

unconditionally -----------------| COILAPFIL := 0

| COILBPFIL := 0

| COILCPFIL := 0

| COILDPFIL := 0

| COILUFIL := 0

END: DIS\_CLEAR\_FILTERS

35-67

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - IDM Up Interrupt Logic

BEGIN: EDIS\_CPUOK

;execute when called from IDM\_PRCS

E-DIS has output an IDM\_PW = CPUOK\_PW, engine not turning. This logic will

determine if a PIP signal occurs while the EDIS module is indicating that the

engine is not turning.

CPU\_OK\_1 = 0 ---------------------------| V\_CPU\_OK\_TMR := 0

(this is the first IDM interrupt | CPU\_OK\_1 := 1

since E-DIS determined the engine | (indicates first IDM received)

is not turning) | VKOEO\_CPUOK := 1

| (used by KOEO E-DIS module

| test)

| Do: DIS\_CLEAR\_FILTERS

|

| --- ELSE ---

|

V\_CPU\_OK\_TMR <= V\_CPU\_OK\_DUR -----------| Do: DIS\_CLEAR\_FILTERS

(time limit before determining |

if PIP's are being received while |

engine is not turning has not |

been reached) |

| --- ELSE ---

CCM\_TST\_ENA = 1 ------------------| |

|AND -| CODE\_1356\_FLG := 1

TSLPIP <= V\_CPU\_OK\_PTM -----------| | (set flag for BG processing)

(PIP's are occurring while | CPU\_OK\_1 := 0

the E-DIS is indicating the | (clear flag in preparation to

engine is not turning) | test again)

| Do: DIS\_CLEAR\_FILTERS

|

CALIBRATION NOTE: |

|

calibration of V\_CPU\_OK\_PTM |

should be incrementally less |

than V\_CPU\_OK\_DUR | --- ELSE ---

|

| (no pip while engine not

| turning)

| CPU\_OK\_1 := 0

| (clear flag in preparation

| to test again)

| DO: DIS\_CLEAR\_FILTERS

END: EDIS\_CPUOK

BEGIN: EDIS\_NOFAIL

unconditionally ------------------------| CPU\_OK\_1 := 0

| VKOEO\_CPUOK := 0

END: EDIS\_NOFAIL

35-68

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - PIP Down Interrupt Logic

BEGIN: CURRENT\_COIL

;execute only when called from 'fgcoilidm' proc

ENGCYL = 2 ----------|

|

SYNC\_CTR = 0 --| |AND -| temp(A) = 1

| | | temp(B) = 0

SYNC\_CTR = 2 --|OR --| | temp(C) = 0

| | temp(D) = 0

SYNC\_CTR = 4 --| |

| --- ELSE ---

ENGCYL = 2 ----------| |

|AND -| temp(A) = 0

SYNC\_CTR = 1 --| | | temp(B) = 1

|OR --| | temp(C) = 0

SYNC\_CTR = 3 --| | temp(D) = 0

|

| --- ELSE ---

ENGCYL = 3 ----------| |

| |

SYNC\_CTR = 0 --| |AND -| temp(A) = 1

| | | temp(B) = 0

SYNC\_CTR = 3 --|OR --| | temp(C) = 0

| | temp(D) = 0

SYNC\_CTR = 6 --| |

| --- ELSE ---

ENGCYL = 3 ----------| |

|AND -| temp(A) = 0

SYNC\_CTR = 1 --| | | temp(B) = 1

|OR --| | temp(C) = 0

SYNC\_CTR = 4 --| | temp(D) = 0

|

| --- ELSE ---

ENGCYL = 3 ----------| |

|AND -| temp(A) = 0

SYNC\_CTR = 2 --| | | temp(B) = 0

|OR --| | temp(C) = 1

SYNC\_CTR = 5 --| | temp(D) = 0

|

| --- ELSE ---

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - PIP Down Interrupt Logic

(continued from previous page)

ENGCYL = 4 ----------| |

| |

SYNC\_CTR = 0 --| |AND -| temp(A) = 1

| | | temp(B) = 0

SYNC\_CTR = 4 --|OR --| | temp(C) = 0

| | temp(D) = 0

SYNC\_CTR = 8 --| |

| --- ELSE ---

ENGCYL = 4 ----------| |

|AND -| temp(A) = 0

SYNC\_CTR = 1 --| | | temp(B) = 1

|OR --| | temp(C) = 0

SYNC\_CTR = 5 --| | temp(D) = 0

|

| --- ELSE ---

ENGCYL = 4 ----------| |

|AND -| temp(A) = 0

SYNC\_CTR = 2 --| | | temp(B) = 0

|OR --| | temp(C) = 1

SYNC\_CTR = 6 --| | temp(D) = 0

|

| --- ELSE ---

ENGCYL = 4 ----------| |

|AND -| temp(A) = 0

SYNC\_CTR = 3 --| | | temp(B) = 0

|OR --| | temp(C) = 0

SYNC\_CTR = 7 --| | temp(D) = 1

|

| --- ELSE ---

|

| temp(A) = 0

| temp(B) = 0

| temp(C) = 0

| temp(D) = 0

END: CURRENT\_COIL

35-70

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - PIP Down Interrupt Logic

BEGIN: DIS\_PIPDOWN\_FG

;execute in the pip down interrupt routine

CRKFLG = 1 ---------------| PIPIDM := 0

;crank mode | VPIPCNT := 0

| VCIDCNT := 0

| VPIPERRCNT := 0

| VPIPPASCNT := 0

| ;no testing is performed until crank mode is

| ;exited

|

| --- ELSE ---

|

| Do: FGPIPTST

| ;foreground part of PIP test is performed

| Do: IDM\_RLBLTY\_CHK

| ;is idm signal reliable

END: DIS\_PIPDOWN\_FG

BEGIN: IDM\_RLBLTY\_CHK

;execute when called

;IDM signal is NOT reliable above certain RPM (N) and below a certain

;battery voltage(VBAT) level. When spout test indicates that requested

;spark advance is out of spout test range, bypass IDM/Coil tests.

VBAT < IDM\_VBATMIN --|

|

VBAT > IDM\_VBATMAX --|

|OR --| IDM\_RLBL\_FLG := 0

N > IDM\_NMAX --------| | (idm is currently not reliable)

| | V\_SPK\_FLG := 0

IGNTST\_RSIR = 0 -----| | (clear spark indicator flag)

| PIPIDM := 0

| (clear pip-idm relation register)

|

| --- ELSE ---

|

| IDM\_RLBL\_FLG := 1

| (idm is reliable)

| Do: INCPIPIDM

| (pip idm relation register is incremented

| accounting for this pip occurrance)

| Do: FGCOILIDM

| (foreground logic for the testing of coil

| failures or idm failures is performed)

END: IDM\_RLBLTY\_CHK

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FGPIPTST

[(DT12S+DT34S)/2]/DT23S <

[1-PIPERR] ---|

(PIP error indicated) |

|OR --| VPIPFLG := 1

[(DT12S+DT34S)/2]/DT23S > | | (failure indicated during this period)

[1+PIPERR] ---| | VPIPERRCNT := VPIPERRCNT + 1

| (tally pip failures to be used by bg

| pip fault filter)

|

| --- ELSE ---

|

| VPIPFLG := 0

| (document a valid pip during this

| period)

| VPIPPASCNT := VPIPPASCNT + 1

| (tally valid pips, used by bg pip

| fault filter)

END: FGPIPTST

BEGIN: INCPIPIDM

;execute when called

PIPIDM < 127 -------------------------| PIPIDM := PIPIDM + 1

(PIPIDM not at its upper clip) (pip idm relation register is

incremented accounting for this

pip occurrance)

END: INCPIPIDM

35-72

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - PIP Down Interrupt Logic

BEGIN: FGCOILIDM

;execute when called

V\_SPK\_FLG <> 0 -----------------| V\_SPK\_FLG := 0

(ignition event since previous | (reset for next event)

pip down has been documented | V\_IDM\_FLG := 0

in the IDM interrupt) | (reset for next event)

| V\_COILOK\_CTR := V\_COILOK\_CTR + 1

| (tally consecutive spark events)

| Do: COIL\_OK\_CTR\_CHK

| VIDMPASCNT := VIDMPASCNT + 1

| (tally valid idm (spark) events,

| used by bg idm fault filter)

|

| --- ELSE ---

V\_IDM\_FLG = 0 ------------| |

(first missed IDM after | |

valid IDM) |AND -| V\_COILOK\_CTR := 0

| |

V\_SYNCFLG = 1 ------------| | V\_IDM\_FLG := 1

(coil determination | (first missed idm has taken place

possible) | after valid idm)

| V\_IDM\_CTR := 1

| (tally first consecutive missed

| idm event)

| Do: CURRENT\_COIL

| Do: DETERMINE\_PRIMARY\_COIL

| (document coil associated with

| missed idm)

|

| --- ELSE ---

|

V\_SYNCFLG = 1 ------------------| V\_COILOK\_CTR := 0

(coil determination possible, | V\_IDM\_CTR := V\_IDM\_CTR + 1

process remainder of | (tally missed IDM event - note

consecutively missed IDMs) | that a missed IDM event in this

| case is VNREVIDM rotations of

| the engine with no IDMs occurring)

| Do: IDM\_CTR\_CHK

| Do: CURRENT\_COIL

| Do: DETERMINE\_PRIMARY\_COIL

|

| --- ELSE ---

|

V\_IDM\_FLG = 1 ------------------| (coil determination not possible -

(coil determination not | first missed IDM after valid IDM)

possible, process remainder | V\_COILOK\_CTR := 0

of consecutively missed | V\_IDM\_CTR := V\_IDM\_CTR + 1

IDMs) | Do: IDM\_CTR\_CHK

| V\_PAC\_U\_CTR := V\_PAC\_U\_CTR + 1

| (increment Unknown Coil counter)

|

| --- ELSE ---

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

| V\_COILOK\_CTR := 0

| V\_IDM\_FLG := 1

| V\_IDM\_CTR := 1

| V\_PAC\_U\_CTR := V\_PAC\_U\_CTR + 1

| (increment Unknown Coil counter)

END: FGCOILIDM

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - PIP Down Interrupt Logic

BEGIN: COIL\_OK\_CTR\_CHK

;execute only when called from 'fgcoilidm' proc

V\_COILOK\_CTR >= ENGCYL \* VNREVIDM ---------| V\_PAC\_A\_CTR := 0

(coils are all working) | V\_PAC\_B\_CTR := 0

| V\_PAC\_C\_CTR := 0

| V\_PAC\_D\_CTR := 0

| V\_PAC\_U\_CTR := 0

| (clear any left over

| coil failure data)

END: COIL\_OK\_CTR\_CHK

BEGIN: IDM\_CTR\_CHK

;execute only when called from 'fgcoilidm' proc

V\_IDM\_CTR >= ENGCYL \* VNREVIDM ------------| VIDMERRCNT := VIDMERRCNT + 1

(missed IDM determined to be an IDM | (tally failed IDM, used by

circuit failure - not due to coil | BG IDM fault filter)

failures)

END: IDM\_CTR\_CHK

BEGIN: DETERMINE\_PRIMARY\_COIL

;execute only when called from 'fgcoilidm' proc

temp(A) = 1 ------------| V\_PAC\_A\_CTR := V\_PAC\_A\_CTR + 1

(coil A) | (tally coil A failures)

|

| --- ELSE ---

|

temp(B) = 1 ------------| V\_PAC\_B\_CTR := V\_PAC\_B\_CTR + 1

(coil B) | (tally coil B failures)

|

| --- ELSE ---

|

temp(C) = 1 ------------| V\_PAC\_C\_CTR := V\_PAC\_C\_CTR + 1

(coil C) | (tally coil C failures)

|

| --- ELSE ---

|

temp(D) = 1 ------------| V\_PAC\_D\_CTR := V\_PAC\_D\_CTR + 1

(coil D) (tally coil D failures)

END: DETERMINE\_PRIMARY\_COIL

35-75

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - PIP Up Interrupt Logic

BEGIN: CIDTST\_PIPUP\_FG

(execute in the PIP up interrupt routine)

CRKFLG = 1 ------|

|OR -----------| VPIPCNT := 0

VPIPFLG = 1 -----| | (clear since pip is no longer valid)

(in crank or pip failure) | VCIDCNT := 0

| (clear, invalid pip will invalidate

| the cid test)

|

| --- ELSE ---

|

| VPIPCNT := VPIPCNT + 1

| (tally consecutive pip periods between

| cids)

| Do: CIDTST

| (number of pips/cid test)

END: CIDTST\_PIPUP\_FG

BEGIN: CIDTST

(execute when called)

VCIDSW = 0 ---------------------|

(CID test cal'd out) |OR --| VPIPCNT := 0

| | VCIDCNT := 0

VCID\_BYPS = 1 ------------------| | VCID\_BYPS := 0

(bg is bypassing test) |

| --- ELSE ---

VPIPCNT = ENGCYL \* 2 -----------| |

(number of PIP periods before | |

a CID signal is expected) |AND -| VCIDFLG := 0

| | (indicate CID is valid)

VCIDCNT = 1 --------------------| | VCIDPASCNT := VCIDPASCNT + 1

(exactly one CID signal | (tally valid cids, used by bg cid

has occurred; tallied in the | fault filter)

CID interrupt logic) | VPIPCNT := 0

| VCIDCNT := 0

|

| --- ELSE ---

|

VPIPCNT = ENGCYL \* 2 -----------------| VCIDFLG := 1

(number of PIP periods before | (expected number of cid signals

a CID signal is expected) | not seen, indicate a cid

| failure)

| VCIDERRCNT := VCIDERRCNT + 1

| (tally cid failures, used by bg cid

| fault filter)

| VPIPCNT := 0

| VCIDCNT := 0

| V\_SYNCFLG := 0

| (indicates loss of sync)

END: CIDTST

35-76

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - IDM DOWN Interrupt Logic

Calculate the IDM positive pulsewidth. (In this logic IDM up

and IDM down refer to the signal as seen at the EEC - vehicle

harness)

unconditionally ---------| IDM\_PW := DATA\_TIME - IDM\_PW\_STARTM

CONTINUOUS DIS TEST - CID Down Interrupt Logic

When a VRS type CID sensor is in use, this logic documents this interrupt has

been executed. This logic also indicates whether or not the engine was in

sync when this interrupt occurred.

HP\_CIDSEL = 1 -----------|

(vrs type cid sensor) |

|

UNDSP = 0 ---------------|AND -| VCIDCNT := VCIDCNT + 1

(not underspeed) | | (document number of cid events

| | between pip periods)

SYNC\_CTR = ENGCYL \* 2 ---| | V\_SYNCFLG := 1

(one full rotation of | (sync\_ctr is indicating the correct

the cam | value when this cid event occurs)

|

| --- ELSE ---

|

HP\_CIDSEL = 1 -----------------| VCIDCNT := VCIDCNT + 1

| (document number of cid events

| between pip periods)

| V\_SYNCFLG := 0

| (sync\_ctr is not indicating the correct

| value when this cid event occurs or

| the engine is in underspeed mode)

35-77

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - CID UP Interrupt Logic

When a Hall type CID sensor is in use, this logic documents this interrupt

has been executed. This logic also indicates whether or not the engine was

in sync when this interrupt occurred.

HP\_CIDSEL = 0 -----------|

(hall type cid sensor) |

|

UNDSP = 0 ---------------|AND -| VCIDCNT := VCIDCNT + 1

(not underspeed) | | (document number of cid events

| | between pip periods)

SYNC\_CTR = ENGCYL \* 2 ---| | V\_SYNCFLG := 1

(one full rotation of | (sync\_ctr is indicating the correct

the cam) | value when this cid event occurs)

|

| --- ELSE ---

|

HP\_CIDSEL = 0 -----------------| VCIDCNT := VCIDCNT + 1

| (document number of cid events

| between pip periods)

| V\_SYNCFLG := 0

| (sync\_ctr is not indicating the

| correct value when this cid event

| occurs or the engine is in

| underspeed mode)

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - Background Logic

CCM\_TST\_ENA = 1 -----------| Do: CIDBG

| Do: DRIVER\_ACTION\_PROCEDURE

| Do: PIPBG

| Do: IDMBG

| Do: PRIMARY\_COIL\_COUNTER\_CHK

| Do: PRIMARY\_COIL\_FILTER\_CHK

| Do: CODE\_1356\_CHK

| Do: CODE\_1357\_CHK

|

| --- ELSE ---

PUTMR > 4(sec) ------| |

|AND -| Do: CODE\_1356\_CHK

CRKFLG = 1 ----------| | Do: DRIVER\_ACTION\_PROCEDURE

|

| --- ELSE ---

|

| Do: DRIVER\_ACTION\_PROCEDURE

35-79

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CIDBG

VCIDSW = 1 ----------------------|

(cid test cal'd in) |

|

VPIPFLG = 0 ---------------------|

(no intermittent pip fault) |

|

PIPTSTFIL = 0 -------------------|AND -| CIDTSTFIL := CIDTSTFIL + (CIDUP \*

(no other pip fault indications)| | VCIDERRCNT) - VCIDPASCNT

| | VCIDERRCNT := 0

N > V\_CIDN\_MIN ------------------| | VCIDPASCNT := 0

(rpm window) | | Do: CID\_FILLVL\_CHK

| | (determine if cid service code

N < V\_CIDN\_MAX ------------------| | is to be set)

|

| --- ELSE ---

|

VCIDSW = 1 ----------------------------| VCIDPASCNT := 0

| VCIDERRCNT := 0

| VCID\_BYPS := 1

END: CIDBG

BEGIN: CID\_FILLVL\_CHK

When the filter exceeds its level, the service code is set.

CIDTSTFIL > CIDTSTLVL -------------| malfunction(ccm,P0340)

|

| --- ELSE ---

|

| clear\_malf(P0340)

CIDTSTFIL > CIDLVLEXP -------------| FFG\_CID := 1

(failure indication defined |

by external user thru cal |

of CIDLVLEXP) |

| --- ELSE ---

|

| FFG\_CID := 0

END: CID\_FILLVL\_CHK

35-80

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - Background Logic

This logic provides a mechanism for determining an action that may cause a

vehicle to stall has occurred. The first action that may cause a vehicle to

stall is the application of brakes. On a manual transmission, braking

without depressing the clutch may cause a stall. Also, releasing the clutch

abruptly may cause a stall. When either one of the above actions are

performed by the driver the timer V\_CL\_BRK\_TMR is reset (to zero). This

timer is then used in tests (e.g., hard fault pip test) that may require

knowledge of these driver actions that may cause a vehicle to stall. This

helps prevent false indication of failure (i.e., pip failure) should a

vehicle stall occur due to driver actions.

BEGIN: DRIVER\_ACTION\_PROCEDURE

BIFLG = 1 ------------------------|

(brake on) |

|

BIHP = 0 -------------------------|

(no brake input h/w) |

|

P0703MALF = 1 --------------------|

(boo failure) |

|OR --| V\_CL\_BRK\_TMR := 0

TRLOAD = < 2 ---------| | | V\_PRE\_CPP := FFG\_CPP

(manual;1/0 swtchs) | | |

| | |

P0704MALF = 1 --------| | |

(cpp failure) |OR --| | |

| | | |

V\_PRE\_CPP = 0 --| | | | |

|AND -| |AND -| |

FFG\_CPP = 1 ----| | |

| |

IGNR\_CPP = 1 ---------------| |

(clutch input cal'd in) |

| --- ELSE ---

|

| V\_PRE\_CPP := FFG\_CPP

END: DRIVER\_ACTION\_PROCEDURE

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - Background Logic

BEGIN: PIPBG

DT23S < VPMAX --------------|

(rpm limit via dt23s) |AND -| Do: INTERMITTENT\_PIP\_CHK

| | Do: PIP\_FILLVL\_CHK

TSLPIP <= V\_PIP\_HARD -------| | (determine if service code is to be set)

(not a hard fault) | VPIPERRCNT := 0

| VPIPPASCNT := 0

|

| --- ELSE ---

|

DT23S < VPMAX --------------------| IDM\_BYPASS := 1

(rpm based on dt23s indicates | TSLIDM := 0

sufficient rpm to test pip the | (tslidm becomes a "time since

last time a pip period was able | pip has been restored"

to be calculated. dt23s | timer until tslidm > vdly6 when

maintains its last calculated | tslidm takes on its normal roll)

value) | Do: HARDFAULT\_PIP\_CHK

| VPIPERRCNT := 0

| VPIPPASCNT := 0

| (in this decision block, a

| potential hard fault pip

| failure has been indicated)

|

| --- ELSE ---

|

| VPIPERRCNT:= 0

| VPIPPASCNT:= 0

END: PIPBG

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - Background Logic

BEGIN: INTERMITTENT\_PIP\_CHK

VPIPERRCNT = 0 ----| PIPTSTFIL := PIPTSTFIL + (PIPUP \* VPIPERRCNT) -

(no foreground | VPIPPASCNT

pip errors | (pip fault filter modified)

indicated) |

| --- ELSE ---

|

| IDM\_BYPASS := 1

| (pip failure is indicated, bypass idm test)

| TSLIDM := 0

| (tslidm becomes a "time since pip has been

| restored" timer until tslidm > vdly6 when

| tslidm takes on its normal roll)

| PIPTSTFIL := PIPTSTFIL + (PIPUP \* VPIPERRCNT) -

| VPIPPASCNT

| (pip fault filter modified)

END: INTERMITTENT\_PIP\_CHK

BEGIN: PIP\_FILLVL\_CHK

Service code is set when the filter exceeds the level.

PIPTSTFIL > PIPTSTLVL --------| malfunction(ccm,P0320)

|

| --- ELSE ---

|

| clear\_malf(P0320)

PIPTSTFIL > PIPLVLEXP --------| FFG\_PIP := 1

(failure indication defined |

by external user thru cal |

of PIPLVLEXP) |

| --- ELSE ---

|

| FFG\_PIP := 0

END: PIP\_FILLVL\_CHK

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - Background Logic

BEGIN: HARDFAULT\_PIP\_CHK

V\_CL\_BRK\_TMR >= V\_CL\_BRK\_TM --| malfunction(ccm,P0320)

(no driver actions have | FFG\_PIP := 1

occurred that may appear |

as a pip failure) |

| --- ELSE ---

|

| clear\_malf(P0320)

| FFG\_PIP := 0

END: HARDFAULT\_PIP\_CHK

BEGIN: IDMBG

IDM\_BYPASS = 1 -------------| Do: IDM\_BYPASS\_TMR\_CHK

(idm test is temporarily | V\_PAC\_A\_CTR := 0

bypassed due to an | V\_PAC\_B\_CTR := 0

indicated pip failure) | V\_PAC\_C\_CTR := 0

| V\_PAC\_D\_CTR := 0

| V\_PAC\_U\_CTR := 0

| PIPIDM := 0

| VIDMERRCNT := 0

| VIDMPASCNT := 0

|

| --- ELSE ---

|

VIDMERRCNT > 0 ------------| Do: IDM\_NOISE\_CHK

(foreground is indicating | Do: IDM\_FILLVL\_CHK

idm failures) | V\_PAC\_A\_CTR := 0 (coil failure registers

| V\_PAC\_B\_CTR := 0 are cleared since the

| V\_PAC\_C\_CTR := 0 foreground is

| V\_PAC\_D\_CTR := 0 indicating that an idm

| V\_PAC\_U\_CTR := 0 failure is present)

| PIPIDM := 0

| VIDMERRCNT := 0

| VIDMPASCNT := 0

|

| --- ELSE ---

|

| Do: IDM\_NOISE\_CHK

| Do: IDM\_FILLVL\_CHK

| VIDMERRCNT := 0

| VIDMPASCNT := 0

END: IDMBG

35-84

CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - Background Logic

BEGIN: IDM\_BYPASS\_TMR\_CHK

TSLIDM > VDLY6 -----------| IDM\_BYPASS := 0

(pip has been restored | TSLIDM := 0

sufficiently long, the | V\_IDM\_CTR := 0

idm test may now be |

resumed) | --- ELSE ---

|

| V\_IDM\_CTR := 0

END: IDM\_BYPASS\_TMR\_CHK

CONTINUOUS DIS TEST - Background Logic

BEGIN: IDM\_NOISE\_CHK

The PIPIDM register is incremented on PIP and decremented on IDM. This

procedure is performed only when the PIP is known to be good. Therefore any

extra IDMs relative to the number of PIPs is an indication that either noise

has entered the IDM circuit or that an intermittent IDM circuit failure has

occurred and the intermittent is sufficiently rapid to cause more than one

IDM interrupt per PIP.

PIPIDM < V\_IDM\_NOISE -----| IDMFIL := IDMFIL + IDMUP

(more idms than pips | (modify the idm fault filter)

have been received) | PIPIDM := 0

|

| --- ELSE ---

|

| IDMFIL := IDMFIL + IDMUP \* VIDMERRCNT -

| VIDMPASCNT

| (at this point there may or may not have

| been any idm failures, the idm filter

| will be modified according to the values of

| vidmerrcnt and vidmpascnt during this

| background pass)

END: IDM\_NOISE\_CHK

BEGIN: IDM\_FILLVL\_CHK

Service code is set when the filter exceeds the level.

IDMFIL > IDMLVL ---------| malfunction(ccm,P1351)

|

| --- ELSE ---

|

| clear\_malf(P1351)

END: IDM\_FILLVL\_CHK

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - Background Logic

BEGIN: PRIMARY\_COIL\_COUNTER\_CHK

Coil primary fault filters are controlled.

V\_PAC\_A\_CTR > V\_1PAC\_ERR ---------------| COILAPFIL := COILAPFIL + CPRIMUP

(sufficient coil A failures recognized | V\_PAC\_A\_CTR := 0

in foreground to cause the coil A |

fault filter to increment) |

| --- ELSE ---

|

| COILAPFIL := COILAPFIL - 1

V\_PAC\_B\_CTR > V\_1PAC\_ERR ---------------| COILBPFIL := COILBPFIL + CPRIMUP

(sufficient coil B failures recognized | V\_PAC\_B\_CTR := 0

in foreground to cause the coil B |

fault filter to increment) |

| --- ELSE ---

|

| COILBPFIL := COILBPFIL - 1

V\_PAC\_C\_CTR > V\_1PAC\_ERR ---------------| COILCPFIL := COILCPFIL + CPRIMUP

(sufficient coil C failures recognized | V\_PAC\_C\_CTR := 0

in foreground to cause the coil C |

fault filter to increment) |

| --- ELSE ---

|

| COILCPFIL := COILCPFIL - 1

V\_PAC\_D\_CTR > V\_1PAC\_ERR ---------------| COILDPFIL := COILDPFIL + CPRIMUP

(sufficient coil D failures recognized | V\_PAC\_D\_CTR := 0

in foreground to cause the coil D |

fault filter to increment) |

| --- ELSE ---

|

| COILDPFIL := COILDPFIL - 1

V\_PAC\_U\_CTR > V\_1PAC\_ERR ---------------| COILUFIL := COILUFIL + CPRIMUP

(sufficient coil U failures recognized | V\_PAC\_U\_CTR := 0

in foreground to cause the coil U |

fault filter to increment) |

| --- ELSE ---

|

| COILUFIL := COILUFIL - 1

END: PRIMARY\_COIL\_COUNTER\_CHK

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - Background Logic

BEGIN: PRIMARY\_COIL\_FILTER\_CHK

Primary coil fault filters are checked. If the filter exceeds the primary

coil failure threshold CPRIMLVL a service code is stored.

COILAPFIL > CPRIMLVL ---| malfunction(P0351)

|

| --- ELSE ---

|

| clear\_malf(P0351)

COILBPFIL > CPRIMLVL ---| malfunction(P0352)

|

| --- ELSE ---

|

| clear\_malf(P0352)

COILCPFIL > CPRIMLVL ---| malfunction(P0353)

|

| --- ELSE ---

|

| clear\_malf(P0353)

COILDPFIL > CPRIMLVL ---| malfunction(P0354)

|

| --- ELSE ---

|

| clear\_malf(P0354)

COILUFIL > CPRIMLVL ---| malfunction(P0350)

|

| --- ELSE ---

|

| clear\_malf(P0350)

END: PRIMARY\_COIL\_FILTER\_CHK

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS DIS TEST - Background Logic

BEGIN: CODE\_1356\_CHK

CODE\_1356\_FLG = 1 ----------------------| malfunction(ccm,P1356)

(pips have occurred while edis |

indicates the engine was not turning) | CODE\_1356\_FLG := 0

|

| --- ELSE ---

|

| clear\_malf(P1356)

END: CODE\_1356\_CHK

BEGIN: CODE\_1357\_CHK

CODE\_1357\_FLG = 1 ----------------------| malfunction(ccm,P1357)

(unexpected idm pw's have been |

received) | CODE\_1357\_FLG := 0

|

| --- ELSE ---

|

| clear\_malf(P1357)

END: CODE\_1357\_CHK

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CONTINUOUS SELF TEST, DISTRIBUTORLESS IGNITION SYSTEM TEST - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

KEY ON ENGINE SELF-TEST OF THE EDIS MODULE

The following test outputs a engine off malfunction code P1358,

if the CPU OK signal (64 us) from the EDIS module is not present.

;begin Key On Engine Off (KOEO) self-test of the edis module.

CCM\_EO\_ENA = 1 ------------| Do: EO\_EDIS\_TEST

BEGIN: EO\_EDIS\_TEST

V\_CPUOK\_ENA = 1 -----------|

|AND -| malfunction(ccm,P1358)

VKOEO\_CPUOK = 0 -----------| |

| --- ELSE ---

|

| clear\_malf(P1358)

END: EO\_EDIS\_TEST

;end engine off self-test of the edis module

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CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

35.3 PROFILE CORRECTION LOGIC (CDAN2)

OVERVIEW

Profile correction refers to mathematically compensating for pip hardware

deviations of a pip period from 360/ENGCYL degrees of rotation. The

fundamental basis for calculating the correction factor is the fact that 360

degrees of rotation is accurate on the wheel. That is the edge representing

0 degrees and the edge representing 360 degrees are one in the same.

Therefore a reference 360 degrees of rotation is available. The correction

factor is a correction to the velocity calculation.

delta theta / delta time = velocity

where theta is assumed to be 360/ENGCYL. Corrected velocity is given by:

(delta theta / delta time) \* CF = velocity

where CF (one for each pip period in a rotation) is given by:

CF = delta theta actual / delta theta nominal

Under the assumption that the actual velocity over the pip period under

consideration (the period for which CF is being calculated) and the velocity

over a rotation (360 degrees of crank rotation) containing the pip period in

question are equal, then:

CF = (delta time over the pip period / delta time over the rotation) \* ENGCYL

The adaptive profile correction factors learning is divided into categories:

- Continuos Learning (To select this feature set CF\_MTR\_IGNR = 1)

- Learn until CFs are mature (To select this feature set CF\_MTR\_IGNR = 0)

Continuous Learning:

During the PIP interrupt, data collection of the previous pip down to pip

down period for the calculation of profile correction factors is performed.

The ENGCYL \* 2 - 1 periods are held in the array CF\_PERIOD[]. The most

recent period is contained in the array register CF\_PERIOD\_1 with the

previously stored periods shifting up one position in the array. The oldest

period is then discarded. Also the value of SYNC\_CTR is saved in

CFSYNCCTRFG. There are sufficient periods of PIP down to PIP down that every

profile may have a correction factor generated for it. Having SYNC\_CTR

allows associating the periods with actual profiles. The background

procedures then, when conditions permit, calculate a correction factor for

each profile from the current data. These correction factors are averaged

into the values of the correction factors previously processed and stored in

KAM.

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CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Learn until CFs are mature:

During the PIP interrupt the data is collected as described in the previous

section. PIP\_EVNT\_CTR is incremented by 1 every PIP interrupt. If DFSFLG =

0 then PIP\_EVNT\_CTR is reset to zero and CF\_DFS0 is also set to zero.

CF\_DFSO is set to 1 only if DFSFLG=1 and after a calibratable number of PIP

events (PIP\_EVNT\_MAX) have elapsed. This is to make certain that CF learning

is done only after DFSO mode is 'stabilized'. When conditions permit, the

correction factors are calculated by averaging CFx\_NEW\_RAW values for

CF\_DLY\_MIN number of events the very first time after power-up and

CF\_SKIP\_MIN number of events until CFs are mature. For a greater control of

the step size of correction factors, two filter constants are provided.

Namely, CF\_FK\_FAST and CF\_FK\_SLOW. If CF\_FAST\_THRS >= |CFx - CFx\_AV| >=

CF\_SLOW\_THRS, a slow filter constant (CF\_FK\_SLOW) is used in the calculation

of CFx\_AV and CFx values and if |CFx - CFx\_AV| > CF\_FAST\_FAST then a fast

filter constant (CF\_FK\_FAST) is used. When |CFx - CFx\_AV| < CF\_SLOW\_THRS,

the CFs are considered mature, CF\_MTR\_FLG, CF\_KAM\_MTR are set to 1, and

profile correction factors will not be updated until next power-up. If a KAM

reset occurs, all the KAM variables are initialized to their appropriate

values (see strategy ladder logic for details).

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CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Registers:

- CF\_DLY\_CNT = A counter to count the initial (right after power-up) number

of events of CFx\_NEW values used in calculating CFx\_AV.

- CF\_FC = This register either contains the value of CF\_FK\_FAST or

CF\_FK\_SLOW when in 'learn until mature' mode and it contains the value of

CF\_FK when in continuous mode.

- CF\_FDGE\_FCTR = Profile CF normalizing (i.e. causes sum of CFs to equal

4) factor.

- CF\_LOOPS = Number of positions in the profile correction data array

(cf\_tm\_stmp[]) remaining to be filled.

- CF\_PERIOD\_1 = Pip period 1 in profile correction que of periods.

- CF\_PERIOD\_2 = Pip period 2 in profile correction que of periods.

- CF\_PERIOD\_3 = Pip period 3 in profile correction que of periods.

- CF\_PERIOD\_4 = Pip period 4 in profile correction que of periods.

- CF\_PERIOD\_5 = Pip period 5 in profile correction que of periods.

- CF\_PERIOD\_6 = Pip period 6 in profile correction que of periods.

- CF\_PERIOD\_7 = Pip period 7 in profile correction que of periods.

- CFSYNCCTRFG = Saved value of sync\_ctr in profile correction foreground

- CF\_SYNC\_CTR = Value of SYNC\_CTR the last time data was entered into the

profile correction factor array.

- CF\_SKIP\_CNT = A counter to count the number of events of CFx\_NEW values

used in calculating CFx\_AV (before CFx\_AV is used to compare with CFx).

This reset to zero after CF\_SKIP\_MIN counts. If feature of averaging

CFx\_AV values before comparing with CF needs to be turned off, a value of

zero should be written to CF\_SKIP\_MIN.

- CF1 = Filtered correction factor for profile 1, stored in KAM.

- CF2 = Filtered correction factor for profile 2, stored in KAM.

- CF3 = Filtered correction factor for profile 3, stored in KAM.

- CF4 = Filtered correction factor for profile 4, stored in KAM.

- CF1\_AV = Rolling average value of CF1\_NEW. Initialize to CF1.

- CF2\_AV = Rolling average value of CF2\_NEW. Initialize to CF2.

- CF3\_AV = Rolling average value of CF3\_NEW. Initialize to CF3.

- CF4\_AV = Rolling average value of CF4\_NEW. Initialize to CF4.

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CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- CF1\_NEW = Corrected new value of profile 1 correction factor.

- CF2\_NEW = Corrected new value of profile 2 correction factor.

- CF3\_NEW = Corrected new value of profile 3 correction factor.

- CF4\_NEW = Corrected new value of profile 4 correction factor.

- CF1\_NEW\_RAW = New raw value of profile 1 correction factor.

- CF2\_NEW\_RAW = New raw value of profile 2 correction factor.

- CF3\_NEW\_RAW = New raw value of profile 3 correction factor.

- CF4\_NEW\_RAW = New raw value of profile 4 correction factor.

- LOAD = Universal LOAD as ratio of air charge over standard.

- N = RPM.

- NOISE\_COUNT = When non-zero no assessment of misfire is made.

- PIPTSTFIL = Pip circuit failure fault filter.

- PIP\_DWN\_DEL = AICE period as read by the EEC, AICE ticks.

- PROFILE = Most recent profile of the ENGCYL profiles that will have

correction factors calculated.

- PIP\_EVNT\_CTR = Incremented every PIP event. It is reset to zero if DFSO

mode is off.

- SYNC\_CTR = Sequence counter incremented every PIP rising edge that is

used to indentify the cycle and position.

- TOTMISFIL = Rolling average filter for misfire events.

- TQ\_BRAKE\_S = Actual net torque produced by engine.

- VSBAR = Filtered vehicle speed.

Bit Flags:

- CF\_DFSO = When equal to 1, enables profile correction to learn correction

factors in a decel\_fuel\_shut\_off mode. This flag is set in the

background logic after counting (pip\_evnt\_ctr) a calibratable number of

pip events (pip\_evnt\_max) in DFSO. It is cleared when DFSO mode is off.

- CF\_FC\_FLG = Flag indicating continued use of slow filter constant; 1 ->

using slow filter.

- CF\_KAM\_MTR = When equal to 1, indicates that the KAM contains matured

- CF\_MTR\_FLG = When equal to 1, indicates that CFs are mature and no

further learning is required.

- CF\_RDY = When equal to 1 it allows update of profile correction factors.

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CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- KAM\_ERROR = Indicates Keep Alive RAM is invalid.

| - MISFDELTAERR = Misfire Comm. error indicator.

- NEW\_CF\_DATA = Indicates to bg profile logic that fg has updated data

array since last bg.

- PIP\_HIGH = PIP input level.

- V\_SYNCFLG = VIP indicator, 1 -> engine in sync.

Calibration Constants:

- AICE\_SETR1\_B(bit 3) = AICE setup register "B" value.

- CF\_DFSO\_IGNR = If set, enables learning of profile CFs regardless of the

state of DFSO mode. If clear, enables learning of profile CFs in DFSO

mode only.

- CF\_DLY\_MIN = Number of events CFx\_AV values be averaged the very first

after power-up before comparing these values with CFx values.

- CF\_ENA = Switch to turn on adaptive profile correction; 1 -> on.

- CF\_FK = Filter constant for "averaging" of profile CFs in continuous

mode.

- CF\_FK\_FAST = Fast filter constant for "averaging" of profile correction

factors, events.

- CF\_FK\_SLOW = Slow filter constant for "averaging" of profile correction

factors, events.

- CF\_FAST\_THRS = The threshold value of |CFx - CFx\_AV|, above which the CFs

will be learned faster and below this value Cfs will be learned slower.

- CF\_FK = Filter constant for "averaging" of profile correction factors,

events.

- CF1\_INIT = Initial value of profile correction factor 1.

- CF2\_INIT = Initial value of profile correction factor 2.

- CF3\_INIT = Initial value of profile correction factor 3.

- CF4\_INIT = Initial value of profile correction factor 4.

- CF\_LOAD\_MAX = Max load for profile correction factor updates.

- CF\_LOAD\_MIN = Min load for profile correction factor update.

| - CF\_LOCK\_SW = Switch which when set to 1 locks out profile coefficient

| updates once the profile KAM mature (CF\_KAM\_MTR) flag is set. This

| option should be selected if learning coefficients under fueled

| conditions. This option should not be selected if learning coefficients

| in DFSO.

35-94

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- CFMAX = Maximum allowed profile correction factor value.

- CFMIN = Minimum allowed profile correction factor value.

- CF\_MTR\_IGNR = If set, enables learning of profile CFs all the time. If

clear, stops learning of profile CFs after they are mature.

- CF\_N\_MAX = Max RPM for profile correction factor update.

- CF\_N\_MIN = Min RPM for profile correction factor update.

- CF\_SLOW\_THRS = The threshold value of |CFx - CFx\_AV| below which the CFs

are considered mature. If the result of |CFx - CFx\_AV| is greater than

CF\_SLOW\_THRS and less than CF\_FAST\_THRS, the CFs will be learned at a

slower rate.

- CF\_SKIP\_MIN = Number of events CFx\_AV values be averaged before comparing

these values with CFx values. Note: This logic is executed every PIP

event as opposed to CF\_DLY\_MIN, which only runs the very first time after

power-up.

- CF\_VSBARMAX = Max. speed for profile correction factor updates.

- CF\_VSBARMIN = Min. speed for profile correction factor update.

- CF\_MAX\_TQ = Max net torque for profile correction update, ft/lb.

- CF\_MIN\_TQ = Min net torque for profile correction factor update, ft/lb.

- ENGCYL = Number of PIP'S per engine revolution; 2 -> 4 cylinder engine (2

PIP/rev) 3 -> 6 cylinder engine (3 PIP/rev) 4 -> 8 cylinder engine (4

PIP/rev).

- NORMALIZE\_CF = When equal to 1, causes correction factors to be forced to

sum to ENGCYL, otherwise CF's are taken array.

- NOISE\_IGNR = If set, enables learning of profile CFs under noisy

conditions. If clear, stops learning of profile CFs until noise

disappears.

- PIP\_EVNT\_MAX = When in DFSO, number of PIP events to wait before learning

(i.e., CF\_DFSO = 1) profile CFs.

| - TOTMIS\_THRS = Number of TOTMIS events above which CF updates will be

| disabled.

35-95

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VC\_PROFILE\_COM7

BEGIN: PROFILE CORRECTION FACTOR PIP UP LOGIC

(performed during the pip up processing)

PIP\_EVNT\_CTR := PIP\_EVNT\_CTR + 1

END: PROFILE CORRECTION FACTOR PIP UP LOGIC

BEGIN: PROFILE\_RAM\_INIT

In RAM init proc initialize the following parameters as shown below:

unconditionally ------------------------| CF\_RDY := 0

| CF\_DFSO := 0

| CF\_FDGE\_FCTR := 0

| NEW\_CF\_DATA := 0

| CF\_SYNC\_CTR := 0

| CFSYNCCTRFG := 0

| PROFILE := 0

| PIP\_EVNT\_CTR := 0

| CF\_SKIP\_CNT := 0

| CF\_DLY\_CNT := CF\_SKIP\_MIN

| CF\_KAM\_MTRO := CF\_KAM\_MTR

| CF1\_AV := CF1

| CF2\_AV := CF2

| CF3\_AV := CF3

| CF4\_AV := CF4

| CF\_PERIOD\_1 .. CF\_PERIOD\_7 := 0

| ;set cf\_period\_1 thru cf\_period\_7

| ;to zero

| CF1\_NEW\_RAW .. CF4\_NEW\_RAW := 0

| ;set cf1\_new\_raw thru cf4\_new\_raw

| ;to zero

| CF\_FC\_FLG := 0

CF\_KAM\_MTR = 0 -------------------|

|AND -| CF\_FC := CF\_FK\_FAST

CF\_MTR\_IGNR = 0 ------------------| |

| --- ELSE ---

CF\_KAM\_MTR = 1 -------------------| |

|AND -| CF\_FC := CF\_FK\_SLOW

CF\_MTR\_IGNR = 0 ------------------| |

| --- ELSE ---

|

CF\_MTR\_IGNR = 1 ------------------------| CF\_FC := CF\_FK

35-96

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| ;

| ; If CF\_LOCK\_SW is set to 1, lock out profile coefficient updates

| ; if the coefficients are already mature. This option should be

| ; selected only if profile learning is calibrated to occur under

| ; fueled mode conditions.

| ;

| CF\_KAM\_MTR = 1 -------------------|

| |AND -| CF\_MTR\_FLG := 1

| CF\_LOCK\_SW = 1 -------------------| |

| | --- ELSE ---

| |

| | CF\_MTR\_FLG := 0

END: PROFILE\_RAM\_INIT

PROFILE CORRECTION FACTOR FOREGROUND LOGIC:

(This logic is executed during the PIP interrupt as directed by the

logic, with the following constraints:

- Execute this logic after PIP\_HIGH has been updated and before

PIP\_DWN\_DEL is updated.

- When executing on PIP up edges, execute this logic before SYNC\_CTR

is updated.)

CF\_MTR\_FLG = 1 -------------|

|AND -|

CF\_MTR\_IGNR = 0 ------------| |

(CFs are mature; no need to |OR --| EXIT FOREGROUND LOGIC

collect data in foreground) | |

| |

NEW\_CF\_DATA = 1 ------------------| |

(enough data is collected, stop |

until BG logic can process it) |

|

| --- ELSE ---

PIP\_HIGH = 0 ---------------------| |

| |

CF\_RDY = 1 -----------------------|AND -| NEW\_CF\_DATA := 1

| | (indicates to BG that new data is

CF\_LOOPS = 0 ---------------------| | available for calculating CFs)

| Do: SHIFT\_PERIODS

| CFSYNCCTRFG := SYNC\_CTR

| (current value of sync\_ctr is

| saved for BG use in associating

| CFs with appropriate profile)

|

| --- ELSE ---

PIP\_HIGH = 0 ---------------------| |

|AND -| Do: SHIFT\_PERIODS

CF\_RDY = 1 -----------------------| | CF\_LOOPS := CF\_LOOPS - 1

| (data array is filling)

35-97

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: SHIFT\_PERIODS

Collect the current period, shifting the data registers

and discarding the oldest value.

ENGCYL = 4 -----------------------------| CF\_PERIOD\_7 := CF\_PERIOD\_6

| CF\_PERIOD\_6 := CF\_PERIOD\_5

| CF\_PERIOD\_5 := CF\_PERIOD\_4

| CF\_PERIOD\_4 := CF\_PERIOD\_3

| CF\_PERIOD\_3 := CF\_PERIOD\_2

| CF\_PERIOD\_2 := CF\_PERIOD\_1

| CF\_PERIOD\_1 := PIP\_DWN\_DEL

|

| --- ELSE ---

|

ENGCYL = 3 -----------------------------| CF\_PERIOD\_5 := CF\_PERIOD\_4

| CF\_PERIOD\_4 := CF\_PERIOD\_3

| CF\_PERIOD\_3 := CF\_PERIOD\_2

| CF\_PERIOD\_2 := CF\_PERIOD\_1

| CF\_PERIOD\_1 := PIP\_DWN\_DEL

|

| --- ELSE ---

|

ENGCYL = 2 -----------------------------| CF\_PERIOD\_3 := CF\_PERIOD\_2

| CF\_PERIOD\_2 := CF\_PERIOD\_1

| CF\_PERIOD\_1 := PIP\_DWN\_DEL

END: SHIFT\_PERIODS

; End PIP UP interrupt (foreground) processing

35-98

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROFILE CORRECTION FACTOR BACKGROUND LOGIC:

KAM\_ERROR = 0 --------------------|

(no kam reset) |AND -| Do: CHECK\_DFSO\_STATUS

| | Do: CHECK\_CONDITIONS

CF\_ENA = 1 -----------------------| | (determine if conditions are

(adaptive profile correction | valid for calculating CFs)

is turned on) |

| Do: RUN\_PROFILE\_CF\_BG

|

| --- ELSE ---

|

| (adaptive correction factor

| generation has been cal'd out or

| a KAM reset has occurred.

| Correction factor registers will

| contain the initial calibration

| values of the correction factors.

|

| CF1 := CF1\_INIT

| CF2 := CF2\_INIT

| CF3 := CF3\_INIT

| CF4 := CF4\_INIT

| CF\_KAM\_MTR := 0

| Do: PROFILE\_RAM\_INIT

35-99

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CHECK\_DFSO\_STATUS

DFSFLG = 0 ----------------------------| PIP\_EVNT\_CTR := 0

(not in dfso) | CF\_DFSO := 0

|

| -- ELSE ---

|

PIP\_EVNT\_CTR >= PIP\_EVNT\_MAX ----------| CF\_DFSO := 1

(in dfso)

END: CHECK\_DFSO\_STATUS

BEGIN: RUN\_PROFILE\_CF\_BG

When data has been updated by the foreground and conditions are present

to calculate correction factors, the correction factors will be updated.

NEW\_CF\_DATA = 1 ------------------|

(new, valid data |

available from FG) |AND -| Do: UPDATE\_CFs

| | CF\_LOOPS := NUMCYL - 1

CF\_RDY = 1 -----------------------| | NEW\_CF\_DATA := 0

(conditions to calculate |

accurate CFs present) |

| --- ELSE ---

|

CF\_RDY = 0 -----------------------------| CF\_LOOPS := NUMCYL - 1

| NEW\_CF\_DATA := 0

END: RUN\_PROFILE\_CF\_BG

35-100

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CHECK\_CONDITIONS

The following conditions must be true before accurate CFs can be

calculated.

MIS\_TST\_RDY = 1 ------------|

(misfire ready) |OR --|

| |

CF\_DFSO\_IGNR = 0 -----------| |

(dfso mode cal'd in) |

|

TOTMISFIL < TOTMIS\_THRS ----------|

(acceptable misfire rolav) |

|

MISFDELTAERR = 0 -----------------|

(no AICE errors indicated) |

|

CF\_DFSO = 1 ----------------| |

|OR --|

CF\_DFSO\_IGNR = 1 -----------| |

(cf learning under |

dfso not required) |

|

V\_SYNCFLG = 1 --------------------|

(in sync) |AND -| CF\_RDY := 1

| | (conditions indicate that

LOAD <= CF\_LOAD\_MAX --------------| | accurate CFs can be calculated)

| |

LOAD >= CF\_LOAD\_MIN --------------| |

| |

N <= CF\_N\_MAX --------------------| |

| |

N >= CF\_N\_MIN --------------------| |

| |

TQ\_BRAKE\_S <= CF\_MAX\_TQ ----------| |

| |

TQ\_BRAKE\_S >= CF\_MIN\_TQ ----------| |

| |

NOISE\_COUNT = 0 ------------| | |

|OR --| |

NOISE\_IGNR = 1 -------------| | |

(noise check cal'd out) | |

| |

CF\_MTR\_FLG = 0 -------------| | |

(cfs are not mature | | |

cont. learning) |OR --| |

| | |

CF\_MTR\_IGNR = 1 ------------| | |

(always learn cfs) | |

| |

VSBAR <= CF\_VSBARMAX -------------| |

| |

VSBAR >= CF\_VSBARMIN -------------| |

| --- ELSE ---

|

| CF\_RDY := 0

END: CHECK\_CONDITIONS

35-101

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: UPDATE\_CFs

AICE\_SETR1\_B(bit 3) = 1 -----------| CF\_SYNC\_CTR := CFSYNCCTRFG - 1

;using front mfds or pip sensor | ; profile for first CF to be

| ; calculated is one cylinder event

| ; previous from the cylinder event

| ; that data was last gathered

|

| --- ELSE ---

|

| CF\_SYNC\_CTR := CFSYNCCTRFG - 2

| ; profile for first CF to be calculated

| ; is one cylinder event previous from

| ; the cylinder event that data was last

| ; back gathered and an additional

| ; period due to the period read for

| ; the previous sync\_ctr value

ENGCYL = 4 -----------------------------| Do: ADJUST\_CF\_SYNC\_CTR

| (maintain valid range of sync\_ctr)

| Do: DETERMINE\_8CYL\_PROFILE

| (determine first profile

| represented in data set)

| Do: CALC\_NEW\_8CYL\_CFs

| (calculate CFs from current set

| of data)

| Do: CALC\_NEW\_8CYL\_CF\_AV

|

| --- ELSE ---

|

ENGCYL = 3 -----------------------------| Do: ADJUST\_CF\_SYNC\_CTR

| (maintain valid range of sync\_ctr)

| Do: DETERMINE\_6CYL\_PROFILE

| (determine first profile

| represented in data set)

| Do: CALC\_NEW\_6CYL\_CFs

| (calculate CFs from current set

| of data)

| Do: CALC\_NEW\_6CYL\_CF\_AV

|

| --- ELSE ---

|

ENGCYL = 2 -----------------------------| Do: ADJUST\_CF\_SYNC\_CTR

| (maintain valid range of sync\_ctr)

| Do: DETERMINE\_4CYL\_PROFILE

| (determine first profile

| represented in data set)

| Do: CALC\_NEW\_4CYL\_CFs

| (calculate CFs from current set

| of data)

| Do: CALC\_NEW\_4CYL\_CF\_AV

END: UPDATE\_CFs

35-102

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ADJUST\_CF\_SYNC\_CTR

CF\_SYNC\_CTR < 0 ------------------------| CF\_SYNC\_CTR := CF\_SYNC\_CTR + NUMCYL

END: ADJUST\_CF\_SYNC\_CTR

BEGIN: DETERMINE\_8CYL\_PROFILE

CF\_SYNC\_CTR = 3 ------------------|

|OR --| PROFILE := 4

CF\_SYNC\_CTR = 7 ------------------| |

| --- ELSE ---

CF\_SYNC\_CTR = 0 ------------------| |

|OR --| PROFILE := 1

CF\_SYNC\_CTR = 4 ------------------| |

| --- ELSE ---

CF\_SYNC\_CTR = 1 ------------------| |

|OR --| PROFILE := 2

CF\_SYNC\_CTR = 5 ------------------| |

| --- ELSE ---

CF\_SYNC\_CTR = 2 ------------------| |

|OR --| PROFILE := 3

CF\_SYNC\_CTR = 6 ------------------|

END: DETERMINE\_8CYL\_PROFILE

BEGIN: DETERMINE\_6CYL\_PROFILE

CF\_SYNC\_CTR = 3 ------------------|

|OR --| PROFILE := 1

CF\_SYNC\_CTR = 0 ------------------| |

| --- ELSE ---

CF\_SYNC\_CTR = 1 ------------------| |

|OR --| PROFILE := 2

CF\_SYNC\_CTR = 4 ------------------| |

| --- ELSE ---

CF\_SYNC\_CTR = 2 ------------------| |

|OR --| PROFILE := 3

CF\_SYNC\_CTR = 5 ------------------|

END: DETERMINE\_6CYL\_PROFILE

35-103

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: DETERMINE\_4CYL\_PROFILE

CF\_SYNC\_CTR = 1 ------------------|

|OR --| PROFILE := 2

CF\_SYNC\_CTR = 3 ------------------| |

| --- ELSE ---

CF\_SYNC\_CTR = 2 ------------------| |

|OR --| PROFILE := 1

CF\_SYNC\_CTR = 0 ------------------|

END: DETERMINE\_4CYL\_PROFILE

35-104

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CALC\_NEW\_8CYL\_CFs

Raw correction factors are calculated from the current data set (array of

periods). According to the assumptions and theory, the correction

factors should sum to ENGCYL. However, the constant velocity assumption may

be violated resulting in the CF's not summing to zero. This does not

substantially affect the validity of the raw correction factors. However for

consistency of the CF values, the CF's may be corrected to sum to zero if

the calibration parameter NORMALIZE\_CF = 1.

CALC\_8CYL\_CORRECTED\_FACTORS performs this adjustment for 8 cylinder engines.

PROFILE = 1 ----------------------------| CF1\_NEW\_RAW := (CF\_PERIOD\_2 /

| (CF\_PERIOD\_1 +

| CF\_PERIOD\_2 +

| CF\_PERIOD\_3 +

| CF\_PERIOD\_4)) \*

| ENGCYL

|

| CF4\_NEW\_RAW := (CF\_PERIOD\_3 /

| (CF\_PERIOD\_2 +

| CF\_PERIOD\_3 +

| CF\_PERIOD\_4 +

| CF\_PERIOD\_5)) \*

| ENGCYL

|

| CF3\_NEW\_RAW := (CF\_PERIOD\_4 /

| (CF\_PERIOD\_3 +

| CF\_PERIOD\_4 +

| CF\_PERIOD\_5 +

| CF\_PERIOD\_6)) \*

| ENGCYL

|

| CF2\_NEW\_RAW := (CF\_PERIOD\_5 /

| (CF\_PERIOD\_4 +

| CF\_PERIOD\_5 +

| CF\_PERIOD\_6 +

| CF\_PERIOD\_7)) \*

| ENGCYL

|

| Do: CALC\_8CYL\_CORRECTED\_FACTORS

|

| --- ELSE ---

(continued on next page)

35-105

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

PROFILE = 2 ----------------------------| CF2\_NEW\_RAW := (CF\_PERIOD\_2 /

| (CF\_PERIOD\_1 +

| CF\_PERIOD\_2 +

| CF\_PERIOD\_3 +

| CF\_PERIOD\_4)) \*

| ENGCYL

|

| CF1\_NEW\_RAW := (CF\_PERIOD\_3 /

| (CF\_PERIOD\_2 +

| CF\_PERIOD\_3 +

| CF\_PERIOD\_4 +

| CF\_PERIOD\_5)) \*

| ENGCYL

|

| CF4\_NEW\_RAW := (CF\_PERIOD\_4 /

| (CF\_PERIOD\_3 +

| CF\_PERIOD\_4 +

| CF\_PERIOD\_5 +

| CF\_PERIOD\_6)) \*

| ENGCYL

|

| CF3\_NEW\_RAW := (CF\_PERIOD\_5 /

| (CF\_PERIOD\_4 +

| CF\_PERIOD\_5 +

| CF\_PERIOD\_6 +

| CF\_PERIOD\_7)) \*

| ENGCYL

|

| Do: CALC\_8CYL\_CORRECTED\_FACTORS

|

| --- ELSE ---

(continued on next page)

35-106

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

PROFILE = 3 ----------------------------| CF3\_NEW\_RAW := (CF\_PERIOD\_2 /

| (CF\_PERIOD\_1 +

| CF\_PERIOD\_2 +

| CF\_PERIOD\_3 +

| CF\_PERIOD\_4)) \*

| ENGCYL

|

| CF2\_NEW\_RAW := (CF\_PERIOD\_3 /

| (CF\_PERIOD\_2 +

| CF\_PERIOD\_3 +

| CF\_PERIOD\_4 +

| CF\_PERIOD\_5)) \*

| ENGCYL

|

| CF1\_NEW\_RAW := (CF\_PERIOD\_4 /

| (CF\_PERIOD\_3 +

| CF\_PERIOD\_4 +

| CF\_PERIOD\_5 +

| CF\_PERIOD\_6)) \*

| ENGCYL

|

| CF4\_NEW\_RAW := (CF\_PERIOD\_5 /

| (CF\_PERIOD\_4 +

| CF\_PERIOD\_5 +

| CF\_PERIOD\_6 +

| CF\_PERIOD\_7)) \*

| ENGCYL

|

| Do: CALC\_8CYL\_CORRECTED\_FACTORS

|

| --- ELSE ---

(continued on next page)

35-107

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

PROFILE = 4 ----------------------------| CF4\_NEW\_RAW := (CF\_PERIOD\_2 /

| (CF\_PERIOD\_1 +

| CF\_PERIOD\_2 +

| CF\_PERIOD\_3 +

| CF\_PERIOD\_4)) \*

| ENGCYL

|

| CF3\_NEW\_RAW := (CF\_PERIOD\_3 /

| (CF\_PERIOD\_2 +

| CF\_PERIOD\_3 +

| CF\_PERIOD\_4 +

| CF\_PERIOD\_5)) \*

| ENGCYL

|

| CF2\_NEW\_RAW := (CF\_PERIOD\_4 /

| (CF\_PERIOD\_3 +

| CF\_PERIOD\_4 +

| CF\_PERIOD\_5 +

| CF\_PERIOD\_6)) \*

| ENGCYL

|

| CF1\_NEW\_RAW := (CF\_PERIOD\_5 /

| (CF\_PERIOD\_4 +

| CF\_PERIOD\_5 +

| CF\_PERIOD\_6 +

| CF\_PERIOD\_7)) \*

| ENGCYL

|

| Do: CALC\_8CYL\_CORRECTED\_FACTORS

END: CALC\_NEW\_8CYL\_CFs

35-108

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CALC\_8CYL\_CORRECTED\_FACTORS

CF\_FDGE\_FCTR := ENGCYL / (CF1\_NEW\_RAW + CF2\_NEW\_RAW +

CF3\_NEW\_RAW + CF4\_NEW\_RAW)

NORMALIZE\_CF = 1 -----------------------| CF1\_NEW := CF1\_NEW\_RAW \*

| CF\_FDGE\_FCTR

| CF2\_NEW := CF2\_NEW\_RAW \*

| CF\_FDGE\_FCTR

| CF3\_NEW := CF3\_NEW\_RAW \*

| CF\_FDGE\_FCTR

| CF4\_NEW := CF4\_NEW\_RAW \*

| CF\_FDGE\_FCTR

|

| --- ELSE ---

|

| CF1\_NEW := CF1\_NEW\_RAW

| CF2\_NEW := CF2\_NEW\_RAW

| CF3\_NEW := CF3\_NEW\_RAW

| CF4\_NEW := CF4\_NEW\_RAW

END: CALC\_8CYL\_CORRECTED\_FACTORS

BEGIN: CALC\_NEW\_8CYL\_CF\_AV

CF\_MTR\_IGNR = 1 ------------------------| Do: USE\_CF\_NEW\_TO\_CALC\_CFs

| Do: MODIFY\_8CYL\_CF\_FILTERS

|

| --- ELSE ----

CF\_MTR\_IGNR = 0 ------------------| |

|AND -| Do: CALC\_ENGCYL\_CF\_AV

| CF\_DLY\_CNT =< CF\_DLY\_MIN ---------| | CF\_DLY\_CNT := CF\_DLY\_CNT + 1

|

| --- ELSE ---

CF\_MTR\_IGNR = 0 ------------------| |

|AND -| Do: CALC\_ENGCYL\_CF\_AV

| CF\_SKIP\_CNT =< CF\_SKIP\_MIN -------| | CF\_SKIP\_CNT := CF\_SKIP\_CNT + 1

|

| --- ELSE ---

|

| CF\_SKIP\_CNT := 0

| Do: CHK\_KAM\_FOR\_8CYL\_FK

| Do: CALC\_ENGCYL\_CF\_AV

| Do: DETERMINE\_8CYL\_CF\_MATURITY

END: CALC\_NEW\_8CYL\_CF\_AV

35-109

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CALC\_ENGCYL\_CF\_AV

ENGCYL = 4 ------------------------| CF1\_AV :=

| CF1\_AV + CF\_FC \* (CF1\_NEW - CF1\_AV)

| CF2\_AV :=

| CF2\_AV + CF\_FC \* (CF2\_NEW - CF2\_AV)

| CF3\_AV :=

| CF3\_AV + CF\_FC \* (CF3\_NEW - CF3\_AV)

| CF4\_AV :=

| CF4\_AV + CF\_FC \* (CF4\_NEW - CF4\_AV)

|

| --- ELSE ---

|

ENGCYL = 3 ------------------------| CF1\_AV :=

| CF1\_AV + CF\_FC \* (CF1\_NEW - CF1\_AV)

| CF2\_AV :=

| CF2\_AV + CF\_FC \* (CF2\_NEW - CF2\_AV)

| CF3\_AV :=

| CF3\_AV + CF\_FC \* (CF3\_NEW - CF3\_AV)

|

| --- ELSE ---

|

ENGCYL = 2 ------------------------| CF1\_AV :=

| CF1\_AV + CF\_FC \* (CF1\_NEW - CF1\_AV)

| CF2\_AV :=

| CF2\_AV + CF\_FC \* (CF2\_NEW - CF2\_AV)

END: CALC\_ENGCYL\_CF\_AV

35-110

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CALC\_NEW\_6CYL\_CFs

Raw correction factors are calculated from the current data set (array of

periods). According to the assumptions and theory, the correction

factors should sum to ENGCYL. However, the constant velocity assumption may

be violated resulting in the CF's not summing to zero. This does not

substantially affect the validity of the raw correction factors. However for

consistency of the CF values, the CF's may be corrected to sum to zero if

the calibration parameter NORMALIZE\_CF = 1.

CALC\_6CYL\_CORRECTED\_FACTORS performs this adjustment for 6 cylinder engines.

PROFILE = 1 ----------------------------| CF1\_NEW\_RAW := (CF\_PERIOD\_2 /

| (CF\_PERIOD\_1 +

| CF\_PERIOD\_2 +

| CF\_PERIOD\_3)) \*

| ENGCYL

|

| CF3\_NEW\_RAW := (CF\_PERIOD\_3 /

| (CF\_PERIOD\_2 +

| CF\_PERIOD\_3 +

| CF\_PERIOD\_4)) \*

| ENGCYL

|

| CF2\_NEW\_RAW := (CF\_PERIOD\_4 /

| (CF\_PERIOD\_3 +

| CF\_PERIOD\_4 +

| CF\_PERIOD\_5)) \*

| ENGCYL

|

| Do: CALC\_6CYL\_CORRECTED\_FACTORS

|

| --- ELSE ---

|

PROFILE = 2 ----------------------------| CF2\_NEW\_RAW := (CF\_PERIOD\_2 /

| (CF\_PERIOD\_1 +

| CF\_PERIOD\_2 +

| CF\_PERIOD\_3)) \*

| ENGCYL

|

| CF1\_NEW\_RAW := (CF\_PERIOD\_3 /

| (CF\_PERIOD\_2 +

| CF\_PERIOD\_3 +

| CF\_PERIOD\_4)) \*

| ENGCYL

|

| CF3\_NEW\_RAW := (CF\_PERIOD\_4 /

| (CF\_PERIOD\_3 +

| CF\_PERIOD\_4 +

| CF\_PERIOD\_5)) \*

| ENGCYL

|

| Do: CALC\_6CYL\_CORRECTED\_FACTORS

|

| --- ELSE ---

(continued on next page)

35-111

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

PROFILE = 3 ----------------------------| CF3\_NEW\_RAW := (CF\_PERIOD\_2 /

| (CF\_PERIOD\_1 +

| CF\_PERIOD\_2 +

| CF\_PERIOD\_3)) \*

| ENGCYL

|

| CF2\_NEW\_RAW := (CF\_PERIOD\_3 /

| (CF\_PERIOD\_2 +

| CF\_PERIOD\_3 +

| CF\_PERIOD\_4)) \*

| ENGCYL

|

| CF1\_NEW\_RAW := (CF\_PERIOD\_4 /

| (CF\_PERIOD\_3 +

| CF\_PERIOD\_4 +

| CF\_PERIOD\_5)) \*

| ENGCYL

|

| Do: CALC\_6CYL\_CORRECTED\_FACTORS

END: CALC\_NEW\_6CYL\_CFs

35-112

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CALC\_6CYL\_CORRECTED\_FACTORS

CF\_FDGE\_FCTR := ENGCYL / (CF1\_NEW\_RAW + CF2\_NEW\_RAW +

CF3\_NEW\_RAW)

NORMALIZE\_CF = 1 -----------------------| CF1\_NEW := CF1\_NEW\_RAW \*

| CF\_FDGE\_FCTR

| CF2\_NEW := CF2\_NEW\_RAW \*

| CF\_FDGE\_FCTR

| CF3\_NEW := CF3\_NEW\_RAW \*

| CF\_FDGE\_FCTR

|

| --- ELSE ---

|

| CF1\_NEW := CF1\_NEW\_RAW

| CF2\_NEW := CF2\_NEW\_RAW

| CF3\_NEW := CF3\_NEW\_RAW

END: CALC\_6CYL\_CORRECTED\_FACTORS

BEGIN: CALC\_NEW\_6CYL\_CF\_AV

CF\_MTR\_IGNR = 1 -----------------------| Do: USE\_CF\_NEW\_TO\_CALC\_CFs

| Do: MODIFY\_6CYL\_CF\_FILTERS

|

| --- ELSE ----

CF\_MTR\_IGNR = 0 -----------------| |

|AND -| Do: CALC\_ENGCYL\_CF\_AV

| CF\_DLY\_CNT =< CF\_DLY\_MIN --------| | CF\_DLY\_CNT := CF\_DLY\_CNT + 1

|

| --- ELSE ---

CF\_MTR\_IGNR = 0 -----------------| |

|AND -| Do: CALC\_ENGCYL\_CF\_AV

| CF\_SKIP\_CNT =< CF\_SKIP\_MIN ------| | CF\_SKIP\_CNT := CF\_SKIP\_CNT + 1

|

| --- ELSE ---

|

| CF\_SKIP\_CNT := 0

| Do: CHK\_KAM\_FOR\_6CYL\_FK

| Do: CALC\_ENGCYL\_CF\_AV

| Do: DETERMINE\_6CYL\_CF\_MATURITY

END: CALC\_NEW\_6CYL\_CF\_AV

35-113

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CALC\_NEW\_4CYL\_CFs

Raw correction factors are calculated from the current data set (array of

periods). According to the assumptions and theory, the correction

factors should sum to ENGCYL. However, the constant velocity assumption may

be violated resulting in the CF's not summing to zero. This does not

substantially affect the validity of the raw correction factors. However for

consistency of the CF values, the CF's may be corrected to sum to zero if

the calibration parameter NORMALIZE\_CF = 1.

CALC\_4CYL\_CORRECTED\_FACTORS performs this adjustment for 4 cylinder engines.

PROFILE = 1 ----------------------------| CF1\_NEW\_RAW := (CF\_PERIOD\_2 /

| (CF\_PERIOD\_1 +

| CF\_PERIOD\_2)) \*

| ENGCYL

|

| CF2\_NEW\_RAW := (CF\_PERIOD\_3 /

| (CF\_PERIOD\_2 +

| CF\_PERIOD\_3)) \*

| ENGCYL

|

| Do: CALC\_4CYL\_CORRECTED\_FACTORS

|

| --- ELSE ---

|

PROFILE = 2 ----------------------------| CF2\_NEW\_RAW := (CF\_PERIOD\_2 /

| (CF\_PERIOD\_1 +

| CF\_PERIOD\_2)) \*

| ENGCYL

|

| CF1\_NEW\_RAW := (CF\_PERIOD\_3 /

| (CF\_PERIOD\_2 +

| CF\_PERIOD\_3)) \*

| ENGCYL

|

| Do: CALC\_4CYL\_CORRECTED\_FACTORS

END: CALC\_NEW\_4CYL\_CFs

35-114

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CALC\_4CYL\_CORRECTED\_FACTORS

CF\_FDGE\_FCTR := ENGCYL / (CF1\_NEW\_RAW + CF2\_NEW\_RAW)

NORMALIZE\_CF = 1 -----------------------| CF1\_NEW := CF1\_NEW\_RAW \*

| CF\_FDGE\_FCTR

| CF2\_NEW := CF2\_NEW\_RAW \*

| CF\_FDGE\_FCTR

|

| --- ELSE ---

|

| CF1\_NEW := CF1\_NEW\_RAW

| CF2\_NEW := CF2\_NEW\_RAW

END: CALC\_4CYL\_CORRECTED\_FACTORS

BEGIN: CALC\_NEW\_4CYL\_CF\_AV

CF\_MTR\_IGNR = 1 ------------------------| Do: USE\_CF\_NEW\_TO\_CALC\_CFs

| Do: MODIFY\_4CYL\_CF\_FILTERS

|

| --- ELSE ----

CF\_MTR\_IGNR = 0 ------------------| |

|AND -| Do: CALC\_ENGCYL\_CF\_AV

| CF\_DLY\_CNT =< CF\_DLY\_MIN ---------| | CF\_DLY\_CNT := CF\_DLY\_CNT + 1

|

| --- ELSE ----

CF\_MTR\_IGNR = 0 ------------------| |

|AND -| Do: CALC\_ENGCYL\_CF\_AV

| CF\_SKIP\_CNT =< CF\_SKIP\_MIN -------| | CF\_SKIP\_CNT := CF\_SKIP\_CNT + 1

|

| --- ELSE ---

|

| CF\_SKIP\_CNT := 0

| Do: CHK\_KAM\_FOR\_4CYL\_FK

| Do: CALC\_ENGCYL\_CF\_AV

| Do: DETERMINE\_4CYL\_CF\_MATURITY

END: CALC\_NEW\_4CYL\_CF\_AV

35-115

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: DETERMINE\_8CYL\_CF\_MATURITY

|CF1\_AV - CF1| < CF\_SLOW\_THRS -----|

|

|CF2\_AV - CF2| < CF\_SLOW\_THRS -----|

|AND -| CF\_MTR\_FLG := 1

|CF3\_AV - CF3| < CF\_SLOW\_THRS -----| | (cfs are mature; don't need any

| | further learning)

|CF4\_AV - CF4| < CF\_SLOW\_THRS -----| | CF\_KAM\_MTR := 1

(compare old cfs with new cfs) |

| --- ELSE ---

|

| CF\_MTR\_FLG := 0

| Do: USE\_CF\_AV\_TO\_CALC\_CFs

| Do: MODIFY\_8CYL\_CF\_FILTERS

| (cfs are not mature

| continue learning)

END: DETERMINE\_8CYL\_CF\_MATURITY

BEGIN: DETERMINE\_6CYL\_CF\_MATURITY

|CF1\_AV - CF1| < CF\_SLOW\_THRS -----|

|

|CF2\_AV - CF2| < CF\_SLOW\_THRS -----|AND -| CF\_MTR\_FLG := 1

| | (cfs are mature; don't need any

|CF3\_AV - CF3| < CF\_SLOW\_THRS -----| | further learning)

(compare old cfs with new cfs) | CF\_KAM\_MTR := 1

|

| --- ELSE ---

|

| CF\_MTR\_FLG := 0

| Do: USE\_CF\_AV\_TO\_CALC\_CFs

| Do: MODIFY\_6CYL\_CF\_FILTERS

| (cfs are not mature

| continue learning)

END: DETERMINE\_6CYL\_CF\_MATURITY

35-116

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: DETERMINE\_4CYL\_CF\_MATURITY

|CF1\_AV - CF1| < CF\_SLOW\_THRS -----|

|AND -| CF\_MTR\_FLG := 1

|CF2\_AV - CF2| < CF\_SLOW\_THRS -----| | (cfs are mature; don't need any

(compare old cfs with new cfs) | further learning)

| CF\_KAM\_MTR := 1

|

| --- ELSE ---

|

| CF\_MTR\_FLG := 0

| Do: USE\_CF\_AV\_TO\_CALC\_CFs

| Do: MODIFY\_4CYL\_CF\_FILTERS

| (cfs are not mature

| continue learning)

END: DETERMINE\_4CYL\_CF\_MATURITY

35-117

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CHK\_KAM\_FOR\_8CYL\_FK

CF\_KAM\_MTR = 1 -----------------------|

|

CF\_FC\_FLG = 1 ------------------------|

(slow filter used previously) |

|OR --| CF\_FC := CF\_FK\_SLOW

|CF1 - CF1\_AV| =< CF\_FAST\_THRS -| | |

| | | CF\_FC\_FLG := 1

|CF2 - CF2\_AV| =< CF\_FAST\_THRS -| | | (once slow filter is in

|AND -| | use, continue to use it)

|CF3 - CF3\_AV| =< CF\_FAST\_THRS -| |

| |

|CF4 - CF4\_AV| =< CF\_FAST\_THRS -| |

|

|

|

|

|

| --- ELSE ---

|

|

|

| CF\_FC := CF\_FK\_FAST

END: CHK\_KAM\_FOR\_8CYL\_FK

BEGIN: CHK\_KAM\_FOR\_6CYL\_FK

CF\_KAM\_MTR = 1 -----------------------|

|

CF\_FC\_FLG = 1 ------------------------|

(slow filter used previously) |OR --| CF\_FC := CF\_FK\_SLOW

| |

|CF1 - CF1\_AV| =< CF\_FAST\_THRS -| | | CF\_FC\_FLG := 1

| | | (once slow filter is in

|CF2 - CF2\_AV| =< CF\_FAST\_THRS -|AND -| | use, continue to use it)

| |

|CF3 - CF3\_AV| =< CF\_FAST\_THRS -| |

|

| --- ELSE ---

|

|

| CF\_FC := CF\_FK\_FAST

END: CHK\_KAM\_FOR\_6CYL\_FK

35-118

CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CHK\_KAM\_FOR\_4CYL\_FK

CF\_KAM\_MTR = 1 -----------------------|

|

CF\_FC\_FLG = 1 ------------------------|

(slow filter used previously) |OR --| CF\_FC := CF\_FK\_SLOW

| |

|CF1 - CF1\_AV| =< CF\_FAST\_THRS -| | | CF\_FC\_FLG := 1

|AND -| | (once slow filter is in

|CF2 - CF2\_AV| =< CF\_FAST\_THRS -| | use, continue to use it)

|

|

| --- ELSE ---

|

| CF\_FC := CF\_FK\_FAST

END: CHK\_KAM\_FOR\_4CYL\_FK

BEGIN: USE\_CF\_NEW\_TO\_CALC\_CFs

cf1\_new := CF1\_NEW

cf2\_new := CF2\_NEW

cf3\_new := CF3\_NEW

cf4\_new := CF4\_NEW

CF\_FC := CF\_FK

END: USE\_CF\_NEW\_TO\_CALC\_CFs

BEGIN: USE\_CF\_AV\_TO\_CALC\_CFs

cf1\_new := CF1\_AV

cf2\_new := CF2\_AV

cf3\_new := CF3\_AV

cf4\_new := CF4\_AV

END: USE\_CF\_AV\_TO\_CALC\_CFs

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CONTINUOUS SELF TEST, PROFILE CORRECTION LOGIC - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: MODIFY\_8CYL\_CF\_FILTERS

cf1\_new >= CFMIN -----------------|

|

cf1\_new <= CFMAX -----------------|

|

cf2\_new >= CFMIN ----------------|

|

cf2\_new <= CFMAX ----------------|

|AND -| CF1 := CF1 + CF\_FC\*(cf1\_new - CF1)

cf3\_new >= CFMIN ----------------| |

| | CF2 := CF2 + CF\_FC\*(cf2\_new - CF2)

cf3\_new <= CFMAX ----------------| |

| | CF3 := CF3 + CF\_FC\*(cf3\_new - CF3)

cf4\_new >= CFMIN ----------------| |

| | CF4 := CF4 + CF\_FC\*(cf4\_new - CF4)

cf4\_new <= CFMAX ----------------|

END: MODIFY\_8CYL\_CF\_FILTERS

BEGIN: MODIFY\_6CYL\_CF\_FILTERS

cf1\_new >= CFMIN ----------------|

|

cf1\_new <= CFMAX ----------------|

|

cf2\_new >= CFMIN ----------------|

|AND -| CF1 := CF1 + CF\_FC\*(cf1\_new - CF1)

cf2\_new <= CFMAX ----------------| |

| | CF2 := CF2 + CF\_FC\*(cf2\_new - CF2)

cf3\_new >= CFMIN ----------------| |

| | CF3 := CF3 + CF\_FC\*(cf3\_new - CF3)

cf3\_new <= CFMAX ----------------|

END: MODIFY\_6CYL\_CF\_FILTERS

BEGIN: MODIFY\_4CYL\_CF\_FILTERS

cf1\_new >= CFMIN ----------------|

|

cf1\_new <= CFMAX ----------------|

|AND -| CF1 := CF1 + CF\_FC\*(cf1\_new - CF1)

cf2\_new >= CFMIN ----------------| |

| | CF2 := CF2 + CF\_FC\*(cf2\_new - CF2)

cf2\_new <= CFMAX ----------------|

END: MODIFY\_4CYL\_CF\_FILTERS

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CHAPTER 36

ROM IDENTIFICATION CODE

36-1

ROM IDENTIFICATION CODE - CDAN2

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

36.1 ROM IDENTIFICATION CODE (CDAA0)

ROM identification codes are used by both IC and module suppliers. The IC

suppliers require a means of identifying ROM chip contents quickly since they

produce different calibration bit patterns on the same wafer. The module

suppliers utilize these codes to insure that the ROM/module combination is

correct.

In the past, the ROM identification codes (CALID and VERID) were generated by

hand. They were then distributed to Engine Systems to put in their

calibrations for Cert. If any change to the Cert calibration was made or a

different strategy used, new values had to be generated and calibrated in.

For 1988 and beyond, the procedure has been changed to make this process

easier. The new process removes CALID and replaces it with ROM\_TO. In

addition, VERID has been deleted and a new parameter "FIXSUM" has been added.

FIXSUM should always be set to 0. Specifically:

1. The non-modifiable Vector parameter "ROM\_TO" replaces the old CALID

parameter as the ROM chip identifier. The ROM\_TO value is generated by

Vector during a calibration release and is located at 200A HEX. This

value is the complement of the ROM pattern CHECKSUM and is also used to

perform the EEC-IV diagnostic "CHECKSUM Memory Test".

2. The new parameter "FIXSUM" is a Vector calibration parameter located at

2004 HEX and should always be set to 0. This parameter will be used to

assure the ROM\_TO values are unique and will only be changed by the SWDV

engineer if a duplicate ROM\_TO value is found.

ROM IDENTIFICATION CODE PROCEDURES

1. PEDD SW will set the value of the calibration parameter FIXSUM to 0 in

the base release.

2. When Engine Systems releases a CERT calibration, the ROM chip ID code,

ROM\_TO, will be automatically generated by VECTOR, and the value is to be

recorded on the calibration release sheet submitted to SWDV.

3. PEDD SWDV will verify that the ROM\_TO value is not the same as any other

previous ROM\_TO prior to sending the binary file to EED. If the ROM\_TO

value matches another, PEDD SWDV will change the value of FIXSUM and

generate a new ROM\_TO value, which will be checked again for a match.

This process is repeated until a unique ROM\_TO value is generated.

4. For production calibrations only, EED systems will receive and record the

value of ROM\_TO for final ROM verification.

5. EED will then transmit the binary file to the vendors, verify the ROM

chip against the binary file, verify the CHECKSUM, verify the RAM

read/write test, and verify the ROM\_TO value and location.

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