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ELECTRONIC FUEL INJECTION (SFI-MA) STRATEGY BOOK

| STRATEGY LEVEL "GUFB"

NOTE: OVER 16K; REQUIRES 2732 CHIPS

FOR USE WITH EEC-IV MODULES: SFI-MA1, SFI-MA2 AND SFI-MA3

COMMENTS OR QUESTIONS SHOULD BE DIRECTED TO PAUL BALTUSIS ON

EXTENSION 72583.

THE PROCEDURE FOR OBTAINING COPIES OF THIS BOOK OR ANY OTHER

AVAILABLE "GU" DOCUMENTATION IS EXPLAINED ON THE NEXT PAGE.

PAUL BALTUSIS

POWERTRAIN STRATEGY SECTION

CONTROL SYSTEMS DEPT

POWERTRAIN ELECTRONICS

DEVELOPMENT DEPARTMENT - PTOPE

| DECEMBER 7, 1987

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

NOTE: A NEW MODULE (PROCESSOR) #XF-252812 IS REQUIRED TO RUN

THIS AND ALL SUCCEEDING VERSIONS OF THIS STRATEGY.

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"GU" STRATEGY DOCUMENTATION

ALL CURRENT STRATEGY DOCUMENTATION IS STORED ON THE VAX COMPUTER CLUSTER.

DOCUMENTATION CAN BE OBTAINED BY LOGGING INTO A VAX COMPUTER (I.E. SYS2) AND

ISSUING ONE OR MORE OF THE FOLLOWING VAX/DCL COMMANDS.

GENERALLY, THREE TYPES OF DOCUMENTATION ARE AVAILABLE:

1. UPDATE PACKAGES - CHANGE BARS AT THE LEFT MARGIN ARE USED TO INDICATE

WHERE CHANGES IN TEXT HAVE OCCURRED SINCE THE PREVIOUS LEVEL. SOME OF THESE

CHANGES MAY SIMPLY BE ENHANCEMENTS OR CORRECTIONS TO THE TEXT OF THE PREVIOUS

LEVEL AND MAY BE UNRELATED TO THE STRATEGY LEVEL CHANGE. THIS FILE CAN BE

USED AS A QUICK REFERENCE TO SHOW THE CHANGES WHICH HAVE BEEN MADE FOR THIS

RELEASE. AT THIS TIME THE VIP SECTION IS NOT INCLUDED IN THE UPDATE PACKAGE.

THE FILE NAME FORMAT IS GU\*\*UP.MEM, WHERE \*\* IS THE DESIRED NEW STRATEGY

LEVEL.

2. PRELIMINARY VERSION - THE FILE FORMAT IS GU\*\*EX.MEM, WHERE \*\* IS THE

DESIRED STRATEGY LEVEL. IF THIS FILE EXISTS, THEN APPROVED DOCUMENTATION IS

NOT AVAILBALE AT THIS TIME. WHEN THE FINAL VERSION IS APPROVED, IT WILL

REPLACE THE PRELIMINARY VERSION ON THE SYSTEM AS A COMPLETE BOOK.

3. COMPLETE BOOKS - THE FILE NAME FORMAT IS GU\*\*.MEM, WHERE \*\* IS THE

DESIRED STRATEGY LEVEL. CHANGES IN TEXT WHICH HAVE OCCURRED SINCE THE

PREVIOUS LEVEL BOOK WILL BE INDICATED WITH CHANGE BARS. AT THIS TIME THE VIP

SECTION WILL NOT CONTAIN CHANGE BARS. THE INDEX CONTAINS AN ENTRY, "CHANGED

PAGES," WHICH LISTS ALL PAGES CONTAINING CHANGES.

THE FOLLOWING VAX/DCL COMMANDS MAY BE HELPFUL IN WORKING WITH STRATEGY BOOK

DOCUMENTATION:

TO DETERMINE IF A SPECIFIC STRATEGY BOOK IS AVAILABLE, TYPE:

DIR STRATEGY:GU\*\*.MEM

DIR STRATEGY:GU\*\*UP.MEM

TO OBTAIN A LINE PRINTER COPY OF A GIVEN DOCUMENT, TYPE:

PRINT/NOFEED STRATEGY:GU\*\*.MEM where \*\* = the desired strategy level

TO OBTAIN A XEROX COPY OF A GIVEN DOCUMENT, TYPE:

XEROX STRATEGY:GU\*\*.MEM/DEST=EEE/NAME=name/COPIES=no/PMODE=P

where: \*\* = the desired strategy level

name = your user name

no = desired number of copies (i.e. 1)

TO DETERMINE TARGETING OF EMR'S FOR FUTURE RELEASES, TYPE:

DISEMR

TO DETERMINE THE STATUS OF STRATEGY BOOK DOCUMENTATION, TYPE:

@STRATEGY:BOOKSTATUS

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5-1 to 5-4 THROTTLE MODE SELECTION GXL0

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6-2 to 6-8 FUEL OVERVIEW GUE0

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6-13 to 6-20 OPEN LOOP STRATEGY GUE0

6-21 to 6-35 CLOSED LOOP STRATEGY GUA0

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6-74 to 6-87 PULSEWIDTH EQUATION GUF1

6-88 to 6-92 SPEED LIMITER GUE0

6-93 to 6-106 INJECTOR TIMING GUE0

6-107 to 6-115 INJECTOR OUTPUT CONTROL GUE0

6-115 to 6-116 FUEL PUMP GXA0

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(INCLUDES HEATED WINDSHIELD RECOGNITION)

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(Inlet Air Strategy)

(Supercharger Strategy)

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22-1 to 22-6 KAM GUE0

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24-1 to 31 SELF-TEST VIP GUF1

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CHAPTER 1

STRATEGY EVOLUTION

1-1

STRATEGY EVOLUTION - GUFB

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STRATEGY EVOLUTION

SOURCE EVOLUTION

FILE FILE

EMR NO. DESCRIPTION/REMARKS

| GUFA GUFB

| (12/7/87)

| 9-423 Add a proportional control term

| to DEBYMA.

GUF1 GUFA

(3/11/87)

8-300 Add minimum Daspot Clip when vehicle is

moving to prevent declutch stalls.

8-301 ISC - Apply FN880(CTNTMR) only when

CTNFLG = 1.

GUF0 GUF1

(2/6/87)

8-234C Revise Mass Air Flow Sensor FMEM logic.

8V-285B VIP - Revise implementation, documentation,

and logic relating to BP sensor FMEM.

8V-285C VIP - Clarify documentation. Including all

cases of BP sensor faults for clearing

BAPCNT and setting MINTIM2 to clock value.

8V-287 VIP - Revise FMEM logic setting KAM

indicating MAFS failure during forced stall.

9-089 S/W - Correct error in Thermactor Bypass

Logic.

9-091 S/W - Correct error in

INJECTOR\_UPDATE\_REQUEST routine.

9-097 S/W - Run ARCHI filter during Mass Air

Meter FMEM.

9-100 VIP - Eliminate stalling after running VIP.

GUE0 GUF0

(12/22/86)

7-442 Revise EOS.014 module for documentation only

to create EOS.V01 module.

7-442A Cancel EMR 7-442.

8-064G Documents the module and CPU pin number for

the FPM for model years 1988 and 1989.

8-092I S/W - In the MFLOW module, clear FFMTMR

after it is used for UROLAV\_TC.

8V-285 VIP - Add BP FMEM.

8V-285A VIP - Add BPSSW, add FMEM documentation.

9-054 Move filter on Air Charge (manifold filling)

to foreground.

9-054A Revise manifold filtering logic to be

compatible with FMEM.

9-069 Add function FN884 for ISC Crank.

9-072 S/W - Modify VSBAR calculation.

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STRATEGY EVOLUTION - GUFB

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GUD0 GUE0

(11/26/86)

7-566A Clarify, revise, thrift original strategy

logic.

8-033 Add Heated Windshield Strategy.

8-033A Implement 8-034A,B,C in GX.

8-034A Add DNDSUP = 0 to Heated Windshield logic.

8-034B Define range, resolution, etc for ACRT and

HWPPM.

8-034C Redefine HWPPM.

8-135 Add MU type Speed Limiting.

8-135B Revise strategy logic and documentation

relative to Speed Limiting.

8-135C Clarify that FN179A applies to WOT spark,

as well as Part Throttle Spark.

8-159 Improve Cruise control command switch

Debounce filter.

8-167 Revise Decel Fuel Shutoff Logic.

8V-173A VIP - Correct VIP error causing false

continuous error codes 41 and 91.

8-201 S/W - Set a flag for faster determination

of PHEHP.

8-229 S/W - Use a common routine to do clip for

DP and 'DP.

8-236 S/W - Restructure foreground Spark code to

use common subroutines.

8-237A S/W - Process HIG\_PIP\_MISC code in PIP

input routine, instead of as a trigger.

8-271 Compute new air charge correction for

leakage and add in foreground.

8-271A Revise logic so that the AIR37 clip includes

all sources of air.

8-280 S/W - Correct FN1355 table lookup error

affecting GUA0 through GUD0.

9-012 Implement Adaptive Fuel KAM initialization

as a subroutine.

9-012A Add KWUCTR register to Adaptive Table

validation.

9-021 Delete DAC register to display EFTR and

support code.

9-023 ISC thrift - Delete IPSBFG register and TP

decision branch.

9-024 S/W - Eliminate 2 unnecessary jumps in

FRGRND\_FUEL\_CALC module.

9-031 Reinit RATCH to RATCHIV during TP failure.

9-035 Revise convention for table labels in FCA.

9-041 Complete 8-138. (Delete CRKFLG logic from

CRKTMR and allow free-run).

9-044 S/W - Process LOAD\_OUTPUT directly in

OUTPUT\_CMD\_EDGE instead of using call.

9-045 Revise PIP\_DATA routines for byte and

chrono efficiency.

9-046 Modify Decel Fuel Shutoff Logic to add Cal

Switch to use it at Part Throttle for

enrichment via FN374(N).

0-003 Implement EXP-147 and EXP-147A into main

stratvine (Spark angle pulsewidth transfer

function change for CT20).

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STRATEGY EVOLUTION - GUFB

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0-003A Revise transfer function for SAPW, change

clips on SAPW.

GUC1 GUD0

(11/12/86)

7-573C Revise FCA for FN824 to say "N\_BYTE" instead

of "BYTERPM", revise strategy book.

7-579A S/W - Revise foreground control of fuel

pulses to support Bank-to-Bank EFI.

7-688 Revise strategy book to specify requirements

for FN1327.

8-032A H/W - Remove 2nd output for ACL put in

by 8-032.

8V-064E VIP - Correct interference between normal

and VIP fuel pump control.

8V-064F VIP - Use VIP\_FP\_OVERRIDE instead of

corrupting TSLPIP.

8V-188A VIP - Correct error in VIP fault filter

relating to Threshold Level Flag.

8-234 Add FMEM strategy for Mass Air meter.

8-234A Revise logic, include base values.

8-234B Add Cranking check to FMEM logic of 8-234A.

8-240 S/W - Revise range of parameters EDNHYS and

SPUCLP.

8-261 Delete NOPS from start of O.I. #1 module.

8-263 Document how the PIP noise filter works.

8-264 S/W - Thrift code in Fuel service routine.

GUC0 GUC1

(11/5/86)

8-266 S/W - Correct problem in ISC related to

adding 7V-709 in GUB0.

8-267 S/W - Correct problem related to FN1035

(ARCHOR) lookup.

GUB0 GUC0

(Merged with GUAC) (10/23/86)

8-061A Add new row to Adaptive Fuel table

exclusively for Idle.

8-107 Use relative LOAD (PERLOAD) instead of

absolute LOAD.

8-107A Use LOAD for EGR (Delete APECHG, APEBAR,

APELOAD) etc. Add ability to disable

PERLOAD usage.

8-107B FN035 to be function of N, Not N\_BYTE.

8-136 Add Lugging Mode. Thrift Open Loop Fuel.

8-136A Use DNDSUP instead of NDSFLG in "C"

calculation logic.

8-189 Use special temperature Normalizing

function for FN1861.

8-223 Revise documentation in CRANK/UNDERSPEED/RUN

logic (N < NSTALL).

9-007 Revise and thrift Foreground/Background.

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STRATEGY EVOLUTION - GUFB

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9-033 Revise Vector lower limit for parameter

XFREPT.

GUA0 GUB0

(10/17/86)

7V-025 VIP - Implement the MIL logic using a

single timer.

7-209 VIP - New Continuous EGO test for MIL.

7-209B VIP - Do EGO Test after a certain number

of TP transitions rather than time at

Part Throttle.

7-209C VIP - Ensure against false codes 41 and 91

if EGO Test is bypassed.

7-225E VIP - Add TFMFLG and MFMFLG before

performing Continuous VSS Test.

7-479 VIP - Modify entry to EGR tests for

compatibility with 3-state PFEHP.

7-482 VIP - VIP Test power steering pressure

switch.

7-552 VIP - Ensure proper VIP entry even if FMEM

is in effect on ITP.

7-560 VIP - Short index external RAM locations.

7V-593D VIP - Modify VIP code for a 13 byte thrift.

7V-593F VIP - Cancel 7V-593 through 7V-593E.

7V-643 VIP - Add initialization of LAMBSE to VRLAM2

at beginning of KOER goose Test.

7V-650 VIP - Put OCCDT4 and OCCDT7 in individual

strategy OCCDT calibration files.

7-681 VIP - Improve accuracy and resolution of

dither Purge Duty Cycle and frequency.

7V-706 VIP - Correct VIP so that if EGO Test fails,

Thermactor and Fuel Tests are bypassed.

7V-709 VIP - Revise ISC Strategy to make VIP ISC

calibration independent from the normal

engine ISC calibration.

7V-709A VIP - FN820A is MU only; GU uses FN820B.

7V-709B VIP - Use parameter name V820A in GU to

replace FN820B (for file commonality).

7V-709C VIP - Substitute 1.0 for FN824 when VIP

running flag = 1.

8V-056 VIP - Remove all previous EMR history from

VIP source files.

8V-064A VIP - Incorporate new continuous fuel pump

circuit test.

8V-064C VIP - Revise VIP documentation of names,

etc.

8-092D Correct errors relating to Manifold

Filling Filter.

8-092E VIP - Do time based VIP filter constant

routines for VIP filter constants.

8-092F Correct register clobbered by rolling

average routine relating to EGR.

8V-101 VIP - Add MAF sensor test to VIP.

8V-111 VIP - Gives blanket authority to fix

documentation in VIP files without any

further EMRs.

8-115 VIP - Delete Cal. parameter VSPCLP and

delete setting ADVLIM = 0 from Self-Test.

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STRATEGY EVOLUTION - GUFB

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8V-121 VIP - Expand allowable error codes from

32 to 'N'.

8V-125 VIP - Expand the meaning of goose flag to

allow output of one digit codes up to 90.

8V-127 VIP - Quit displaying service code 16 for

engine-running EGO test failure.

8V-139 VIP - Revise type checks to allow ease of

changing between MTXSW and TRTYPE.

8V-162 VIP - Thrift PSPS Input Test in running VIP.

8V-162A VIP - Correct Software to bypass VIP KOER

Brake Input Test if BIHP not 1.

8V-173 VIP - Control EMR for GU VIP; Basic idea is

to use MU VIP 53A as a base for GU VIP.

8V-174 VIP - Do not enter, or remain in, KOEO VIP

if underspeed or run mode.

8V-174A VIP - Do not do cruise control static test

if in underspeed mode.

8V-188 VIP - Recode Continuous VIP fault filter to

allow up to 8 bytes of error codes.

8V-190 VIP - Assign 2 bytes of RAM to FMEM monitor.

8V-206 VIP - Change flag VPFESEL to PHEHP\_FLG.

8V-215 VIP - Change position of Continuous code

67 to a unique slot.

8-216 Move ROM\_TO from 9FFE to calid

location ^200A.

8-216A Add dummy parameter to tweak ROM\_TO

if needed.

8-216C Documentation for ROM\_TO code.

8V-232 VIP - Don't force Closed Throttle mode when

doing engine running Self-Test.

9V-004 VIP - Revise SCVNT and SCVAC VIP parameters

(OCCDT1 & OCCDT2) to OCCDTA & OCCDTB.

GUAB GUAC

(10/14/86)

8-248 S/W - Revise the KAMRFn determination in

Adaptive Fuel.

GUAA GUAB

(10/7/86)

8-061A Add new row to Adaptive Fuel table

exclusively for Idle.

8-092D Correct errors relating to Manifold

Filling Filter.

8-092F Correct register clobbered by rolling

average routine relating to EGR.

8-107 Use relative LOAD (PERLOAD) instead of

absolute LOAD.

8-107A Use LOAD for EGR (Delete APECHG, APEBAR,

APELOAD) etc. Add ability to disable

PERLOAD usage.

8-107B FN035 to be function of N, Not N\_BYTE.

8-136 Add Lugging Mode. Thrift Open Loop Fuel.

8-136A Use DNDSUP instead of NDSFLG in "C"

calculation logic.

8-189 Use special temperature Normalizing

function for FN1861.

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STRATEGY EVOLUTION - GUFB

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8-223 Revise documentation in CRANK/UNDERSPEED/RUN

logic (N < NSTALL).

GUA0 GUAA

(9/25/86)

9-007 Revise and thrift Foreground/Background

8-092D S/W - Correct errors relating to

Manifold Filling filter in GUA0.

GXZ0 GUA0

(9/15/86)

7-379 S/W filter of digital inputs.

7-379A Implement 7-379 in MU, GX, 9X, etc.

7-386B S/W - Revise parameter MIKE100 and verify

that paths do not exceed this time.

7-386D S/W - Do 7-386B for MU & GU, except set

MIKE100 to 66 clock ticks.

7-573B ISC - Add Neutral/Drive Idle Speed gains

and spark feedback.

7-651C Cancel 7-651. 7-651A, 7-651B for GX. Do

thrift part of 7-651A.

8-046 S/W - Utilize common byte count allocation

technique.

8-047 Start ECT averaging for TCSTRT calculation

at TKON2.

8-047A Revise logic to re-compute TCSTRT after

a stall.

8-047C Cancel 8-047B. Clarify that TCSTRT isn't

part of Inferred BP.

8-047D Ensure that PIP counter control logic is

coded as previously specified.

8-053 Allow 'on the boundary' range checks to be

good sensor values for FMEM as well as VIP.

8-089 Make BIAS, Peak-to-Peask amplitude and TAU

tables of speed/load.

8-089B Change the X input of 1343,1351,1352,1353,

1354,1355 from FN070/3 to FN039.

8-089C Create dedicated register for BIAS, correct

documentation.

8-092 Rework rolling average subroutine to give

truer time constants.

8-092A Make manifold filling filter constant truly

time (BG loop variant).

8-092B Amend 8-092A. Respecify manifold filling

time constants.

8-092C Reverse filter increment/decrement logic.

8-092G Documentation changes for 8-092, to agree

with the code.

8-138 Thrifts in ISC and CRKTMR.

8-180 Delete AXOD.

8-182A Delete FN's 088 and 089, which are no longer

needed.

8-182B Delete FN's 1330 and 1341.

8-211 S/W - Delete code from cal-console call that

reads alternate calibrations.

8-211A S/W - Thrift console routine.

9-003 Replace 7 hardware switches with TRLOAD and

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STRATEGY EVOLUTION - GUFB

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TSTRAT.

9-003A Revise for compatibility with multiplexed

NDS/ACC.

9-003B Correct ISC documentation relating to 9-003.

GXY1 GXZ0

(8/4/86)

6-391 Clip DELOPT to 922 counts after it is

filtered.

6-391A Implement EMR 6-391.

6-410A Implement EMR-410 - Initialize TBART to same

value as RATCH initialization.

7-429B Revise Spark equation to be like MU.

7-457 Delete entire EGO aging strategy.

7-521 Revise cruise control; delete Fav speed,

delete variable freq duty cycle.

7-521A VSC - Byte thrift - Delete VSCPUL.

7-634 Major ISC revisions (7-634,B,C cancelled

by 8-137).

7-634B Clarify start up hicam DSDRPM direction to

agree with other recent EMR's.

7-634C Cleanup documentation, delete TGFLG, thrift

N/D desired RPM and DESMAF logic.

7-656 Use fixed INJDLY for Idle instead of table

value.

7-659 S/W - Byte thrift to speed up foreground

execution time.

7-667 Do not do decel fuel shut off if any FMEM

flag is set.

7-669 Correct non-recognition of "Drive" on a

neutral to fourth transition.

7-669A Delete EMR 7-669; N/D logic is not required.

7-670 Use 3-state hardware present switch (0=null,

1=VSS only, 2=VSS+Cruise).

7-670B Revise original EMR. (originally issued as

7-670A).

7-670C Revise 7-670A.

8-035 Install signed spark table as FN(ECT,MAP).

8-048 Add vehicle speed to logic inputs

for decel fuel shutoff.

8-048A Respecify parameters. Specify correct

existing DFSO logic.

8-105A S/W - Implement 8-105 - byte thrift.

8-137 Delete 7-634,A,B,C,D. Revise/simplify ISC.

8-137A Cleanup EMR for ISC changes; define A3CTMR.

8-154 Make parameters IXFRPR and XFREPT signed.

8-161 Thrift PPCTR logic in Decel Fuel Shutoff.

8-182 Make range of CIDRSW 0 to 1.

GXY0 GXY1

(7/2/86)

7-666 Init SPKMUL to 0.99. If any FMEM failure,

set SPKMUL to 0.99.

8-134 Delete TKTMR from timer list.

8-140 Correct resolution problem with foreground

fuel (FUEL\_C and FORFUL1,2)

8-140A Clarify that 8-140 was partially required

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STRATEGY EVOLUTION - GUFB

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by strategy resolution misspec.

8-141 Cancel EMR's not required for GX: 6-291,

7-092, 7-259, 7-388, 7-417, 7-441, 7-441A,

8-080, 8-080A, 8-080B, 8-103.

GXX1 GXY0

(6/13/86)

7-199 Inititalize FAM filter to (N\*ENGCYL\*ARCHG).

7-653 Include hysteresis on DELRAT to exit FAM;

Add clip on (AMPEM-EM) on entry to FAM.

7-694 Implement 'DNAC' addition.

8-032 Implement Ride Control Strategy.

8-050 Add Upstream Air flag in Thermactor Air

Strategy for use with ECAD.

8-050A ECAD revisions.

8-050B ECAD revisions.

8-050C ECAD - Respecify and correct calibration

constant values.

8-077 Byte thrift - Eliminate alternate

calibrations.

8-090 Move the ATOD routine ahead of the Throttle

Mode select routine.

GXX0 GXX1

(5/19/86)

8-074 S/W - FUEL - Correct usage of ML3W

instruction.

8-079 S/W - FUEL - Output Routine - Injector

firing during CRANK fix.

GXW0 GXX0

(5/8/86)

7-455 FUEL - Foreground Fuel Calculation.

7-455A FUEL - Foreground Fuel Calculation cleanup.

7-671 S/W - Delete the KEYOFF flag and the code

that references it.

8-023 Air Meter Correction Table.

8-029 Delete INJDLY2, Rename INJDLY1 to INJDLY.

8-030 Raw Air Charge Calculation time reduction.

GXV0 GXW0

(4/25/86)

6-607A S/W - Correct CTNTMR logic; clip to

(NIOLD + NIHYS).

7-384 S/W - Add new engr. console call.

7-432 S/W - Automatic generation of MROM

identifier.

7-453 Purge output frequency should be 10 Hz.

7-453A Delete EVRPM and EVRPMH.

7-575 Revise High Speed Fan Logic.

7-575A EMR - 575, use LOAD instead of MAPPA.

7-588 Make DASPOT a function of DSTPR

- (RATCH + DELHYS).

7-614 Disable Transient Fuel if in DFSO (and fuel

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STRATEGY EVOLUTION - GUFB

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is shut off).

7-614A Delete SW\_TFI from Transient Fuel.

7-633 S/W - Neutral Idle Injector Delay.

7-636 If in ISC Failure Mode Strategy, set

DSDRPM to FMMDSD.

7-677 Documentation - ISC/FAM - BGCNT docu.

7-681 S/W - Purge Duty Cycle in Foreground.

8-026 Expand MFA table.

8-027 Delete Synchronous Sampling of the

EPT sensor.

GXU1 GXV0

(2/24/86)

7-494 Dillon S/W - Include overflow check in Fuel

Pulsewidth equation.

7-525 Zaghati Add Closed Throttle check to DFSO; Add

2 breakpoints to FN131.

7-574 Baltusis Add C/L Fuel delay after DFSO.

7-590 Baltusis S/W - Execute AEFUEL right after

TAR calculation in Convert Routine.

8-018 Ward Incorporate the Manifold Filling Model.

8-018A Ward Name & range changes - Manifold Filling.

GXU0 GXU1

(2/4/86)

7-580 Hughes S/W - Insure ACITMR cleared for all cases

of ACIFLG clear.

7-586 Hughes S/W - Correct O/L Lambse.

7-587 Meshkinnafas S/W - Correct repeaters error.

7-589 Meshkinnafas S/W - Fix for EFTR calc.

GXT0 GXU0

(1/23/86)

6-589C Hughes Correct Software Rel. to ATMR3.

7-411 Allen Dual MKAY.

7-411A Allen SIGKAY/MKAY fix.

7-421 Zaghati Eliminate Upstream air on WOT after a

certain time from start.

7-486 Ward Rearrange MCAL Region assignments.

7-486A Ward Put parameters from MISC module in

Region 1.

7-486B Meshkinnafas Change Region assignments for GX.

7-449A Hughes S/W - Set base value of MHPFD to 0.24.

7-541 Meshkinnafas S/W - Save FN311 & FN212A in RAM.

7-560 Meshkinnafas S/W - Short Index External RAM

automatically.

7-577 Ward S/W - Correct temp. register usage in DFSO.

0-002 Allen CID-VRS added to CID-HALL.

GXS0 GXT0

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STRATEGY EVOLUTION - GUFB

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(1/8/86)

6-469 Pearson S/W - Reprioritize Repeaters.

6-469A Pearson Cancel EMR 6-469.

6-705 Zaghati Allow air on heavy crowds only until

engine stabilizes.

6-705A Ward Implement 6-705 in GX.

7-094E Ward S/W - Invert THS3/2.

7-172B Chupa S/W - Eliminate redundant operation,

SAFTOT is done in Foreground.

7-197B Ward Revise Adaptive Fuel Default logic.

7-373 Baltusis Add a percentage deadband around

equilibrium fuel to turn off transient fuel.

7-387 Baltusis Delete FN824(N);

Add FN824A(DSDRPM-N).

7-402 Baltusis Reorder code to check unique

NDSFLG condition first.

7-402A Baltusis Revise logic so that reordering code

isn't needed, dont implement 7-402.

7-403 Baltusis Use 100% ISC Duty Cycle in Crank

Mode even if FMEM flag is set.

7-413 Ward I/M test changes.

7-413B Ward Change +FN180(CTNTMR) to -FN180(CTNTMR).

7-413C Ward Delete HPTPMR timer.

7-414 Zaghati Include HSPFLG in Dump Air logic; include

W.O.T. in O/C Fuel Logic.

7-414A Ward Clarify 7-414 for GX.

7-426 Ward Change all references of OCPSSW to THRMHP.

7-427 Baltusis Add a third position to PFEHP;

If PFEHP = 2, disable EGR strategy.

7-427A Baltusis Set EM = 0 & EGRACT = 0 when

no EGR control is required.

7-428 Zaghati Initialize TPBAR to RATIV.

7-435 Baltusis Delete DASMAX dashpot clip,

replace with a function of RPM.

7-435A Baltusis Add Vector clip to FN882,

maximum clip of 2.0.

7-437 Baltusis Correct Transient Fuel "M" logic.

7-444 Ward Allow torque truncation spark if N > TTNOV

\* VSBAR without executing AXOD code.

7-466 Huck Revise code to clip all negative DELPR

results to 0.

7-466A Huck Ignore code revisions in 7-466, implement

revisions in 7-466A.

7-474 Liller S/W - Modify the MAF repeaters module.

7-475 Mingo S/W - Prevent inhibition of high speed

outputs due to large carousel count.

7-524 McIntee S/W - Clip injector beta to < 1.75.

7-530 Liller S/W - Separate Injdly register for each

bank.

8-016 Ward Allow clutch input to be selectable for

DFSO logic & for ISC logic.

8-017 Ward Change base values of MAFK1 to 1.00 &

MAFK2 to 0.00.

8-020 Liller S/W - DOL code revisions.

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GXR0 GXS0

(10/31/85)

7-371 McIntee S/W - Move the external Ram ares designated

as Keep Alive Memory to ^700 - ^7FF.

7-422 Mazzara S/W - FCA changes for SWDV testing.

7-449 Mazzara S/W - Set base value of MHPFD to .24.

0-001 Allen Provide support for High Data Rate

Electronic Spark System for CT-20

design contest.

0-001A Allen Revise Spark Angle Pulse Width equation and

correct limits for SAPW.

GXQ0 GXR0

(10/4/85)

6-517C Harris VIP - Correct Type\_check error.

6-517D Rachedi VIP - Revise Cylinder Balance Test.

6-517E Harris VIP - Revise calibration constant values.

6-519A Sass VIP - Add MTXSW criteria to Self-Test.

6-549 Yagley S/W - Set PTPFLG = 1, if PIP interrupt

occurs.

6-677 Rachedi VIP - ISC Duty Cycle.

7-025 Neubacher VIP - FMEM & MIL v36.

7-025A Mingo VIP - Implement MIL using a single timer.

7-025B Hughes VIP - Apply 7-025 to 9X & GX Versions.

7-028 Neubacher VIP - Include a bulb check with MIL.

7-028A Mingo VIP - Cancel bulb test when disableEOLT

has been set.

7-029B Ward Set EGRACT to 0 when EGR is disabled.

7-087 Sass VIP - New filter for ISC.

7-105 Sass VIP - Use KIHP & GOOSW.

7-230 Mingo VIP - Rewrite error codes & STO output

for byte efficiency.

7-236 Pearson S/W - Transfer between VAX/DEC-20.

7-243 Yagley Use VSBAR to enter RPM Control.

7-245 Yagley Use VSBAR to enter MFA Mode.

7-257 Sass VIP - Protect against STI noise.

7-257A Schumaker VIP - Include 9X in EMR 7-257.

7-257B Sass VIP Documentation clarification of

7-257 & 7-257A.

7-261A Harris Clip KWUCTR to 255 in Warm\_up

logic.

7-286 Neubacher VIP - Add MIL documentation.

7-286A Neubacher VIP - Revise MIL documentation.

7-305 Rachedi VIP - Fix error code 33 at ALT.

7-305A Mingo VIP - Do not implement 7-305A for GX.

7-352A Baltusis Include GX in 7-352, Correct PE

calculation.

7-378 Liller S/W - TTBAR filter does not work if

PFEHP = 1.

GXP0 GXQ0

6-499A Yagley Clarify TIPFLG & CTFLG logic.

6-585 Zagheti Bypass Knock Control Strategy.

6-585A McIntee Revise Knock detention logic.

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6-585B Baltusis Add KIHP switch to bypass knock.

7-195 Yagley Rename DISFLG to CIDHP.

7-198C Dillon Revise APT determination code.

7-238 Mazzara S/W - Remove VERID.

7-255 Mortimer S/W - Protect SPKAD register

from noise.

7-261 Baltusis Two Speed Adaptive Fuel Learning.

7-347 McIntee S/W - Avoid ML3W instruction.

8-007 Hardy S/W - Change CCDFLG to CCDSW in CCD

logic.

GXO0 GXP0

6-531 McIntee S/W - Add overflow check in EGR

Control algorithm.

6-724 Chupa S/W - FKINJD effectiveness improvement.

7-094 Yagley Implement AXOD strategy.

7-094A Yagley Revise LAMMUL logic for AXOD.

7-094C Yagley Revise AXOD.

7-094D Ward Add RATIV & NPSSW.

7-191A Baltusis Revise definitions in AXOD.

7-192 Yagley Revise AXOD & Idle Speed.

7-194 Yagley Define brake input logic.

7-206 Yagley Add Torque Truncation Spark Retard.

7-215 Yagley Revise Tip-in logic.

7-241 Baltusis AXOD 3-4 upshift delay time.

7-246 Chupa S/W - Proper update of SPKAD index

register.

7-268 Baltusis Revise scaling of TTNOV.

7-319 Dewey S/W - Fix to BAPXFR.

8-010 Meshkinnafas S/W - Correct scaling error in

EGRDC calculation.

8-010A Meshkinnafas S/W - Overflow check in EGRDC calc.

8-011 Chupa S/W - RPM Vector clip to 7600 RPM.

GXN0 GXO0

6-431 Hardy Delete IDMAX from Getfile.

7-117 Baltusis Add FN306.

7-137A Yagley Support 3.8L FWD programs with EDF.

7-147 Yagley Smooth trasition to MFA.

7-172 Baltusis DAC total spark advance.

7-172A Yagley Revise range of SAFTOT.

7-174 Baltusis Revise IPSIBR update logic.

7-197 Baltusis Revise use idle adaptive cells.

7-197A Taylor Add Else condition to logic.

7-198 Baltusis Remove LAMBSE reset from ISC.

7-198A Baltusis Set ISLAST before DSDRPM.

7-226 Dewey Revise Mode select logic.

GXM0 GXN0

7-090 Yagley Add integrated VSC.

7-090A Yagley Revise VSC (include Hardware present sw).

7-09A Yagley Do VSC only if VSCHP = 1.

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7-137 Yagley Add 2-speed EDF.

7-140 Yagley Revise VSC.

7-140B Yagley Use Rising edge of VS Sensor input.

7-140C Maurer Calculate speed after 2nd MPH transition.

7-251 S/W - Delete PIP\_OK logic.

GXL0 GXM0

6-642 Baltusis Add Logic Switch to force NDSFLG.

6-670 Yagley Revise DASHPOT preposition.

6-674 Yagley Ensure Time delay in shutting off A/C.

6-675 Yagley AETAR added.

6-678 Baltusis Add conditions to clear latch.

6-689 Chupa Correct underflow for tip-in.

6-689A Chupa Do 6-689.

7-089 Yagley Do NOT open EGR unless DESEM>MINDES+DESHY.

7-089A Yagley Set CONPR = EPTBAR, if disabled or too low.

7-229 Meshkinafas Save PE value.

GXK0 GXL0

6-336 Pearson Move calibration parameters.

6-425 Chupa Correct Software error Re: Filter constant

for NDBAR.

6-428 Pearson/Geer Make (CHECKSUM) Uncommon.

6-574 McIntee Revise injector output algorithm.

6-574A McIntee Change logcation of label Injector 400.

6-608 Hughes Correct minor issue in throttle mode.

6-679 Yagley Revise Region assignments to fit in memory.

6-709 Yagley Reduce ambiguity of document and S/W.

6-700 Rein Check all timect subroutine calls.

7-076 Yagley Convert GX Stratvine to multi-cal.

7-168 Chupa Move BP to external RAM.

7-179 Yagley Assign Parameters to Regions.

7-202 Liller Revise Non-signature mode to avoid two

injectors firing on same PIP.

GXJ0 GXK0

6-231 Heikkila WCOTMR changed to ACWTMR.

6-240 Heikkila Define WCOTMR where (TP-RATCH) is

negative.

6-393 Yagley Revise DOL ALGORITHM.

6-393A McIntee/Yagley Improve and simplify DOL algorithm.

6-434 Chupa Revise/Clarify LAMBSE reset Logic.

6-486 Zaghati Ramp decel fuel "SHUTOFF".

6-486A Yagley Define "DMIN"

6-486B Zaghati Allow decel S/O at commencement of decel.

6-547 McIntee Fix Transient error in DOL calculation.

6-619 Yagley Change Range - FN1124 TO 0-31.75.

6-620 Zaghati Filter INJDLY before use in foreground.

6-645 McIntee Eliminate extraneous type checks.

6-690 Chupa Correction to clip logic - LAMSE2.

6-694 Chupa Clip FN374 to min, not maximum.

7-010C Armitage Information EMR relating to FAM Logic.

7-103 Yagley Incorporate FMEM strategy.

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7-104 Yagley Delete FN348A--Use FN348.

7-107 McIntee Remove Asynchronous AE.

7-116 Yagley Commonize low speed output EVR.

7-129 Yagley Revise Closed Loop Fuel/Adaptive learning.

7-136 Yagley Replace IDLTMR/CTNTMR with EXTMR.

7-143 Chupa Free up unused RAM.

7-145 Yagley Decrease EGR if in MFA MODE.

7-150 Velting Store PHFDLT instead of DT12S/2 into HFDLTA.

7-156 Yagley Provide Rich Open Loop LAMBSE.

GXI0 GXJ0

6-140 Chupa Modify Self-Test to avoid undesirable

PW modifiers.

6-140A Mortimer Revision to 6-140.

6-140B Chupa Revision to 6-140.

6-432 Baltusis Revise desired RPM and desired

airflow calculations.

6-432A Baltusis Revise original ISC EMR.

6-432B Baltusis Correct ISFLAG logic.

6-432C Baltusis Change NDADLT to NDDELT.

6-495 Zaghati Increase Repetition of FN367.

6-496 Zaghati Increase Range of FN367.

6-545 Ratkowski Eliminate use of ML3W.

6-583 Zaghati Add Unique Spark adder in Neutral.

6-584 Zaghati Unique Injection timing - Neutral.

6-588 Yagley Open Loop Tip-in Retard permitted.

6-589 Baltusis Revise DESMAF calculation.

6-589A Baltusis Rename FN018B to FN018 (ATMR3).

6-590 Baltusis 100% duty cycle to ISC actuator.

6-590A Baltusis Modify Reinit during Running.

6-590C Yagley First-RPM/STALLN Compare to set

REFLG.

6-598 Zaghati New timer to delay Rich Open Loop.

6-602 Yagley Increase range of CTATMR.

6-610 Yagley EGR disabled, set EM=0 if in RPM

ISC control or FMEM extant.

6-635 Yagley Revise Anticipatory FAM.

6-664 Chupa Correct Canister Purge problem.

7-083 Yagley Add Open Loop ability during Crowds.

7-114 Yagley 3 PIP intervals that limit RPM.

7-114A Yagley Shorten MINPIP to MNPIP.

7-120 Chupa Change FN652A to Cal-Par.

7-131 Chupa Change FN036 to Cal-Par.

GXH0 GXI0

6-144A Ward Correct EPTZER input to EPTBAR.

6-615 Yagley Delete ACCFLG = 1 in Closed Throttle.

6-646 Chupa Define BG\_Timer as Byte.

7-029A Yagley Define FKEACT.

7-054 Armitage I/O definition to support 3.0L.

7-054A Yagley Clarify A/C-NDS input handling.

7-078 Yagley Add inlet air control.

7-102 Dewey Add Thermactor Option.

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8-002 Allen Add option to use distributorless

Ignition, instead of Sig. PIP.

8-002A Allen Delete all ref. to SIGDC, if DISFLG

= 1, then SIGPIP = 1.

GXG0 GXH0

$5E-190 Sass VIP - Word/byte efficiency.

$5E-190A Sass VIP - Thrift word/byte.

$5E-203 Sass VIP - Insure ISC Precondition.

6-125 Davison VIP - Add single EGO self-test.

6-125A Davison VIP - Revise 6-125.

6-133A Davison VIP - Show new Stereo-EGO terms.

6-148C Rachedi VIP - Upgrade PFE/EVR Self-Test.

6-152 Davison VIP - Add Crossed-EGO check.

6-157 Davison VIP - Add manufacturing test.

6-157A Rachedi VIP - Checksum to include 32K ROM.

6-157B Rachedi VIP - Commonize Veh and EED test.

6-157C Rachedi VIP - Instruction for STO "off"

6-224 Mingo VIP - Revise Knock Window Routine.

6-229 Sweppy VIP - Use FMEM.

6-245 Rachedi VIP - Delete Transmission test,

Add 6-246.

6-246 Krzyske VIP - Revise Knock Test.

6-263 Mingo VIP - Revision to implement 6-162.

6-270 Krzyske VIP - Add Keypower circuit test.

6-275 Krzyske VIP - Actuate EDF/HEDF outputs.

6-297 Sass VIP - Re-enter KODO Self-test.

6-301 Sass VIP - Revise KAMREF reference.

6-327 Sass VIP - Obviate interference between

STO/KTS.

6-331 Tedesco VIP - Avoid Transient Fuel when

in Self-Test.

6-347 Rachedi VIP - New Fuel test for 2-EGO sys.

6-347A Krzyske VIP - Save Test time.

6-348 Rachedi VIP - Add Air test for 2-EGO sys.

6-387 Krzyske VIP - Documentation revision only.

6-388 Rachedi VIP - Improved PIP and IDM Test.

6-388A Rachedi VIP - Revise PIP test.

6-388B Harris VIP - Revise PIP->IDM test logic.

6-388C Rachedi VIP - Revise PIP-IDM test.

6-388D Rachedi VIP - Correct continuous PIP/IDM.

6-400 Sass VIP - Accomodate various air flows.

6-400B Baltusis VIP - Bypass 98% Duty Cycle clip.

6-400C Mingo VIP - Byte thrift, revise FLRNFG.

6-438 Girdis VIP - Revise macros, ROM 1 and 2.

6-452 Krzyske VIP - Delete ECT rationality.

6-460 Krzyske VIP - Verify continuous codes-KAM.

6-460A Neubacher VIP - delete 3U strat. from 6-640.

6-463 Schumaker VIP - 11 Byte thrift.

6-475 Rachedi VIP - Revise SW documentation only.

6-476 Rachedi VIP - Revise SW documentation only.

6-483 Krzyske VIP - Resolve Multi-cal conflicts.

6-500 Mingo VIP - EOL RAM test revision.

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6-501 Mingo VIP - Revise output circuit check.

6-501A Mingo VIP - Revise 6-501.

6-501B Mingo VIP - Revise Output circuit check.

6-517 Rachedi VIP - New cylinder balance test.

6-517A Rachedi VIP - Revises 6-517.

6-517B Rachedi VIP - Avoid engine stall.

6-518 Mingo VIP - Prevent false indications.

6-536 Mingo VIP - Revise EVR Output circuit ck.

6-573 Rachedi VIP - Calib. Capability for PSPS.

6-573A Rachedi VIP - Supercedes 6-573.

6-586 Sass VIP - Extend KAM extension.

6-586A Rachedi VIP - Revise 6-586.

6-595 Rachedi VIP - Commonize Goose.

6-599A Krzyske VIP - Prevent false error code 74.

6-599B Krzyske VIP - maintain flag naming con.

6-599C Baltusis VIP - BIHP specification.

6-612 Mingo VIP - Revise Goose.

6-621 Pearson VIP - Adjust MAPCNT.

6-627 Mingo VIP - Create Mask of output state.

6-632 Krzyske VIP - Code 33 revision.

6-646 Chupa VIP - Define BG\_Timer as Byte.

7-019A Rachedi VIP - Add PFE EGR test; delete AM1 and

AM2; revise MAP sensor name.

7-073 Yagley Rename EGRSW->PFEHP.

GXF0 GXG0

6-419 Allen Revise Signature PIP.

6-419A Allen Revise Switching in Spark

logic between Single and

Double Edge.

6-419C Salamon Use Tick values for SPKSWH/SPKSWL.

6-548 Allen Revise Signature PIP.

7-052 Allen Implement 6-419, 6-419A, 6-419C

at same time as 6-548.

7-070 Liller Revision to Injector pulse S/W.

7-071 Liller Revise cranking fuel pulse S/W.

SCM-008 Gaynier Eliminate use of nested "get files"

in software routines.

GXE0 GXF0

6-577 Liller Revise PIP input processing mod.

6-597 McIntee Revise Transient fuel.

6-601 Liller Fix Injector Sync. Routine.

7-033 Allen Add computer controlled dwell

for Distributorless Ignition

System.

7-033A Allen Revise 7-033.

7-033B Allen Make CCDFLG calibratible.

7-033C Velting/Allen Final revision/Documentation.

GXD0 GXE0

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6-414 Yagley Revise TIP-in Retard.

6-414A Yagley Load hysteresis in CTFLAG.

6-455 Zaghati Bypass MFA at altitude.

6-456 Zaghati Time delay before upstream air

in Decel. Delete unused timers.

6-456A Yagley Define HMCTM.

6-470A Baltusis Revise IVPWR to IIVPWR.

6-481 Yagley Insert SIL Chapter.

6-499 Yagley Revise Retard logic, clarify

flags: TIPFLG and CTFLAG.

6-506 Yagley Turn off fuel as RPM limiter.

6-508 Yagley Delete ACDFLG, use ACCFLG.

6-541 Yagley Revise Retard logic.

6-587 Liller Add 3 levels to foreground.

7-055 Liller Fix overflow in aircharge calc.

7-056 Liller Correct Transient Fuel S/W.

SCM-006 Gaynier V29, KAM\_Qualify.

GXC0 GXD0

6-164 Yagley A/C status logic revision.

6-164A Yagley Further A/C status revision.

6-241 Armitage ISC revisions.

6-278 Armitage Add RPM Adder vs Act.

6-312 Zaghati/Armitage Revise ISC Mode Select.

6-338 Bosley ISCFLG redefined, SW.

6-377 Zaghati VBAT Cal-Console Displayable.

6-389 Girdis ISCDTY from Byte to Word.

6-441 Brelian Remove All TSAD Strategy.

7-039 Liller Remove Map usage from Sonic EGR.

7-040 Armitage Add 6-164, 6-241, 6-441.

7-042 Liller Correct Fuel sequencing.

GXB0 GXC0

6-145 Hoen Add Stereo EGO Adaptive Fuel

Control re: open/closed loop.

6-145A Yagley Include Table, Row 7 Adaptive Fuel.

6-145B Yagley Revise Adaptive Documentation

to match Code.

6-189 Baltusis Revise Adaptive Fuel Learning

Relating to ACT.

6-189B Baltusis Revise AFACT1/AFACT2 in Adaptive.

6-277 Zaghati Lambda Resets/Jumpback only in

Closed Loop.

6-311 Yagley New DAC Register FAMREG.

6-324C Yagley If ISCKAM pass ISKSUM test, set

ISKSUM = Sum of ISCKAM.

6-325 Yagley Qualify EPTZER as KAM Parameter.

6-346 Hughes Correct Stereo-Adaptive Code.

6-365 Jones 3-Byte Test to go in ROM.

6-367 Chupa Correct Stereo Adaptive load of

BIASCT.

6-375 Ward Add enable interrupt to balance

disable interrupt in CRANK.

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6-394 McIntee Move ECTCNT to External RAM.

6-405 Hardy Delete header module from FCA.

6-433 Yagley Canceled after execution of

LAMBSE=LAMBSE-LMPJMP.

6-433A Yagley Cancel 6-433 - NO problem.

7-029 Yagley Revised PFE Strategy.

7-032 Armitage Use BIASCT instead of ASYBCT.

7-034 Armitage Delete NDCT/NDLAM. Add FN371.

7-034A Armitage Modify Minimum Range for LAMMUL

and FN371.

7-036 Liller Remove Bad instruction clearing

Simultaneous Flag too low RPM.

GXA0 GXB0

6-033A Yagley Change EVR frequency.

6-204 Yagley Add PFE EGR Control.

6-204A Yagley Use FN239 with Pressure/EGR Input,

depending on EGRSW.

6-218 Yagley Delete references to Non-existent

flags.

6-324 Yagley Add checksum to KAM qualification

test during powerup.

6-324B Yagley Do not check KAM\_ERROR flag

during powerup KAM qualification.

6-380 Yagley Do not reinitialize ISCKAM during

KAM qualification.

SCM-001 Gaynier Common Filter constant.

7-026 Gaynier Change FKECT1 to FKECT.

MXG0 MXG3 GXA0

5E-082 McLean Supplement Dual-edge Spark Routine.

5E-082A McLean Delete Registers DIFF0 and DIFF1.

5E-187A McLean Delete Signat, MHPFD to .99.

5-306 Allen/McIntee Correct value of ticks.

6-118 McLean Improve Dynamic spark accuracy.

6-133 Gaynier Remove reference to Left/Right with

regard to Stereo EGO.

6-158 Baltusis Withhold knock windows for

WINCLD PIP Periods.

6-158A Velting Simplify and improve 6-158.

6-166 Yagley Replace single injector slope with

Dual slope and Fox Function.

6-184 Mazzara/McIntee Remove PSTRUC counter.

6-195 Pearson Ensure at least 10 usec wait.

NONE Rutz Commonize scheduler with CH.

6-217 Ratkowski Confirm Calls to IN22 < .992

only, occur.

6-224 Mingo Fix Single Knock Module EOS.

6-224A Mingo Correct Implementation of 6-224.

6-249 McIntee Clear Simultaneous flag if PIP period

indicates > 1953 RPM.

6-272 Velting Revise Knock strategy to correct

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Knock window.

6-295 Zaghati Make Individual cylinder Knock spark

cal console.

6-341 Chupa Correct Scaling in return of feedback

bias from FN312A. Correct KAMREF.

6-343 McIntee Correct software problemm in Transient

Fuel.

6-344 Hughes Correct Software problem for A/C Cutout.

6-363 Liller Correct scaling error dual slope.

7-005 Gaynier/Armitage Revise Fuel Control.

7-005A "" Clarify APELOAD normalizing to

be FN071A.

7-005B "" Clarify/correct 7-005/7-005A.

7-005C "" Modify cranking fuel logic to

reference BP instead of MAP.

7-005D "" Clarify intent of 7-005A re: FN071

and FN071A.

7-005E "" Modify range/resolution specification

for FN071 and FN071A.

7-006 Gaynier/Armitage Revise spark control.

7-007 Gaynier Define Knock Strategy (MAPPA v LOAD)

7-009 Gaynier Revise Thermactor Strategy.

7-010 Gaynier Revise Idle Speed Strategy.

7-010A Armitage Define Calibration parameters LOWLOD/ACLOD.

7-010B Armitage Define new FN820B,delete FN820A.

7-012 Gaynier Control Supercharger Bypass.

7-014 Gaynier Revise Timer control.

7-013 Gaynier/Armitage Add/revise System Equations

for Air and EGR Mass Flow rates.

7-013A "" Replace Aircharge, new range for EM.

7-013B "" Define AELOAD

7-013C "" Modify Range/Resolution for EM/FN037.

7-017 Armitage Revise Sonic EGR Control.

7-020 Armitage Apply 6-166 to GX.

7-022 Armitage Delete overdrive Strategy, delete

thermactor Pump Clutch.

7-024 Armitage TAR conversion in software.

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CHAPTER 2

SYMBOLOGY

2-1

SYMBOLOGY - GXA0

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SYMBOLOGY

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>OR=Y, X<OR=Y, X=Y, and XNOT=Y.

SYMBOL MEANING

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

= EQUAL TO

NOT= NOT EQUAL TO

> GREATER THAN

>OR= GREATER THAN OR EQUAL TO

< LESS THAN

<OR= 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 - GXA0

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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

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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

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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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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.

2-6

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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

ENDIF

ENDIF

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CHAPTER 3

EEC OVERVIEW

3-1

EEC OVERVIEW - GXP0

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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.

3-2

EEC OVERVIEW - GXP0

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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, etcetera). This displays

such information as current Miles per Gallon to the driver.

ELECTRO-DRIVE FAN (EDF) (SFI-MA3)

The Software Output provides a signal for the AC/Electro-drive Fan Controller

to control the Electro drive engine cooling fan.

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 - GXP0

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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.

HIGH SPEED ELECTRO-DRIVE FAN (HEDF) (SFI-MA3)

This software output provides a signal for the AC/Electro-Drive fan which, in

turn, increases the speed of a two-speed electro-drive fan when required via

a normally open relay or an integrated relay controller module.

IAC (SFI-MA3)

The Inlet Air 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.

LOCK-UP SOLENOID (LUS) (SFI-MA3)

This software output controls the lock-up of the AXOD transmission convertor

via a solenoid.

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EEC OVERVIEW - GXP0

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SUPERCHARGER BOOST SOLENOID (SBS) (SFI-MA1)

This software output provides a signal to the supercharger boost solenoid.

The signal can be used in a linear manner (varying frequency and duty cycle)

to control the position of the supercharger boost bypass valve. While the

system is in HLOS, the Boost Solenoid is in the OFF (de-activated) condition.

SPEED CONTROL VACUUM (SCVAC) (SFI-MA3)

This software controls a normally-closed solenoid which applies a vacuum to

the Speed Control Servo. If the SCVNT valve is closed, the state of the

SCVAC controls the position of the Speed Control Servo.

SPEED CONTROL VENT (SCVNT)

This software controls a normally open solenoid which traps (closes) or vents

(opens) a vacuum to the speed ControlServo.

SHIFT INDICATOR LIGHT (SIL) (SFI-MA1)

This output is used to drive a lamp on the instrument panel to signal the

driver to shift gears (manual transmission only) at an optimum point

determined by the strategy.

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).

WIDE OPEN THROTTLE AIR CONDITION CUTOFF (WAC)

This output is used to temporarily disable or turn off the air-conditioning

by activating a normally closed relay.

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EEC OVERVIEW - GXP0

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The remainder of this document describes the normal engine control strategy

(RUN) for the various outputs, including fuel, spark, EGR, thermactor air,

and idle speed control (ISC).

3-6

CHAPTER 4

CRANK/UNDERSPEED/RUN MODE SELECTION STRATEGY

4-1

CRANK/UNDERSPEED/RUN MODE SELECTION - GUF0

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OVERVIEW

The EEC IV strategy operation is divided into three distinct strategy

segments. They 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

4-2

CRANK/UNDERSPEED/RUN MODE SELECTION - GUF0

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UNDERSPEED STRATEGY

Fuel Fire all injector ports in the

same manner as in the RUN mode.

The multiplier FN387 is included

in the pulsewidth equation.

See the Fuel strategy.

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.

4-3

CRANK/UNDERSPEED/RUN MODE SELECTION - GUF0

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DEFINITIONS

INPUTS

Registers:

- ECTCNT = Number of times ECT sensor input was read.

- N = Engine RPM.

- PIPCNT = Number of PIPs which have occurred.

- STALLN = Stall RPM: If the first RPM calculated is greater than this

value, assume there was a reinit, RPM.

- TSLPIP = Time since last PIP.

Bit Flags:

- CRKFLG = Engine Mode Flag. (1 = Crank Mode; 0 NOT= Crank Mode)

Calibration Constants:

- CRKPIP = Number of PIPs between injector outputs during Crank.

- FN387 = Fuelpw Multiplier versus ECT - Input = ECT, Output = Multiplier.

- FN884(TCSTRT) = ISC Duty Cycle in Crank, deg.

- NCNT = Minimum number of PIP necessary to exit CRANK Mode.

- NRUN = Minimum Engine Speed to exit CRANK Mode.

- NSTALL = Engine Stall speed to re-enter CRANK Mode.

- UNRPM = Underspeed Engine Speed, RPM.

- UNRPMH = Hysteresis term for UNDERSPEED Mode.

OUTPUTS

Registers:

- N = See inputs above.

Bit Flags:

- CRKFLG = See inputs above.

- FIRST\_PIP = Indicates that first PIP has been received.

- UNDSP = Run/Underspeed Flag. (1 = Underspeed (or CRANK), 0 = Run)

4-4

CRANK/UNDERSPEED/RUN MODE SELECTION - GUF0

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The Crank Flag is set by the PIP Counter and ECT Counter Control logic which

is described in SYSTEMS EQUATIONS CHAPTER.

PROCESS

CRKFLG = 1 -------------------|

(CRANK mode) |

|AND -------------| CRANK mode

N <OR= NRUN --------| | | CRKFLG = 1

| | | UNDSP = 1

ECTCNT < 8 ---------|OR ------| |

| | --- ELSE ---

PIPCNT < NCNT ------| |

| A stall has occured

|

CRKFLG = 0 -------------------| | CRKFLG = 1

(RUN or UNDERSPEED mode) | | UNDSP = 1

|AND -------------| ECTCNT = 0

N < NSTALL -------------------| |

|

| --- ELSE ---

|

CRKFLG = 1 ---------| |

|OR ------|S Q -------------| UNDERSPEED mode

N < UNRPM ----------| | | CRKFLG = 0

| | UNDSP = 1

N > UNRPM + UNRPMH -----------|C |

|

|

| --- ELSE ---

|

| RUN mode

| CRKFLG = 0

| UNDSP = 0

4-5

CRANK/UNDERSPEED/RUN MODE SELECTION - GUF0

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ENGINE RUNNING REINIT STRATEGY

The reinit strategy attempts to differentiate an engine running reinit from a

normal start engine runup. After a reinit, a "first RPM" is calculated from

the first two PIP rising-edges. If the calculated RPM is greater than idle

RPM, then a reinit is assumed.

TSLPIP >or= 800 msec ---------------------| Set N = 0

| Set FIRST\_PIP = 0

4-6

CHAPTER 5

THROTTLE MODE SELECTION STRATEGY

5-1

THROTTLE MODE SELECTION - GXQ0

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THROTTLE MODE SELECTION STRATEGY

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.

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 SYSTEM EQUATIONS section.

5-2

THROTTLE MODE SELECTION - GXQ0

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DEFINITIONS

INPUTS

Registers:

- APT = Status of Part Throttle. (Set = -1 = Closed Throttle) (Set = 1 =

Wide Open Throttle) (Set = 0 = Part Throttle)

- RATCH = Closed throttle.

- TP = Position of Throttle.

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.

- THBP2 = PT/WOT Breakpoint value above RATCH.

OUTPUTS

Registers:

- APT = See inputs above.

Bit Flags:

- CTPTFG = Closed throttle to PT/WOT transition flag.

- PTSCR = Part throttle mode since exiting CRANK Flag.

5-3

THROTTLE MODE SELECTION - GXQ0

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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

TP <OR= RATCH + DELTA ---------------|S Q -| Closed Throttle mode

| | APT = -1

TP <OR= RATCH + DELTA + HYST2 ------|C |

| --- ELSE ---

|

|

TP > (RATCH+THBP2+HYST2) -|S Q ------------| Wide Open Throttle

| | mode

TP <OR= (RATCH + THBP2) --|C | APT = 1

|

| --- ELSE ---

|

| Part Throttle Mode

| APT = 0

NOTE: PTSCR is initialized to 0.

previous APT = -1 ------------|

|

current APT NOT= -1 ----------|AND ---------| Set CTPTFG = 1

| | Closed Throttle to

CRKFLG = 1 -------------------| | Part Throttle transition

|

| --- ELSE ---

previous APT = -1 ------------| |

| |

current APT NOT= -1 ----------|AND ---------| Set CTPTFG = 1

| | Closed Throttle to

CRKFLG = 0 -------------------| | Part Throttle transition

| Set PTSCR = 1

|

| --- ELSE ---

|

| Set CTPTFG = 0

5-4

CHAPTER 6

FUEL CONTROL STRATEGY

6-1

FUEL CONTROL STRATEGY - OVERVIEW - GUE0

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EEC-IV FUEL CONTROL STRATEGY OVERVIEW

DEFINITIONS

INPUTS

Registers:

- AMPEM = Air mass flow plus EGR mass flow.

- CLFLG = Register that is used solely to indicate fuel mode.

(1 = Closed Loop, 0 = Open Loop)

- EFTR = Transient Fuel Compensation fuel flow, lb/sec.

- EM = EGR mass flow.

- FM = Fuel mass flow.

- LAMBSE1 and LAMBSE2 = Desired equivalence ratios.

Calibration Constants:

- ENGCYL = Number of cylinders per engine revolution

(NUMCYL/2); or number of PIPs per engine

revolution.

- FN1327 = Fuel pulsewidth register map; used to

determine which fuel register is used.

Output = Fuel Register-left offset.

X-input = Injector Output Number

Y-input = Null.

- LAMMAX = Maximum LAMBSE Clip when in Closed Loop.

- LAMMIN = Minimum LAMBSE clip when in Closed Loop.

- NUMCYL = Number of cylinders in the engine.

- NUMEGO = Calibration switch indicating number of

Ego Sensors. 1=mono; 2=stereo.

6-2

FUEL CONTROL STRATEGY - OVERVIEW - GUE0

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OUTPUTS

Registers:

- AEFUEL = Acceleration enrichment desired fuel

flow rate (lb/min).

- AM = Air mass flow.

- BASEFF1 = EGO-1 base fuel flow in Lb/Min.

- BASEFF2 = EGO-2 base fuel flow in Lb/Min.

- BASEFFT = Total base fuel flow in Lb/Min.

- CLFLG = Register that is used solely to indicate fuel mode.

(1 = Closed Loop, 0 = Open Loop)

- DSLMBS1 = Rescaled LAMBSE1 used for DAC'ing stereo EGO.

- DSLMBS2 = Rescaled LAMBSE2 used for DAC'ing mono EGO.

- EFTRFF = Equilibrium fuel transfer rate for transient

fuel compensation (lb/min).

- FM = Fuel mass flow.

- LAMBDA = Air/fuel equivalence ratio.

6-3

FUEL CONTROL STRATEGY - OVERVIEW - GUE0

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SEQUENTIAL ELECTRONIC FUEL INJECTION (SEFI)

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 a signature PIP distributor. The

signature PIP allows the computer to identify cylinder #1. The PIP signal

for cylinder #1 has a unique duty cycle, that is smaller than the normal 50%

duty cycle. The computer recognizes the signature PIP to synchronize the

fuel injections.

6-4

FUEL CONTROL STRATEGY - OVERVIEW - GUE0

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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 CONTROL STRATEGY - OVERVIEW - GUE0

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EFI FUEL CALIBRATION UNITS

\*\*\*\*\* NOTE \*\*\*\*\*

Lambdas are used for all A/F calibration parameters.

Lambda is defined as:

AM/(14.64\*FM) = (AMPEM - EM)/(14.64\*FM)

LAMBDA CLIPS

LAMBSE1 and LAMBSE2 (the desired equivalence ratios) are clipped as shown

below:

CLOSED LOOP FUEL CONTROL -------------| CLIP LAMBSE1 AND

| LAMBSE2 BETWEEN

| LAMMIN AND LAMMAX

|

| --- ELSE ---

|

| CLIP LAMBSE1 AND

| LAMBSE2 BETWEEN

| 0.0000305 AND

| 1.9999695

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

6-6

FUEL CONTROL STRATEGY - OVERVIEW - GUE0

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SPECIAL DAC REGISTERS

Special registers have been added to assist in calibration development by

increasing the resolution of key parameters for display purposes.

DSLMBS1 and DSLMBS2 are calculated as shown:

DSLMBS1 = LAMBSE1 - 1.0

DSLMBS2 = LAMBSE2 - 1.0

Because DSLMBS1 and DSLMBS2 are signed word quantities, a value of zero will

be output as 5 volts.

CLFLG is the Closed Loop flag (if set to 1, fuel mode is closed loop).

All fuel flow registers have Lb/Min units for easy display and comparisons.

They are: BASEFF1 (EGO-1 base fuel flow), BASEFF2 (EGO-2 base fuel flow),

BASEFFT (total base fuel flow), AEFUEL (acceleration enrichment desired fuel

flow rate) and EFTRFF (equilibrium fuel transfer rate for transient fuel

compensation); all units are lb/min.

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FUEL CONTROL STRATEGY - OVERVIEW - GUE0

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EFI BASE FUEL STRATEGY

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.

6-8

FUEL CONTROL STRATEGY - CLOSED LOOP/OPEN LOOP - GUE0

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DEFINITIONS

INPUTS

Registers:

- ATMR1 = Time since start (time since exiting crank

mode), sec.

- ATMR2 = Time since ECT became greater than

TEMPFB, sec.

- CTNTMR = Closed throttle neutral timer.

- EGOSSS = EGO switches since start.

- HLTMR = High Load Timer, sec.

- LOAD = Universal Load parameter, unitless.

= Aircharge normalized to Sea Level.

- NACTMR = Time not at Closed throttle, sec.

- PERLOAD = Percent of Peak LOAD at any altitude, unitless.

- PPCTR = PIP counter for Fuel Ramp, unitless.

- TCSTRT = Temperature of ECT at Cold Startup, deg F.

Bit Flags:

- CHKAIR = Thermactor Status flag.

- HSPFLG = High Speed Mode Flag; 1 = High speed alternate

Fuel/Spark.

- MFAFLG = Managed Fuel/Air State flag.

- NDSFLG = Flag = 0 if transmission in neutral; = 1 if in gear.

- WMEGOL = WRMEGO was 1 at least once.

- WRMEGO = EGO sensor should be warm flag.

Calibration Constants:

- CTHIGH = Hot Start Minimum Engine coolant Temperature,

Deg F.

- CTLOW = Cold Start Maximum ECT, deg F.

- EGOCL1 = Number of EGO switches since start required

to set WRMEGO = 1.

- FN320A(ECT) = Upper PERLOAD Limit for Closed Loop fuel control,

unitless.

6-9

FUEL CONTROL STRATEGY - CLOSED LOOP/OPEN LOOP - GUE0

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- HLCTM = Time delay before high load forced open loop, sec.

- HLODH = Hysteresis term for FN320A(ECT), unitless.

- LOLOD = Minimum LOAD to enter Closed Loop, unitless.

- LOLODH = Closed Loop Enable LOAD hysteresis.

- MFASW = Calibratible switch, which if set, indicates

Managed Fuel Air logic is being used.

- NIOLD = Maximum time to allow closed loop fuel if in

neutral at idle, secs.

- OPCLT1 = ATMR1 Closed Loop enable time delay for

TCSTRT <or= CTLOW.

- OPCLT2 = ATMR1 Closed Loop enable time delay for

CTLOW < TCSTRT < CTHIGH.

- OPCLT3 = ATMR1 Closed Loop Enable Time delay for

TCSTRT >or= CTHIGH.

- OPCLT4 = ATMR2 Closed Loop enable time delay for

TCSTRT <or= CTLOW.

- OPCLT5 = ATMR2 Closed Loop Enable Time Delay for

CTLOW < TCSTRT < CTHIGH.

- PIPNUM = Number of steps to Ramp Fuel, unitless.

- THBP5 = Throttle breakpoint above RATCH for Open Loop Fuel, counts.

OUTPUTS

Registers:

- CLFLG = Register that is used solely to indicate fuel mode.

1 = Closed loop; 0 = Open loop

- EGOSSS = See Inputs above.

Bit Flags:

- NFLG = Neutral idle flag.

- OLFLG = Flag indicating Open loop if set (1); indicating

Closed loop if cleared (0).

- WMEGOL = WRMEGO was 1 at least once.

- WRMEGO = EGO sensor should be warm flag.

6-10

FUEL CONTROL STRATEGY - CLOSED LOOP/OPEN LOOP - GUE0

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PROCESS

APT = 0 -----------------|

|OR -------|

CTNTMR <OR= NIOLD -------| |

|

WRMEGO = 1 -------------------------|

(SEE BELOW) |

|

CHKAIR = 1 -------------------------|AND -----| CLOSED LOOP

(USE INDEX) | | CLEAR OLFLG = 0

| | SET CLFLG = 1

| |

PPCTR = PIPNUM ---------------------| | --- ELSE ---

| |

| | OPEN LOOP

MFAFLG = 0 ---------------| | | SET OLFLG = 1

(USE INDEX) | | | CLEAR CLFLG = 0

|OR ------|

MFASW = 0 ----------------| |

(USE INDEX) |

|

HSPFLG = 0 -------------------------|

(NOT in High Speed Open Loop) |

|

LOAD > LOLOD ----------|S Q---------|

| |

LOAD < LOLOD - LOLODH -|C |

|

HLTMR <OR= HLCTM -------------| |

|OR --|

PERLOAD < FN320A(ECT) ---|S Q-| |

| |

PERLOAD > FN320A(ECT) ---| |

+ HLODH |

|

TP <OR= (RATCH + THBP5) -|S Q ------|

| |

TP > (RATCH+THBP5+HYST2)-| |

|

LDFLG = 0 --------------------------|

(NOT IN LUGGING MODE)

6-11

FUEL CONTROL STRATEGY - CLOSED LOOP/OPEN LOOP - GUE0

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WRMEGO LOGIC

TCSTRT >OR= CTHIGH ------------|

|AND ---|

ATMR1 >OR= OPCLT3 -------------| |

|

CTLOW < TCSTRT < CTHIGH -------| |

|AND ---|OR --|

ATMR1 >OR= OPCLT2 -----| | | |

|AND ---| | |

ATMR2 >OR= OPCLT5 -----| | |

| |

TCSTRT <OR= CTLOW -------------| | |AND --| Set WRMEGO = 1

|AND ---| | | Set WMEGOL = 1

ATMR1 >OR= OPCLT1 -----| | |

|AND ---| |

ATMR2 >OR= OPCLT4 -----| |

|

EGOSSS >OR= EGOCL1 --------------------------|

EGOSSS LOGIC

EGO\_SWITCH -------------------| INCREMENT EGOSSS (CLIP AT 255)

|

| --- ELSE ---

|

| FREEZE EGOSSS

NFLG LOGIC

APT = -1 (CLOSED THROTTLE) ----|

|AND ---| SET NFLG = 1

| |

NDSFLG = 0 (NEUTRAL) ----------| | --- ELSE ---

|

| SET NFLG = 0

6-12

FUEL CONTROL STRATEGY - OPEN LOOP FUEL - GUE0

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DEFINITIONS

INPUTS

Registers:

- APT = At Part Throttle. -1 = Closed throttle; 0 = Part

throttle; 1 = Wide Open throttle.

- ATMR1 = Time since start (time since exiting crank mode), sec.

- LAMBSE2 = Desired open loop (or closed loop) equivalence ratio

for EGO-2 injectors. LAMBSE2 appears in the

fuel pulsewidth equation for EGO-2.

- LAMMUL = Multiplier which is used to prevent cold-engine

stalls following transmission engagement.

- MFAMUL = MFA table ramp-in Multiplier, unitless.

- MULTMR = Time since incrementing LAMMUL, sec.

- PERLOAD = Percent of peak LOAD at any altitude.

- TCSTRT = Temperature of ECT at Cold Start, deg F.

Bit Flags:

- DNDSUP = Drive Neutral select.

- HSPFLG = High speed mode flag; 1 = High Speed alternate fuel/spark.

- IDLFLG = Flag indicating transmission in Drive and at Idle.

- LDFLG = "Lugging" mode open loop flag.

- MFAFLG = Managed Fuel/Air State flag.

- NDSFLG = Flag = 0 if transmission in Neutral; = 1 if in

gear.

- NEUFLG = N/D transition occurred.

- NFLG = Neutral Idle Flag.

- OLFLG = Flag indicating Open loop if set = 1; Closed

loop if set = 0.

- WMEGOL = Flag set if WRMEGO set.

- WRMEGO = If set, EGO sensor should be warm and flag set to

1 if EGO sensor is switching; and reset to 0 if it

has cooled down. Its state is controlled by the

WRMEGO logic.

6-13

FUEL CONTROL STRATEGY - OPEN LOOP FUEL - GUE0

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Calibration Constants:

- CTHIN = Maximum TCSTRT value to use NUMPR.

- CTLOW = Cold Start Maximum ECT, deg F.

- FN022B = Temperature normalizing function; used for table

lookup.

Input = FRCBFT \*ACT + (1-FRCBFT) \* ECT

--OR--

Input = FRCSFT \* ACT + (1-FRCSFT) \* ECT

- FN035(N) = Maximum LOAD at sea level (29.4 dry barometer,

100 deg. f) Input = N (RPM).

- FN072A = PERLOAD normalizing function; used for table lookup.

Input = PERLOAD and Output = Normalized perload.

- FN082 = Load normalizing function; generates table entry

point. Input = LOAD and Output = Normalized Load.

- FN083 = RPM normalizing function; generates table entry

point. Input = N and Output = Normalized N.

- FN300 = Multiplier as a function of ACT, modifies FN1305.

- FN301 = Closed Throttle Open Loop Fuel Multiplier as a

function of RPM.

- FN301N = Neutral Open Loop Fuel Multiplier 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.

- FN311 = MFA altitude multiplier, unitless.

- FN371 = Initial LAMMUL as a function of ECT. This is a Fuel

Multiplier to provide fuel compensation during Drive

Engagement.

- FN393F = Time between Lammul decrements - forward gear.

- FN396A = High Speed Fuel enrichment, mph.

- FN1306 = Startup Open Loop Fuel table = a 10 x 8 table of

lambda values as a function of [FRCSFT\*ACT + (1

- FRCSFT)\*ECT] and ATMR1. TABSFT is the Synonym

for this Table.

- FN022B = Temperature normalizing function (X-input).

FN018 = Time (ATMR1) normalizing function (Y-input).

- FN1307 = Base Open Loop Fuel table = a 10 x 8 table of lambda

values as a function of [FRCBFT\*ACT + (1 - FRCBFT)\*ECT]

and PERLOAD. TABBFT is the Synonym for this Table.

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FUEL CONTROL STRATEGY - OPEN LOOP FUEL - GUE0

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- FN022B = Temperature normalizing function (X-input).

FN072A = PERLOAD normalizing function (Y-input).

- FN1328 = Manage Fuel Air Fuel Table, 10 x 8 table of multipliers

as a function of engine speed N and LOAD.

- X-input = Normalizing function for N - FN070

Y-input = Normalizing function for PERLOAD - FN072A

- FRCBFT = Act fraction for FN1305 lookup.

- FRCSFT = ACT fraction for FN1306 lookup.

- LDEL = Minimum ECT to enable Lugging Open Loop, deg.F.

- LDEM = Maximum ECT to enable Lugging Open Loop, deg.F.

- LDLTM = Minimum time in Lugging Mode (High MAP low RPM)

before entering Lugging Open Loop, seconds.

- LDTM = Minimum time delay after start up to enable Lugging

Open Loop, seconds.

- LDMH = Minimum PERLOAD to enable Lugging Open Loop (near W.O.T.).

- LDMHH = Hysteresis for LDMH.

- MFARMP = MFAMUL Ramp increment, unitless.

- MFASW = Calibratible switch which, if set, indicates

Managed Fuel Air logic is being used.

- NUMPR = Open Loop Fuel multiplier.

- OLMCL = Open Loop Fuel Calibration multiplier.

- OLMTD1 = NUMPR Open Loop fuel multiplier time delay,

sec.

- PRLDSW = Switch which determines the formula for computing PERLOAD.

1 -> PERLOAD = LOAD

0 -> PERLOAD = LOAD/PEAK\_LOAD

- TRLOAD = Transmission Load switch.

0 = Manual Transmission, no clutch or gerar 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.

OUTPUTS

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FUEL CONTROL STRATEGY - OPEN LOOP FUEL - GUE0

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Registers:

- LAMBSE1 = Desired open loop (or closed loop) equivalence ratio

for EGO-1 injectors. LAMBSE1 appears in the

fuel pulsewidth equation for EGO-1.

- LAMMUL = Multiplier which is used to prevent cold-engine

stalls following transmission engagement.

- MFAMUL = MFA table ramp-in Multiplier, unitless.

- MULTMR = Time since incrementing LAMMUL, sec.

Bit Flags:

- LDFLG = "Lugging" mode open loop flag.

- NEUFLG = N/D transition occurred.

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FUEL CONTROL STRATEGY - OPEN LOOP FUEL - GUE0

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OPEN LOOP FUEL LOGIC

PARAGRAPH During Open Loop fuel Control, the desired equivalence ratios

(LAMBSE1 and LAMBSE2) are basically calculated from two tables as modified

for various engine conditions.

PROCESS

Open Loop fuel control ------| Set LAMBSE1 = LAMBSE2

| = C \* [(FN300\*FN1307)

| - FN1306] \* LAMMUL \* OLMCL

HSPFLG = 1 ------------------| LAMBSE1 = LAMBSE1 \* FN396A

| LAMBSE2 = LAMBSE2 \* FN396A

LAMMUL LOGIC

LAMMUL can either jump lean (ramp rich) or jump rich (ramp lean), depending

upon whether neutral to drive transitions cause rich or lean errors.

RAMP BACK LOGIC

MULTMR >OR= FN393F -------| | (LAMMUL was RESET RICH)

(In Forward) |AND --------------| LAMMUL = LAMMUL

| | + 0.0039

LAMMUL < 1.0 ------------| | MULTMR = 0

|

| Clip LAMMUL to

| 1.0 as a maximum

|

| --- ELSE ---

|

MULTMR >OR= FN393F -------| | (LAMMUL was RESET LEAN)

(In Forward) |AND --------------|

| | LAMMUL = LAMMUL

LAMMUL > 1.0 ------------| | - 0.0039

| MULTMR = 0

|

| Clip LAMMUL to

| 1.0 as a minimum

|

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FUEL CONTROL STRATEGY - OPEN LOOP FUEL - GUE0

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LAMMUL RESET LOGIC

TRLOAD <OR= 3 ------------|

(Manual Transmission) | | No LAMMUL RESET

|OR --------------| No change to LAMMUL

CLOSED LOOP --------------| | No change to NEUFLG

(OLFLG = 0) |

| --- ELSE ---

DNDSUP = 1 ---------------| |

(Transmission in gear) | | LAMMUL RESET

|AND -------------| LAMMUL = FN371

NEUFLG = 1 ---------------| | NEUFLG = 0

(Transition from neutral)| |

| --- ELSE ---

|

DNDSUP = 0 ---------------------------------| NEUFLG = 1

(Transmission in neutral)

NOTE: LAMMUL and FN371 have a range of 0 through 1.99.

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FUEL CONTROL STRATEGY - OPEN LOOP FUEL - GUE0

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'C' DEFINITION

LDFLG = 1 --------------------------| LUGGING MODE

| 'C' = FN308 \* FN212A

| + FN309 \* FN129A

|

DNDSUP = 1 (DRIVE) ----------| | --- ELSE ---

| |

APT = -1 (CLOSED THROTTLE) --|AND --| 'C' = FN301

| |

WRMEGO = 0 ------------------| |

|

| --- ELSE ---

|

NFLG = 1 --------------------| |

| |

CTLOW < TCSTRT < CTHIN ------|AND --| 'C' = FN301N \* NUMPR

| |

ATMR1 < OLMTD1 --------------| |

|

| --- ELSE ---

|

MFAFLG = 1 ------------------| |

|AND --| 'C' = 1 + (FN1328 \*

MFASW = 1 -------------------| | FN311 \* MFAMUL)

|

| --- ELSE ---

|

NFLG = 1 ---------------------------| 'C' = FN301N

|

| --- ELSE ---

|

APT = 1 (WIDE OPEN THROTTLE) -------| 'C' = FN303

|

| --- ELSE ---

|

| 'C' = 1

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FUEL CONTROL STRATEGY - OPEN LOOP FUEL - GUE0

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"LUGGING" OPEN LOOP FLAG

The strategy provides the capacity of Open Loop Fuel Control during "lugging"

conditions (Part throttle, high Load, low RPM). The "lugging" Open Loop

multiplier is adjusted for altitude much like Spark and EGR (by means of

FN212A and FN129A).

CALIBRATION NOTES: LDMH and LDMHH should correspond to high loads (near

WOT). LDLTM must be less than or equal to LUGTIM (since LUGTMR is clipped to

LUGTIM).

The logic below sets LDFLG -- the flag which indicates whether lugging Open

Loop is in process or not.

APT = 0 (PART THROTTLE) --------------|

|

LDEL < ECT < LDEH --------------------|

|

LUGTMR >OR= LDLTM --------------------|AND ---| LDFLG = 1

| |

PERLOAD >OR= LDMH + LDMHH -|S Q-------| | --- ELSE ---

| | |

PERLOAD < LDMH ------------|C | | LDFLG = 0

|

WMEGOL = 1 ---------------------------|

MFAMUL LOGIC

The MFAMUL ramps in the MFA tables (FN1328, FN1124 and FN1223). The fuel is

systematically ramped lean with corresponding changes to Spark and EGR.

MFAFLG = 0 --------------------| MFAMUL = 0

|

| --- ELSE ---

|

| MFAMUL = MFAMUL

| + MFARMP

| Clip MFAMUL to 1.0

| as a maximum

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FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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CLOSED LOOP FUEL STRATEGY

STEREO EGO SYSTEMS

The following description applies to each side of an engine if operating in

stereo EGO 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. ANPIP, ENPIP, 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 EGO sensor, the strategy uses

LAMBSE1 and FUELPW1 for the desired LAMBSE and fuel

Pulsewidth. (Set NUMEGO = 1)

INTENT

The goals of the closed loop strategy are:

1. To add capability of introducing large amounts of Air/Fuel biasing (up to

45% expressed as ratio of bias to peak-to-peak amplitude).

2. To maximize the feedback limit cycle frequency for all bias values.

3. To adapt to EGO sensor slow down as the sensor ages (see Adaptive EGO

Strategy).

4. To maintain a simple calibration procedure to describe the closed loop

limit cycle.

APPROACH

The fuel flow is driven in a limit cycle manner about stoichiometry. Using

the EGO (Exhaust Gas Oxygen) sensor, the computer increases or decreases the

injector pulsewidths in a controlled manner. If the EGO reads rich, the

pulsewidths will be decreased (made leaner) at a calculated rate. If the EGO

reads lean, the pulsewidths will be increased (made richer) at a calculated

rate.

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FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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When an EGO 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 EGO switch.

The limit cycle can be biased to operate on the average richer (or leaner) of

stoichiometry.

An example of the closed loop limit cycle is shown after the definitions

section.

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FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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CLOSED LOOP FUEL STRATEGY

DEFINITIONS

INPUTS

Registers:

- ANPIP = Actual number of PIP signals since the last EGO switch; clipped

to a maximum of 255; reset to zero when not in closed loop; reset to zero

after the EGO switches and the jumpback distance is calculated.

- BIAS = Closed Loop biasing term = FN1353(N,LOAD), defined below.

- EGO = Exhaust Gas Oxygen Sensor. (GX has mono and stereo EGO capacity,

EGO-1 and EGO-2 represent the EGO sensors in stereo mode; generic

represent = EGO-n).

- ENPIP = Expected number of PIP signals between EGO switches; reset to 1

when not in closed loop.

- FUELPW1 = EGO-1 injector pulsewidths, clock ticks.

- FUELPW2 = EGO-2 injector pulsewidths, clock ticks.

- LAMBDA = Air/Fuel equivalency ratio.

- LAMBSE1 = Desired open loop (or closed loop) equivalence ratio for EGO-1

injectors. LAMBSE1 appears in the fuel pulsewidth equation for EGO-1.

- LAMBSE2 = Desired open loop (or closed loop) equivalence ratio for EGO-2

injectors. LAMBSE2 appears in the fuel pulsewidth equation for EGO-2.

- PIPRAT = Ratio of the actual number of PIP signals since the last EGO

switch to the expected number of PIP signals between EGO switches;

clipped to a maximum of 1.0.

- TSLAMU = Time since last LAMBDA update.

Bit Flags:

- LEGOFG1 = Lack of EGO-1 switching. (LEGOFG2 reflects state of EGO-2

switching).

- OLFLG = Flag indicating Open Loop if set (1); indicating Closed Loop if

cleared (0).

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/PTPAMP. Input = |BIAS/PTPAMP| and Output = Ramp rate multiplier.

- FN342 = Closed Loop Jumpback distance Multiplier versus |BIAS/PTPAMP|.

(Toward BIAS) Input = |BIAS/PTPAMP| and Output Jumpback distance

Multiplier.

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FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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- FN344 = Closed Loop Jumpback Distance Multiplier versus |BIAS/PTPAMP|.

(Opposite BIAS) Input = |BIAS/PTPAMP| and Output = Jumpback distance

multiplier.

- FN346 = Expected number of PIPs multiplier. Input = |BIAS/PTPAMP| and

Output = Multiplier.

- FN1351(N,LOAD) = System transport lag time; time delay from when a fuel

change is made until the EGO sensor indicates this change, units are

REVs. X-input = FN039 - Normalized engine speed, RPM; Y-input = FN071 -

Normalized engine load, LOAD; Output = Transport delay, REVs.

- FN1352(N,LOAD) = Closed Loop Peak-to-Peak amplitude, units are lambdas.

X-input = FN039 - Normalized engine speed, RPM; Y-input = FN071 -

Normalized engine load ,LOAD; Output = Peak-to-Peak amplitude, PTPAMP.

- FN1353(N,LOAD) = Amount of Bias from stoichiometry, X-input = FN039 -

Normalized engine speed, RPM; Y-input = FN071 - Normalized engine load

,LOAD; Output = Bias from stoichiometry. (Store in register).

- LAMSW = Lambda reset switch.

- LMBJMP = Desired Rich correction.

- NUMEGO = Number of EGO sensors present; mono or stereo only.

- PTPAMP = Limit cycle peak-to-peak amplitude, FN1352(N,LOAD).

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FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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OUTPUTS

Registers:

- ANPIP = Actual number of PIP signals since the last EGO switch; clipped

to a maximum of 255; reset to zero when not in closed loop; reset to zero

after the EGO switches and the jumpback distance is calculated.

- BIAS = Value factored into the Jumpback and Ramping equations, its sign

indicates direction of of these functions (as described in Closed Fuel

Section).

- ENPIP = Expected number of PIP signals between EGO switches; reset to 1

when not in closed loop.

- LAMBSE1 = Desired open loop (or closed loop) equivalence ratio for EGO-1

injectors. LAMBSE1 appears in the fuel pulsewidth equation for EGO-1.

- LAMBSE2 = Desired open loop (or closed loop) equivalence ratio for EGO-2

injectors. LAMBSE2 appears in the fuel pulsewidth equation for EGO-2.

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FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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LIMIT CYCLE DESCRIPTION

(lean bias example)

- - - - - - - - - \*

| \* \* \*

| \* \* \*

| \* \* LEAN \*

| \* \* \*

| \* \* \*

| \* \* \*

| \* | \* \*

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

| \* \* A/F RATIO

| \* \*

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

| | \* \*

| | \* \*

| BIAS \* \*

| TERM \* \*

| \* \*

| RICH \* \*

|--PEAK TO PEAK \* \*

| AMPLITUDE \* \*

| \* \*

- - - - - - - - - - - - - - - - - - - - - - - - \*

EGO SENSOR STATUS

RICH \*\*\*\*\*\*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* \*

\* \*

\* \*

LEAN \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

INJECTOR PULSEWIDTH STATUS

ON \*\* \*\*\*\* \*\*\*\*\* \*\*\*\*\*\* \*\*\*\*\*\*\* \*\*\*\*\*\*\* \*\*\*\*\*

\* \* \* \* \* \* \* \* \* \* \* \* \*

\* \* \* \* \* \* \* \* \* \* \* \* \*

\* \* \* \* \* \* \* \* \* \* \* \* \*

OFF \*\*\*\*\*\*\*\* \*\*\*\*\*\*\* \*\*\*\*\*\* \*\*\*\*\* \*\*\*\* \*\*\*\*\*\* \*\*\*\*\*\*

| |

<--DECREASING --->|<---------INCREASING ------->|<---DECREASING --->

PULSEWIDTH | PULSEWIDTH | PULSEWIDTH

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.

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FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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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 calibration items are: FN1351(N,LOAD), FN1352(N,LOAD), FN1353(N,LOAD).

\*\*\*\*\* Note \*\*\*\*\*

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.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

FN1352(N,LOAD) is also a calibration constant. System transport lag time;

time delay from when a fuel change is made until the EGO 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 \*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

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.

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FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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The logic used to achieve biasing depends on the absolute value of

BIAS/PTPAMP (|BIAS/PTPAMP|): where;

BIAS = Amount of bias from stoichiometry, FN1353(N,LOAD)

PTPAMP = Limit cycle peak-to-peak amplitude, FN1352(N,LOAD)

Any calculated value of |B/P| exceeding 0.45 is clipped to 0.45.

This is done to avoid extremely long limit cycle periods.

FOR NO BIAS |BIAS/PTPAMP| = 0

The limit cycle has full jumpback on both sides of stoichiometry

and uses symmetric pulsewidth ramp rates.

FOR SMALL BIAS 0 < |BIAS/PTPAMP| <OR= 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/PTPAMP| <OR= 0.45

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 CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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CLOSED LOOP LIMIT CYCLE EXAMPLES

(not drawn to scale)

NO BIAS | BIAS/PTPAMP | = 0

\* \* \* \* \*

\*\* \*\* \*\* \*\* \*\*

\* \* \* \* \* \* \* \* \* \* SYMMETRIC RAMP RATES

\* \* \* \* \* \* \* \* \* \* FULL JUMPBACK IN

-----\*---\*---\*---\*---\*---\*---\*---\*---\*--- BOTH DIRECTIONS

\* \* \* \* \* \* \* \* \*

\* \* \* \* \* \* \* \* \*

\*\* \*\* \*\* \*\* \*

\* \* \* \* \*

SMALL BIAS | BIAS/PTPAMP | < 0.171573

\* \* \* \*

\*\* \*\* \*\* \*\*

\* \* \* \* \* \* \* \* SYMMETRIC RAMP RATES

\* \* \* \* \* \* \* \* PARTIAL JUMPBACK

-----\*------\*---\*------\*---\*------\*---\*---- IN ONE DIRECTION

\* \* \* \* \* \* \*

\* \* \* \* \* \* \* \*

\* \* \* \* \* \* \* \*

\*\* \*\* \*\* \*\*

\* \* \* \*

MODERATE BIAS | BIAS/PTPAMP | = 0.171573

\* \* \* \*

\*\* \*\* \*\* \*\*

\* \* \* \* \* \* \* \* SYMMETRIC RAMP RATES

\* \* \* \* \* \* \* \* NO JUMPBACK

-----\*-------\*---\*-------\*---\*-------\*---\*-- IN ONE DIRECTION

\* \* \* \* \* \* \*

\* \* \* \* \* \* \*

\* \* \* \* \* \* \*

\* \* \* \* \* \* \*

\* \* \*

LARGE BIAS | BIAS/PTPAMP | > 0.171573

\* \*

\* \* \* \*

\* \* \* \* \* SYMMETRIC RAMP RATES

\* \* \* \* NO JUMPBACK

-----\*------------\*-------\*------------\*----- IN ONE DIRECTION

\* \* \* \*

\* \* \* \*

\* \* \* \*

\* \* \* \*

\* \*

Note: Limit cycle frequency decreases with increasing bias.

6-29

FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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After an EGO switch, a finite amount of time (equal to the transport lag)

should pass before the EGO can switch. Noise in the EGO system could be

interpreted by the computer as EGO 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 EGO 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 EGO switch

to the expected number of PIP signals between EGO switches; clipped to a

maximum of 1.0. PIPRAT is a temporary register.

PIPRAT = ANPIP/ENPIP

ANPIP = Actual number of PIP signals since the last EGO switch; clipped to a

maximum of 255; reset to zero when not in closed loop; reset to zero after

the EGO switches and the jumpback distance is calculated.

ENPIP = Expected number of PIP signals between EGO switches; reset to 1 when

not in closed loop.

The transport delay (FN1351) is entered as REVS. The strategy uses units of

both seconds and PIPS. The transport delay in PIPS is:

TDPIP = FN1351(N,LOAD) \* ENGCYL

Transport delay in seconds is:

TDSEC = FN1351(N,LOAD) \* 60/N

TDPIP and TDSEC are temporary registers.

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FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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JUMPBACK and ENPIPn CALCULATIONS BASED BIAS and EGO STATE

EGO-n SWITCH

BIAS >OR= 0 -----------| | LAMBSEn = LAMBSEn + [PTPAMP

|AND ---| + | BIAS |] \* FN344

EGO-N SWITCH from Lean | | \* PIPRATn

to Rich --------------| |

| ENPIPn = TDPIP

|

| ANPIPn = 0

|

| --- ELSE ---

BIAS >OR= 0 -----------| |

| |

EGO-n SWITCH from Rich |AND ---| LAMBSEn = LAMBSEn - PTPAMP \*

to Lean --------------| | FN342 \* PIPRATn

|

| ENPIPn = TDPIP \* FN346(|BIAS/PTPAMP|)

|

| ANPIPn = 0

|

| --- ELSE ---

BIAS < 0 --------------| |

|AND ---| LAMBSEn = LAMBSEn +

EGO-n SWITCH from Lean | | PTPAMP \* FN342 \* PIPRATn

to Rich --------------| |

| ENPIPn = TDPIP \* FN346(|BIAS/PTPAMP|)

|

| ANPIPn = 0

|

| --- ELSE ---

BIAS < 0 ---------------| |

|AND --| LAMBSEn = LAMBSEn -[PTPAMP +

EGO-n SWITCH from Rich | | | BIAS |]\* FN344 \* PIPRATn

to Lean ---------------| | ANPIPn = 0

| ENPIPn = TDPIP

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FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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RAMP-RATE CALCULATIONS BASED ON BIAS AND EGO STATE

EGO-n SENSOR HAS NOT SWITCHED

BIAS >OR= 0 ---------| | LAMBSEn = LAMBSEn -

|AND --|

| | (PTPAMP - |BIAS|)\*(1-FN339)\*TSLAMUn

EGO-n Lean ----------| | -------------------------

| TDSEC

|

| --- ELSE ---

|

BIAS < 0 ------------| | LAMBSEn = LAMBSEn -

|AND --|

| | (PTPAMP - |BIAS|)\*FN339\*TSLAMUn

EGO-n Lean ----------| | ----------------------

| TDSEC

|

| --- ELSE ---

|

BIAS >OR= 0 ---------| | LAMBSEn = LAMBSEn +

|AND --|

| | (PTPAMP - |BIAS|)\*FN339\*TSLAMUn

EGO-n Rich ----------| | ----------------------

| TDSEC

|

| --- ELSE ---

|

BIAS < 0 ------------| | LAMBSEn = LAMBSEn +

|AND --|

| | (PTPAMP - |BIAS|)\*(1-FN339)\*TSLAMUn

EGO-n Rich ----------| | -------------------------

| TDSEC

An EGO switch is defined as either:

1. The EGO sensor reads rich during the current background loop and it reads

lean during the previous background loop.

2. The EGO sensor reads lean during the current background loop and it reads

rich during the previous background loop.

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FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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CLOSED LOOP LAMBSE1 AND LAMBSE2 LOGIC

CLOSED LOOP --------------| | MONO EGO OR STEREO

|AND --| EGO WITH LACK OF

LEGOFG1 = 1 ---------| | | EGO-2 SWITCHING.

(see TIMER section) | | | USE EGO-1 SENSOR

|OR -| | ONLY FOR CLOSED LOOP

NUMEGO = 1 ----------| | CONTROL OF LAMBSE1 AND

(MONO EGO) | SET LAMBSE2 = LAMBSE1

|

| --- ELSE ---

|

| STEREO EGO WITH LACK

| OF EGO-1 SWITCHING.

CLOSED LOOP ---------------| | USE EGO-2 SENSOR

|AND -| ONLY FOR CLOSED LOOP

LEGOFG1 = 1 ---------------| | CONTROL OF LAMBSE2 AND

(see TIMER section) | SET LAMBSE1 = LAMBSE2

|

| --- ELSE ---

|

CLOSED LOOP ---------------------| NORMAL STEREO EGO.

| USE EGO-1 SENSOR

| FOR CLOSED LOOP

| CONTROL OF LAMBSE1

| AND

| USE EGO-2 SENSOR

| FOR CLOSED LOOP

| CONTROL OF LAMBSE2

6-33

FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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LAMBDA RESET LOGIC

LAMBSE is reset to 1.0 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.

LAMBSE is reset in Closed Loop as described below.

1) When entering or exiting the Filtered Idle Air Mass Regions (FAM);

2) When Changing load states within FAM; and/or

3) Any time a transition is made from Open Loop to Closed Loop Fuel

control.

LAMBSE is always clipped to 1.0 as a maximum. The intent is to allow rich

errors and to prevent lean errors, given that running rich does not cause any

drivability concerns.

LAMBSE RESET - ENTERING/EXITING FAM REGION

REFFLG = 1 ----------------| | Set JMPFLG = 1

|AND ---| Clip LAMBSE1 and LAMBSE2

JMPFLG = 0 ----------------| | to 1.0 as Maximum.

(Entry into FAM Region) |

| --- ELSE ---

|

REFFLG = 0 ----------------| | Set JMPFLG = 0

|AND ---| Set LAMBSE1 = LAMBSE1

JMPFLG = 1 ----------------| | - LMBJMP

(Exit from FAM Region) | Set LAMBSE2 = LAMBSE2

| - LMBJMP

LAMBSE RESET - LOAD STATE CHANGE AT IDLE

APT = -1 -------------------|AND -----| Clip LAMBSE1 and LAMBSE2

(Closed throttle) | | to 1.0 as maximum.

|

ISFLAG NOT= ISLAST ---------|

(Load state change)

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FUEL CONTROL STRATEGY - CLOSED LOOP FUEL - GUA0

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LAMBSE RESET - OPEN LOOP TO CLOSED LOOP TRANSITION

Previous OLFLG = 1 ---------|AND -----| Clip LAMBSE1 and LAMBSE2

(Last state = Open Loop) | | to 1.0 as Maximum.

|

Current OLFLG = 0 ----------|

(Current state = Closed |

Loop) |

|

LAMSW = 1 ------------------|

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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ADAPTIVE FUEL CONTROL

BACKGROUND

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 contol before the EGO

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 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, the table is not lost on vehicle

shutdown.

ADAPTIVE EGO STRATEGY deleted (GXZ0)

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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DEFINITIONS - ADAPTIVE FUEL CONTROL

INPUTS

Registers:

- ACT = Air charge temperature, deg F.

- ADPTMR = Adaptive learning enable timer (see

TIMER section).

- AEFUEL = Acceleration enrichment fuel flow (lb/min).

- BIAS = Closed loop biasing term = FN1353(N,LOAD).

- CHKSUM = KAM memory word which contains the sum of the

LTMTB1 or LTMTB2 contents.

- COLTBU = A register which contains the column number of

the Adaptive Learning Cell to be updated.

- EFTR = Transient fuel compensation fuel flow (lb/sec).

- EGO = Exhaust Gas Oxygen Sensor. (GX has mono and stereo EGO

capacity, EGO-1 and EGO-2 represent the EGO sensors in

stereo mode; generic represent = EGO-n).

- EGOCT1 = Number of EGO-1 switches since last Adaptive

Fuel Update.

- EGOCT2 = Number of EGO-2 switches since last Adaptive

Fuel Update.

- ISCFLG = ISC MODE Flag (1 = RPM CONTROL Mode).

- 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 = Keep Alive Memory.

- KAMRF1/KAMRF2 = Adaptive Fuel strategy correction factor.

It is composed of the value LTMTB1rc + .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 (or closed loop) equivalence ratio

for EGO-1 injectors. LAMBSE1 appears in the

fuel pulsewidth equation for EGO-1.

- LAMBSE2 = Desired open loop (or closed loop) equivalence ratio

for EGO-2 injectors. LAMBSE2 appears in the

fuel pulsewidth equation for EGO-2.

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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- LEGOFG1 = Lack of EGO-1 switching.

- LEGOFG2 = Lack of EGO-2 switching.

- LPCT1L = Number of background loops that the LAMBSE1

was outside a deadband in the rich direction, with

EGO-1 sensor reading lean.

- LPCT2L = Number of background loops that the LAMBSE2

was outside a deadband in the rich direction, with

EGO-2 sensor reading lean.

- LPCT1R = Number of background loops that the LAMBSE1 was

outside a deadband in the lean direction, with EGO-1

sensor reading rich.

- LPCT2R = Number of background loops that the LAMBSE2 was

outside a deadband in the lean direction, with EGO-2

sensor reading rich.

- LSTCOL = Last normalized column value.

- LSTROW = Last normalized row value.

- LTMTB1rc = EGO-1 Adaptive Fuel cell which corresponds to

r = Integer part of FN021 (LOAD) and

c = Integer part of FN070 (N).

- LTMTB2rc = EGO-2 Adaptive Fuel cell which corresponds to

r = Integer part of FN021 (LOAD) and

c = Integer part of FN070 (N).

- N = Engine revolutions, RPM.

- NRMCES = Current normalized column number.

- NRMRLD = Current normalized row number.

- 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, deg. F

Bit Flags:

- AFMFLG = ACT Failure Mode (FMEM) flag.

- CFMFLG = ECT FMEM flag.

- EFMFLG = EGR FMEM flag.

- HCAMFG = Flag indicating state of Hi Cam.

- MFMFLG = MAP/MAF FMEM flag.

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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- REFFLG = Indication of Idle Air Flow (1 = Idle Air Flow).

- TFMFLG = TP FMEM flag.

- WARM\_UP = Indicates engine warmup occured.

Calibration Constants:

- ADAPTM = Adaptive learning enable time delay

(seconds).

- ADEFTR = Maximum transient fuel compensation fuel

flow to allow adaptive learning (lb/sec).

- ADEGCT = EGO switch requirement to increment counters.

- AELIM = Maximum acceleration enrichment fuel flow to

allow adaptive learning (lb/min).

- AFACT1 = Minimum ACT to Update Adaptive Fuel Table

deg F.

- AFACT2 = Maximum ACT to update Adaptive Fuel Table,

deg F.

- 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 normalized

load LOAD.

- DELAMB = Deadband (around LAMBSE1 = 1.0) within which

loop counter values are not altered.

- FAEGCT = Fast Adaptive EGO count. Number of EGO 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.

- FN021 = LOAD normalizing function for LTMTB1(LTMTB2)

and FN1325. Input = Load and Output = Normalized

Load.

- FN070 = N normalizing function.

- FN1325rc = LTMTB1 and LTMTB2 learning/use control table.

X-input = FN070 - Normalized RPM.

Y-input = FN021 - Normalized Load.

- HCAMSW = Calibratible switch which allows selection of when

and which adaptive fuel cells are to be used.

- KWUCNT = Maximum mumber of warm\_up cycles to use fast adaptive EGO

count. It should be set to approx. 3 to 5 warm\_ups.

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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- MAXADP = Maximum adaptive correction.

- MINADP = Minimum adaptive correction.

- NUMEGO = Switch indicating number of EGO sensors present;

Select mono or stereo.

- RANMUL = Multiplier for Random number generation.

- VECT3 = Minimum coolant temperature (engine on), deg. F

- VECT5 = Starting coolant temperature for warm\_up counter, deg. F

OUTPUTS

Registers:

- CHKSUM = KAM memory word which contains the sum of the

LTMTB1 or LTMTB2 contents.

- COLTBU = A register which contains the column number of

the Adaptive Learning Cell to be updated.

- EGOCT1 = Number of EGO-1 switches since last Adaptive

Fuel Update.

- EGOCT2 = Number of EGO-2 switches since last Adaptive

Fuel Update.

- KAMRF1/KAMRF2 = Adaptive Fuel strategy correction factor.

It is composed of the value LTMTB1rc + .5.

- KWUCTR = KAM warm\_up counter. Stores number of warm\_ups in KAM.

Reset to zero if KAM is corrupted. (battery disconnect,

etc.)

- LPCT1L = Number of background loops that the LAMBSE1

was outside a deadband in the rich direction, with

EGO-1 sensor reading lean.

- LPCT2L = Number of background loops that the LAMBSE2

was outside a deadband in the rich direction, with

EGO-2 sensor reading lean.

- LPCT1R = Number of background loops that the LAMBSE1 was

outside a deadband in the lean direction, with EGO-1

sensor reading rich.

- LPCT2R = Number of background loops that the LAMBSE2 was

outside a deadband in the lean direction, with EGO-2

sensor reading rich.

- LSTCOL = Last normalized column value.

- LSTROW = Last normalized row value.

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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- LTMTB1rc = EGO-1 Adaptive Fuel cell which corresponds to

r = Integer part of FN021 (LOAD) and

c = Integer part of FN070 (N).

- LTMTB2rc = EGO-2 Adaptive Fuel cell which corresponds to

r = Integer part of FN021 (LOAD) and

c = Integer part of FN070 (N).

- NRMCES = Current normalized column number.

- NRMRLD = Current normalized row number.

- RANNUM = Random number adder.

- ROWTBU = Register which contains the row number of the

Adaptive Fuel cell to be updated.

Bit Flags:

- WARM\_UP = Indicates engine warmup occured.

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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ADAPTIVE FUEL TABLE

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 EGO-1 side of the engine is

called KAMRF1 where KAMRF1 = 0.5 + LTMTB1rc. The corresponding fuel

correction for the EGO-2 side is called KAMRF2, where KAMRF2 = 0.5 +

LTMTB2rc.

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 precise location where KAMRF1 and KAMRF2 are used is shown in the fuel

pulsewidth equation.

If KAM fails the KAM validation test (described later), all LTMTB1 and LTMTB2

cells are initialized to 0.5 or 80 (HEX) resulting in a value of KAMRF1 =

KAMRF2 = 0.5 + 0.5 = 1.0.

When allowed, updates to LTMTB1 and LTMTB2 are statistically 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 statistical

distribution is done.

Data extracted from the table undergoes a 4-point linear interpolation. This

is explained further under the FN1325 description. Note that the idle cells

do not undergo four point interpolation. Only the current idle cell is used.

LTMTB1, LTMTB2 and FN1325 share the same normalizing functions. FN021 is the

LOAD normalizing function. FN070 is the engine speed N normalizing function.

As an example of an adaptive fuel table, LTMTB1, is shown on the next page.

EGO-2 Adaptive Fuel Table, LTMTB2, uses similar nomenclature.

6-42

FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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ADAPTIVE FUEL TABLE (LTMTB1)

LTMTB1rc 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

|

6 |60 61 62 63 64 65 66 67 68 69

|

5 |50 51 52 53 54 55 56 57 58 59

|

FN021 4 |40 41 42 43 44 45 46 47 48 49

NORMALIZED

ENGINE 3 |30 31 32 33 34 35 36 37 38 39

LOAD |

(LOAD) 2 |20 21 22 23 24 25 26 27 28 29

|

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

FN070 NORMALIZED

ENGINE SPEED

(N)

The special Adaptive Idle cells are not defined by FN021 or FN070; they are

defined by the value of the ISFLAG. (See ISFLAG definition)

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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FN1325 DESCRIPTION

FN1325 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 FN021 which only goes

from 0 to 7).

The normalizing functions for FN1325, LTMTB1 and LTMTB2 are shared. FN021 is

the LOAD normalizing function. FN070 is the engine speed N normalizing

function.

FN1325 is designed to do the following:

1. Identify LTMTB1 and LTMTB2 cells where learning is allowed to occur.

Learning is allowed in any LTMTB1 and LTMTB2 cells whose corresponding

FN1325rc cell contains a value >OR= 0. Negative FN1325 cell values

disallow learning in the corresponding LTMTB1 and LTMTB2 cell(s).

2. 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 FN1325 cell. The

negative number serves as an offset to LTMTB100 and LTMTB200. 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 FN1325rc except for the cell corresponding to LTMTB142 and LTMTB242,

learning would be allowed only in cell LTMTB142 and LTMTB242 and the

learned correction in LTMTB142 and LTMTB242 would be applied to all

speed-load points for fuel calculations referencing EGO-1 (every cell

referenced by the 4-point linear interpolation routine during the LTMTB1

table lookup would point to cell LTMTB142). This calibration for FN1325

is shown on the next page.

3. 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 FN1325 that is >OR= 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: FN1325 controls the update rate and update area for both LTMTB1

and LTMTB2.

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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LTMTB1 AND LTMTB2 LEARNING/USE CONTROL TABLE FN1325

FN1325 CELLS

Special idle

adaptive cells ---->|-42 -42 -42 -42 -42 -42

|

7 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

|

6 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

|

5 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

|

FN021 4 |-42 -42 20 -42 -42 -42 -42 -42 -42 -42

NORMALIZED |

ENGINE 3 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

LOAD |

(LOAD) 2 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

|

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

FN070 NORMALIZED

ENGINE SPEED

(N)

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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LOOP COUNTER LOGIC FOR PACING ADAPTIVE LEARNING

AFMFLG = 1 ---------------------------|

|

CFMFLG = 1 ---------------------------|

|

MFMFLG = 1 ---------------------------|

|

TFMFLG = 1 ---------------------------|OR --| Disable Adaptive Learning

| |

| | SET LPCT1R = 0

OPEN LOOP FUEL CONTROL ---------------| | SET LPCT1L = 0

| | SET LPCT2R = 0

ADPTMR < ADAPTM ----------------------| | SET LPCT2L = 0

| | EGOCT1 = 0

REFFLG = 1 -------------| | | EGOCT2 = 0

|AND ---------| |

ISCFLG NOT= 1 ----------| | EXIT Adaptive Fuel

| Routine

|

| --- ELSE ---

REFFLG = 1 -------------| |

|AND ---------------| Special Idle Cells

ISCFLG = 1 -------------| |

| SET NRMCES = ISFLAG

| SET COLTBU = ISFLAG

| SET NRMRLD = 8

| SET ROWTBU = 8

|

| --- ELSE ---

|

REFFLG = 0 ---------------------------------| Look up Normal Cell

| coordinates

|

| RANNUM = RANNUM \* RANMUL

| NRMCES = NORM\_N70

| NRMRLD = NORM\_MAPOPE21

| ROWTBU = NRMRLD + 0.5 +

| lower byte of RANNUM

| COLTBU = NRMCES + 0.5 +

| upper byte of RANNUM

|

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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FN1325rc < 0 ---------------------|

|

|NRMRLD - LSTROW| > DELROW -------|OR ------| Change Adpative Region

| |

|NRMCES - LSTCOL| > DELCOL -------| | SET LSTROW = NRMRLD

| (Current Normalized

| Row number)

| SET LSTCOL = NRMCES

| (Current Normalized

| Column number)

| SET LPCT1R = 0

| SET LPCT1L = 0

| SET LPCT2R = 0

| SET LPCT2L = 0

| EGOCNT1 = 0; EGOCNT2 = 0

| EXIT Adaptive Fuel

| Routine

|

| --- ELSE ---

|

SWTFLn = 1 ---------------------------------| Increment EGOCTn if EGOn

| switched

AEFUEL > AELIM -------------------| | Disable Adaptive Learning

| |

|EFTR| >OR= ADEFTR ---------------|OR ------| SET LPCT1R = 0

| | SET LPCT1L = 0

REFFLG = 0 -----------| | | SET LPCT2R = 0

|AND -------| | SET LPCT2L = 0

ROWTBU = 8 -----------| | | EGOCT1 = 0; EGOCT2 = 0

| |

ACT <OR= AFACT1 ------------------| | EXIT Adaptive Fuel

| | Routine

ACT >OR= AFACT2 ------------------|

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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EGO-1 LOOP COUNTER UPDATE

(LPCT1L and LPCT1R)

EGOCT1 >OR= "A" -----------------|

|

EGO-1 is RICH -------------------|AND --| Increment LPCT1R

| |

LAMBSE1 >OR= (1+ BIAS + DELAMB) -| | --- ELSE ---

|

EGO-1 is LEAN -------------------| |

|AND --| Increment LPCT1L

LAMBSE1 <OR= (1+BIAS - DELAMB) --|

|

EGOCT1 >OR= "A" -----------------|

EGO-2 LOOP COUNTER UPDATE

(LPCT2L and LPCT2R)

EGOCT2 >OR= "A" ----------------|

|

EGO-2 is RICH ------------------|

|AND --| Increment LPCT2R

LAMBSE2 >OR= (1+BIAS + DELAMB) -| |

| --- ELSE ---

EGO-2 is LEAN ------------------| |

|AND --| Increment LPCT2L

LAMBSE2 <OR= (1+BIAS - DELAMB) -|

|

EGOCT2 >OR= "A" ----------------|

Where: (See next page)

6-48

FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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WARM\_UP COUNTER LOGIC

WARM\_UP = 0 -----------|

|

TCSTRT < VECT5 --------|

|AND ---| Set WARM\_UP = 1

ECT > VECT3 -----------| | Set KWUCTR = KWUCTR + 1

| | Clip KWUCTR to 255

RUN MODE --------------|

Note: The above logic is actually done in Continuous Self Test.

KWUCTR < KWUCNT ---------------| "A" = FAEGCT

(First few warm\_up cycles) | (Use fast learning rate)

|

| --- ELSE ---

|

KWUCTR >OR= KWUCNT ------------| "A" = ADEGCT

| (Use normal learning rate)

INPUTS/OUTPUTS

KWUCTR = KAM warm\_up counter. Stores number of warm\_ups in KAM. Reset to

zero if KAM is corrupted. (battery disconnect, etc.)

CALIBRATION CONSTANTS

FAEGCT = Fast Adaptive EGO count. Number of EGO 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.

KWUCNT = Maximum mumber of warm\_up cycles to use fast adaptive EGO count. It

should be set to approx. 3 to 5 warm\_ups.

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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ADAPTIVE LEARNING CONDITIONS FOR LTMTB1 (EGO-1) TABLE

LTMTB1 cells are updated when the following conditions are satisfied:

FN1325rc >OR= 0 ----------|

|

LPCT1R > 2\*FN1325rc ------|AND -| LTMTB1rc = LTMTB1rc - 0.0039

| | (1 bit)

LTMTB1rc > MINADP --------| |

| DECREMENT CHKSUM

| SET LPCT1R = 0

| SET EGOCT1 = 0

|

| --- ELSE ---

|

LPCT1L > 2\*FN1325rc ------| | LTMTB1rc = LTMTB1rc + 0.0039

| | (1 bit)

LTMTB1rc < MAXADP --------|AND -| INCREMENT CHKSUM

| | SET LPCT1L = 0

FN1325rc >OR= 0 ----------| | SET EGOCT1 = 0

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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ADAPTIVE LEARNING CONDITIONS FOR LTMTB2 (EGO-2) TABLE

FN1325rc >OR= 0 ----------|

|

LPCT2R > 2\*FN1325rc ------| | LTMTB2rc = LTMTB2rc - 0.0039

|AND -| DECREMENT CHKSUM

LTMTB2rc > MINADP --------| | SET LPCT2R = 0

| SET EGOCT2 = 0

|

| --- ELSE ---

|

LPCT2L > FN1325rc --------| | LTMTB2rc = LTMTB2rc + 0.0039

|AND -| INCREMENT CHKSUM

LTMTB2rc < MAXADP --------| | SET LPCT2L = 0

| | SET EGOCT2 = 0

FN1325rc >OR= 0 ----------|

LPCT2L and LPCT2R logic is shown in the Loop Counter update Section. NOTE

that During Adaptive Learning r = ROWTBU and c = COLTBU.

The Adaptive Fuel Strategy statistically distributes the learned values to

the four adjacent cells to a given speed load point by adding a random number

to the normalized inputs. However, if the engine is operating in one of the

Idle regions (Row 8, Columns 0 - 5), the software does not use the

statistical distribution.

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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USE OF KAM ADAPTIVE FUEL DATA

The adaptive fuel table stored in KAM is used as a reference for both open

and closed loop fuel control.

The adaptive fuel table is referenced as shown below.

CRKFLG = 1 ------------------|

(CRANK Mode) |

|OR --| KAMRF1 = 1.0

LEGOFG1 = 1 ---------| | | KAMRF2 = 1.0

|AND ---| | Use no interpolation

LEGOFG2 = 1 ---------| |

| --- ELSE ---

REFFLG = 1 ----------| |

(In FAM) | |

|AND ---------| KAMRF1 = 0.5 + LTMTB1rc

HCAMFG = 0 -----| | | KAMRF2 = 0.5 + LTMTB2rc

(no RPM adder) |OR -| | r = 8, c = ISFLAG

| | Use no interpolation

HCAMSW = 0 -----| |

(ignore HCAMFG) | --- ELSE ---

|

| KAMRF1 = 0.5 + LTMTB1rc

| KAMRF2 = 0.5 + LTMTB2rc

| Use 4 point interpolation

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, FN26 and BZZRPM.

For purposes of interpolation, the LTMTBn 80 to LTMTBn 85 cells are not

included. These cells should correspond to the special idle cells.

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FUEL STRATEGY - ADAPTIVE FUEL - GUE0

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LACK OF EGO SWITCHING KAMRF

LEGOFG2 = 1 ---------|

|OR ----------| KAMRF2 = KAMRF1

NUMEGO = 1 ----------| |

| --- ELSE ---

|

LEGOFG1 = 1 -----------------------| KAMRF1 = KAMRF2

Note: For purposes of Interpolation, the Idle Adaptive

cells are treated as containing 0.5. These cells

should correspond to Idle Mode.

The use of KAMRF1 and KAMRF2 is shown in the pulsewidth

equation in the FUEL section.

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FUEL STRATEGY - ACCELERATION ENRICHMENT - GXM0

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ACCELERATION ENRICHMENT FUEL DESCRIPTION

In the RUN and UNDERSPEED modes, whenever the rate of change of throttle

angle exceeds a minimum value, acceleration enrichment fuel is delivered

until the manifold filling effect is completed (LOAD stops increasing). The

fuel is delivered at a rate determined by AEFUEL.

AE fuel is delivered synchronous with the base fuel pulse. AEFUEL is added

into the FUELPW calculation (See the FUELPW logic and equations). No

separate AE pulses are delivered.

6-54

FUEL STRATEGY - ACCELERATION ENRICHMENT - GXM0

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DEFINITIONS

- CRANK = Engine startup strategy.

- RUN = Normal engine control strategy, (used once engine

has maintained a certain speed and does not stall).

- UNDERSPEED = Strategy to assist the transition from CRANK

to RUN; it also is called whenever the engine stalls

or stumbles.

INPUTS

Registers:

- AEFUEL = Rate of AE fuel delivery in LB/MIN.

- AELOAD = Filtered LOAD (defined in System Equations).

- LOAD = Normalized ARCHG divided by SARCHG.

- N = Engine speed (revs/min).

- NEW\_AE = Handshaking flag between background and EOS.

- OLDTP = Previous TP sensor value, counts.

- TAR = Throttle Angle Rate of change, deg/sec.

- TP = Throttle position sensor.

Bit Flags:

- AEOFLG = Indicates whether the LOAD rate of change

reflects the manifold filling effect. After the

LOAD begins to increase, the AEOFLG is set to

one to signal manifold filling effect.

- CRKFLG = Flag indicating engine mode; 1 = Crank.

Calibration Constants:

- AEACLD = Change in LOAD indicating that the Intake

Manifold is filling, "Hg.

- AEM = A calibratible multiplier for AE fuel.

- AETAR = Calibratible minimum TAR, deg/sec.

- FN019B = Throttle angle rate normalizing function;

used to clip and scale for table look-up.

Input = throttle angle rate and Output =

Normalized throttle angle rate.

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FUEL STRATEGY - ACCELERATION ENRICHMENT - GXM0

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- FN020B = Temperature normalizing function; used to clip

and scale for table look-up. Input = ECT and

Output = Normalized Temperature.

- FN331B = A multiplier as a function of the present

throttle angle minus the lowest measured

throttle angle (TP - RATCH).

- FN378 = A multiplier as a function of BP. Input = BP

and Output = Multiplier.

- FN1303 = Acceleration enrichment desired fuel flow table.

Output = AE desired fuel flow. TAE is its synonom.

X-input = Normalized throttle angle rate - FN019B

Y-input = Normalized ECT - FN020B

- FRCTAE = TAE ACT to ECT proportioning factor.

- TAE (FN1303) = An 8x7 table of fuel flow as a function

of throttle angle rate of change (TAR) and

temperature. The temperature input can be ECT or

ACT as defined by the combination [FRCTAE\*ACT

+(1-FRCTAE)\*ECT].

The normalizing function for TAR is FN019B. The

normalizing function for the ECT/ACT temperature

combination is FN020B.

- TPDLTA = Minimum TP change that indicates throttle plate

travel.

OUTPUTS

Registers:

- AEFUEL = Rate of AE fuel delivery in LB/MIN.

- NEW\_AE = Handshaking flag between background and EOS.

- OLDTP = Previous TP sensor value, counts.

- TAR = Throttle Angle Rate of change, deg/sec.

Bit Flags:

- AEOFLG = Indicates whether the LOAD rate of change

reflects the manifold filling effect. After the

LOAD begins to increase, the AEOFLG is set to

one to signal manifold filling effect.

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FUEL STRATEGY - ACCELERATION ENRICHMENT - GXM0

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AEFUEL LOGIC

CRKFLG = 1 (CRANK) -------------|

|OR ---| AEFUEL = 0

TAR <OR= AETAR -----------------| |

| |

LOAD - AELOAD <OR= AEACLD -| | |

(Manifold is full) | | |

|AND-| |

AEOFLG = 1 ----------------| |

(Manifold was/is filling) |

| --- ELSE ---

|

AEM\*TAE\*FN331B\*FN378 | AEM\*TAE\*FN331B\*FN378

AEFUEL < ------------------------|OR --| AEFUEL = --------------------

60 | | 60

| |

NEW\_AE = 1 ----------------------| | CLEAR NEW\_AE = 0

TAE (8x7 table of fuel flow function) is used in the above logic diagram.

The X and Y inputs to this table are TAR and Temperature. For throttle angle

rates of change below that of the first column of the TAE Table (17

degrees/second), TAE is set to zero. For TAR values between AETAR and 17

deg/sec, AEFUEL should be constant (to avoid effects of TAR jitter.

NEW\_AE = a handshaking flag between background and EOS. It is set in the

FUEL\_SERVICE routine (rising or falling edge of PIP) and indicates that

current value of AEFUEL has been used. It is cleared by the background when

the AEFUEL calculation is done. When set, the background allows AEFUEL to

decrease if needed. This guarantees that AE will always be output for short

tip-in's.

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FUEL STRATEGY - ACCELERATION ENRICHMENT - GXM0

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The AE fuel is turned off by setting TAR equal to zero, if the driver tips

out (TP decreases). TP is saved as OLDTP to permit recognition of

instantaneous accels or decels. TPDLTA must be set large enough to avoid

treating A/D jitter as a decel condition.

OLDTP - TP > TPDLTA (DECEL) -------| Set TAR = 0

AEOFLG LOGIC

The AEOFLG indicates whether the LOAD rate of change indicates the occurrence

of the manifold filling effect. The rate of change of LOAD represents the

engine response to the driver demand command. There is a short delay between

the TP change and the LOAD change. During this delay, the AEOFLG remains at

zero. After the LOAD begins to increase, the AEOFLG is set to one to signal

the occurrence of the manifold filling effect. After the manifold has filled

(LOAD stops increasing), the software turns off the AE fuel regardless of the

status of the TAR circuit.

TAR > AETAR ---------------|

|AND --|S Q--| SET AEOFLG = 1

LOAD - AELOAD > AEACLD ----| | | (Manifold filling)

| | OLDTP = TP

| |

TAR = 0 --------------------------|C | --- ELSE ---

|

| SET AEOFLG = 0

| (Manifold not filling)

| OLDTP = TP

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FUEL STRATEGY - TRANSIENT FUEL - GUAA

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TRANSIENT FUEL COMPENSATION STRATEGY

BACKGROUND

Transient Fuel is variously referred to as manifold wall wetting, puddling,

filling, fuel film condensation/evaporation.

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.

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FUEL STRATEGY - TRANSIENT FUEL - GUAA

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APPROACH

. 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)

. 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 |

\ /

. The time constant and steady state film mass are calculated from APELOD and

temperature variables 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 |

\ /

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FUEL STRATEGY - TRANSIENT FUEL - GUAA

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TRANSIENT FUEL COMPENSATION STRATEGY

DEFINITIONS

- CRANK = Engine Starting Strategy.

- RUN = Normal engine control strategy.

- UNDERSPEED = Engine Strategy which makes the transition

from CRANK to RUN mode; it also operates when the

engine stalls or stumbles.

INPUTS

Registers:

- AISF = Actual Intake Surface Fuel.

- ATMR1 = Time since exiting Crank Mode, secs.

- DELTIM = Time since last AISF update.

- EFTR = Equilibrium Fuel Transfer Rate during the

previous program pass.

- ISCFLG = ISC Mode Flag (1 = RPM Control Mode).

Bit Flags:

- CRKFLG = Flag indicating engine mode. Set to 1,

if engine Cranking. Set to 0 for other

modes.

- DFSFLG = Indicates Decel Fuel Shutoff.

- EFFLG1 = Equilibrium Fuel Flag. This flag controls

the initialization of AISF.

- UNDSP = Flag set to 1 if engine in UNDERSPEED or CRANK

mode, set to zero otherwise.

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FUEL STRATEGY - TRANSIENT FUEL - GUAA

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Calibration Constants:

- AISFM = Multiplier on AISF when in DFSO. Determines Fuel Puddle

size upon re-entering normal fuel.

- ALPHA = A multiplier proportioning the dependency

of ACT TO ECT.

- EFTC = Equilibrium fuel time constant.

= TEFTC(FN1322) = An 10 X 8 table of equilibrium

fuel transfer time constants as a function of:

ALPHA \* ACT + (1 - ALPHA)\*ECT and APELOD.

- EISF = TEISF(FN1321) = An 10 X 8 table of fuel mass

values as a function of:

ALPHA\*ACT + (1 - ALPHA)\*ECT and APELOD.

- FN071 = Load Normalizing function; used for table

lookup. Input = LOAD and Output = Normalized

load.

- FN374 = Open Loop Fuel multiplier, RPM.

- FN1321 = Equilibrium Intake Surface Fuel Table. TEISF

is the synonym for this Table.

X-input = Normalized ALPHA \* ACT + (1-ALPHA)

\* ECT = FN022A

Y-input = Normalized Load = FN071.

- FN1322 = Equilibrium Fuel Transfer Constant. TEFTC is

the synonym for this Table.

X-input = Normalized ALPHA \* ACT + (1-ALPHA)

\* ECT = FN022A

Y-input = Normalized Load = FN071.

- KFT = Multiplier (can be used to disable transient

fuel compensation by setting equal to zero).

- MEFTRA = Multiplier for accelerations.

- MEFTRD = Multiplier for decelerations.

- MTEFTC = Equilibrium Fuel transfer constant

multiplier.

- MTEISF = Equilibrium intake surface fuel multiplier.

- TEISF = Load Normalizing function; used for table

lookup. Input = LOAD and Output = Normalized

load.

X-input = Normalized ALPHA \* ACT + (1-ALPHA)

\* ECT = FN022A

Y-input = Normalized Load = FN071.

- TFCDED = Percentage deadband around Equilibrium Intake Surface

Fuel to turn off transient fuel.

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FUEL STRATEGY - TRANSIENT FUEL - GUAA

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- TFCISW = Transient fuel compensation initialization

switch.

- TFCTM = Time delay after start before enabling

Transient Fuel compensation.

- TFSMN = Maximum RPM deadband above Idle RPM to disable

Transient Fuel during Dashpot Mode, RPM.

OUTPUTS

Registers:

- AISF = Actual Intake Surface Fuel.

- AEFTRFF = The upper word of the sum of (AEFUEL/2) and (EFTRFF/2).

- EFTR = Equilibrium Fuel Transfer Rate during the

previous program pass.

- EFTRFF = Transient fuel flow in LB/MIN.

- EFTRFFL = The lower word of the sum of (AEFUEL/2) and (EFTRFF/2).

Bit Flags:

- EFFLG1 = Equilibrium Fuel Flag. This flag controls

the initialization of AISF.

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FUEL STRATEGY - TRANSIENT FUEL - GUAA

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TRANSIENT FUEL COMPENSATION STRATEGY CONTROL LOGIC

CRANK mode ---------------|

(CRKFLG = 1) |

|

UNDERSPEED mode ----------|OR -----| DO NOT RUN TRANSIENT

(UNDSP = 1) | | FUEL COMPENSATION

| | EFFLG1 = 0 (CLEAR)

ATMR1 < TFCTM ------------| | EFTR = 0

| |

| --- ELSE ---

|

EFFLG1 = 0 ---------------| |

| |

RUN mode -----------------|AND ----| DO NOT RUN TRANSIENT

(CRKFLG = 0, UNDSP = 0) | | FUEL COMPENSATION

| | INITIALIZE

TFCISW = 1 ---------------| | AISF = MTEISF

(assume wet manifold | \* FN1321(TEISF)

at startup) | EFFLG1 = 1 (SET)

|

|

| --- ELSE ---

|

|

EFFLG1 = 0 ---------------| |

| |

RUN mode -----------------|AND ----| DO NOT RUN TRANSIENT

| | INITIALIZE

TFCISW = 0 ---------------| | AISF = 0

(assume dry manifold | EFFLG1 = 1 (SET)

at startup) |

|

| --- ELSE ---

RUN Mode -----------------| |

| |

DFSFLG = 1 ---------------|AND ----| DO NOT RUN TRANSIENT

(in DFSO) | | FUEL COMPENSATION

| | INITIALIZE AISF =

EFFLG1 = 1 ---------------| | MTEISF\*FN1321(TEISF) \* AISFM

| EFFLG1 = 1 (SET)

| EFTR = 0

|

|

EFFLG1 = 1 ---------------| |

|AND ----| RUN TRANSIENT

RUN mode -----------------| | FUEL COMPENSATION

(CRKFLG = 0, UNDSP = 0) | DO ACTUAL INTAKE SURFACE

| FUEL CALCULATIONS

| DO EQUILIBRIUM FUEL

| TRANSFER CALCULATIONS

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FUEL STRATEGY - TRANSIENT FUEL - GUAA

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EQUILIBRIUM FUEL TRANSFER CALCULATIONS

These calculations are performed during each program pass (background loop)

while transient fuel compensation is enabled. The general form of the rate

calculation is:

EFTR = KFT \* [(EISF \* MTEISF - AISF)/(EFTC \* MTEFTC)]

EISF and EFTC are defined as follows: (NOTE: EISF and EFTC may not be saved

as dedicated registers. They appear here as an aid in showing the

calculations.)

AISF -- Actual Intake Surface Fuel Calculation.

This calculation is performed during each program pass (background loop)

while TFC is enabled. AISF is a time integration of the fuel flow to and

from the manifold puddle.

AISF = AISF + (EFTR \* DELTIM)

EFTR - TRANSIENT FUEL FLOW CALCULATION/MULTIPLIER

REFFLG = 1 ------------------------|

(in FAM region) |

|

ISCFLG > 0 ------------------------|

(RPM control or lockout) |

|

ISCFLG = -1 -----------| |

|AND -------|

N - DSDRPM < TFSMN ----| |

(low RPM decel) |

|

MTEISF \* FN1321 = AISF ------------|OR ----| EFTRFF = 0

(values are equal or 0) | | (stop adding transient

| | fuel to pulsewidth,

|(MTEISF \* FN1321 - AISF)/ | | continue AISF update)

(MTEISF \* FN1321)| <OR= TFCDED ---| |

(percentage difference is small) | --- ELSE ---

|

MTEISF \* FN1321 < AISF --------------------| EFTRFF=EFTR\*60\*MEFTRD

(decrease puddle) | (use decel multiplier)

|

| --- ELSE ---

|

| EFTRFF=EFTR\*60\*MEFTRA

| (use accel multiplier)

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FUEL STRATEGY - TRANSIENT FUEL - GUAA

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Determine total fuel requirements due to manifold filling (AEFUEL) and

wall wetting (EFTRFF) and provide that value to the fuel pulsewidth

equation. The value is divided by two assuming equal distribution between

banks.

AEFTRFF,EFTRFFL = (AEFUEL/2) + (EFTRFF/2)

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FUEL STRATEGY - DECEL FUEL SHUT OFF - GUE0

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DECEL FUEL SHUT OFF STRATEGY

The Fuel Shutoff strategy is divided into two sub-strategies:

1) Decel Fuel Lean Out.

2) Manual Transmission Shift Fuel Lean Out.

The Decel Fuel Lean Out strategy reduces the fuel flow during specific load

and RPM condition only during Closed Throttle Mode. The FUELPWs are

multiplied by FN374 during a decel until the RPM is within the band created

by [DSFRPM - DSFRPH] of the idle RPM range. Typically, FN374 is calibrated

to provide a lean limit air/fuel ratio during the decel RPM range.

The Manual Transmission Shift Fuel Lean out strategy reduces (or eliminates)

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. Typically, FN374 can be calibrated to

zero during the range of shift RPMs.

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FUEL STRATEGY - DECEL FUEL SHUT OFF - GUE0

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DEFINITIONS

INPUTS

Registers:

- APT = If = -1, Closed Throttle.

- ATMR1 = Time since start, sec.

- CTTMR = Time since entering Closed throttle mode, secs. CTTMR is used to

delay Decel Fuel Shutoff (DFSO).

- DLTMR = Decel fuel low load timer, sec.

- DSDRPM = Desired engine speed.

- ECT = Engine Coolant Temperature, deg F.

- LOAD = Normalized ARCHG divided by SARCHG.

- N = Engine speed, RPM.

- NACTMR = Not at Closed Throttle timer, sec.

- 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.

- PPCTR = PIP counter for Fuel Ramp, unitless.

- RATCH = Warm curb Idle Throttle Position, counts.

- TP = Throttle position, counts.

- VSBAR = Vehicle speed, MPH.

Bit Flags:

- AFMFLG = Flag indicating that ACT sensor is in/out of range.

- CFMFLG = Flag indicating that ECT sensor is in/out of range.

- DMFLG = Decel fuel low load timer enabled flag, 1 = Count up timer.

- EFMFLG = Flag indicating that EVP EGR sensor has failed.

- MFAFLG = Managed Fuel/Air state flag.

- MFMFLG = Flag indicating that MAF sensor has failed.

- NDSFLG = Neutral/Drive Flag, 1 = Drive.

- TFMFLG = Flag indicating that TP sensor has failed.

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FUEL STRATEGY - DECEL FUEL SHUT OFF - GUE0

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Calibration Constants:

- AGB = Decel fuel shutoff time delay, sec.

- CTDFSO = 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.

- DFLDH = Decel Fuel low load hysteresis.

- DFLDL = Decel Fuel low load shut off.

- DFLOD = Maximum load to enable decel Fuel Shut-off.

- DFLODH = Hysteresis for DFLOD.

- DFSECT = Minimum ECT to allow Decel Fuel Shutoff.

- DFSVS = Minimum VSBAR for Decel fuel shut off, mph.

- DFSVSH = Hysteresis for DFSVS.

- DLDFSO = Decel Fuel low load shut off time, sec.

- DMIN = Minimum FN379 clip during Fuel Ramp Back, unitless.

- DSFRPH = Hysteresis for DSFRPM, unitless.

- DSFRPM = Minimum RPM for Decel fuel shutoff, RPM.

- DSFTM = Minimum Time at Part Throttle (or WOT) to permit Decel Fuel

Shutoff AFTER CTDFSO seconds, sec. This time requirement prevents decel

fuel shutoff when parking the vehicle.

- DSTM1 = Maximum time that Decel Fuel Shutoff is enabled if decelerating

in Neutral, sec.

- DSTM2 = Maximum time that DFSO logic is enabled during manual

transmission shifts, secs.

- FN374 = Open Loop Fuel multiplier, RPM.

- 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.

- PTDFSW = Part Throttle Decel Fuel shut off switch; 1 = Do Part Throttle

DFSO, 0 = Do Closed Throttle DFSO.

- 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.)

6-69

FUEL STRATEGY - DECEL FUEL SHUT OFF - GUE0

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TRLOAD = Transmission Load switch.

0 = Manual Transmission, no clutch or gerar 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.

OUTPUTS

Registers:

- DLTMR = Decel fuel low load timer, sec.

- PPCTR = PIP counter for Fuel Ramp, unitless.

Bit Flags:

- DFSFLG = Indicates DECEL Fuel shutoff.

- DMFLG = Decel fuel low load timer enabled flag, 1 = Count up timer.

6-70

FUEL STRATEGY - DECEL FUEL SHUT OFF - GUE0

Copyright 1989 FoMoCo

DECEL FUEL SHUT OFF LOGIC

"A" ---------|

|OR ------------------------------|

"B" ---------| |

| |AND -| 'D'=FN374

"C" ---------| | | PPCTR = 1

| |

| |

N - DSDRPM > DSFRPM -------------|S Q----------| |

| | |

N - DSDRPM < DSFRPM - DSFRPH ----|C | |

(DECEL RPM) | | --- ELSE ---

| |

| |

ATMR1 > AGB --------------------| | |

(START UP DELAYS) |OR -----------| |

| | |

ECT >OR= DFSECT ----------------| | |

| |

MFAFLG = 0 ------------------------------------| |

(NOT MANAGED FUEL AIR) | |

| | Driver wants

RUNNING = 0 -----------------------------------| | to accelerate

(NOT IN VIP) | | 'D' = 1.0

| | Increment PPCTR

AFMFLG = 0 ------------------------------------| | once per PIP

| | period

CFMFLG = 0 ------------------------------------| | Clip PIPNUM

|

TFMFLG = 0 ------------------------------------|

|

EFMFLG = 0 ------------------------------------|

|

MFMFLG = 0 ------------------------------------|

When fuel is shut off (FN374) a flag is set - DFSFLG to disable

Transient fuel. See Transient Fuel Compensation Logic for details.

FN374 = 0 -----------------| DFSFLG = 1

|

| --- ELSE ---

|

| DFSFLG = 0

6-71

FUEL STRATEGY - DECEL FUEL SHUT OFF - GUE0

Copyright 1989 FoMoCo

"A" LOGIC

(Normal Decel)

LOAD < DFLOD ----------------------|S Q -------|

| |

LOAD > DFLOD + DFLODH -------------|C |

|

NDSFLG = 1 ---------| |

(Trans. in gear) |OR -----------|S Q -------|

| | |

TRLOAD < 2 ---------| | |

(ignore N/D input) | |

| |

TRLOAD >OR= 4 ------| | |

|OR -| | |

NDDTIM >OR= DSTM1 --| | | |

|AND------|C |AND ----| "A"

NDSFLG = 0 --------------| |

|

CTTMR > CTDFSO --------------------| |

|AND --| |

APT = -1 --------------------------| | |

| | |

CTTMR > CTEDSO ---------------| | | |

(LONG DECEL) |OR -| | |

| | |

NACTMR > DSFTM ----------|S Q-| | |

(CRUISE) | |OR -|

| | |

0 < NACTMR <OR= DSFTM ---|C | |

(SHORT TIP IN) | |

| |

PTDFSW = 1 -------------------------------| |

|

VSBAR >OR= DFSVS --------|S Q -----------------|

|

VSBAR < DFSVS - DFSVSH --|C

6-72

FUEL STRATEGY - DECEL FUEL SHUT OFF - GUE0

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"B" LOGIC

(MANUAL TRANSMISSION SHIFT)

APT = -1 -------------------------------|

(Closed Throttle) |

|

TRLOAD <OR= 3 --------------------------|

(Manual trans.) |

|

NDSFLG = 0 -----------------------------|

|

NDDTIM < DSTM2 -------------------------|AND -| "B"

|

N - DSDRPM > SHFRPM ---------------|S Q-|

|

N - DSDRPM <OR= SHFRPM-SHFHYS -----|C

(Short RPM)

"C" LOGIC

DMFLG = 1 --------------------|

(Decel and Closed Throttle) |AND ----| "C"

|

DLTMR < DLDFSO ---------------|

(Start of Decel)

CALIBRATION HINTS:

The use of Decel Fuel Shutoff can aggravate Clunk. Therefore, DFSO should

occur only at low airflow (low MAP) in order to minimize the rate of change

of Torque. CTDFSO can be used to delay DFSO.

FN374 should be calibrated to avoid lean misfires. Therefore, it should be

either zero (Decel Fuel Shutoff) or greater than the lean limit (Decel Fuel

Lean Out).

CTEDSO should be greater than CTDFSO to prevent DFSO after Tip-in, Tip-out.

For MANUAL TRANSMISSIONS: SHFRPM should be greater than DSFRPM.

6-73

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH, BASE FUEL FLOW - GUF0

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BASE FUEL FLOW CALCULATIONS

OVERVIEW

Using the assumption of equal air flow (AM) between bank 1 and bank 2, a

calculation can be made of the amount of fuel required by the engine to

operate at stoichiometry.

DEFINITIONS

INPUTS

Registers:

- AM = Air mass flow for the engine (lb/min).

- ARCHG = Air charge inducted per intake stroke. Value is updated once per

background loop at the time that AM is computed, (lb).

- 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

n = bank number

r = row

- LAMBSEn = The stoichiometric equivalence value. (n=bank number).

- N = Engine speed in revolutions per minute.

Calibration Constants:

- ENGCYL = The number of cylinders in an engine revolution.

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FUEL CONTROL STRATEGY - FUEL PULSEWIDTH, BASE FUEL FLOW - GUF0

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OUTPUTS

Registers:

- ARCHG\_BG = Air charge inducted per intake stroke. Value is updated once

per background loop at the time that base fuel flow is computed.

- BASEFFn = The fuel flow for bank (n). (lb/min).

The base fuel flow for each bank is:

0.5 \* AM \* KAMRF1

BASEFF1 = -----------------

14.64 \* LAMBSE1

0.5 \* AM \* KAMRF2

BASEFF2 = -----------------

14.64 \* LAMBSE2

where:

AM = ARCHG \* N \* ENGCYL

and:

ARCHG\_BG = ARCHG after the calculation of BASEFF1 and BASEFF2.

6-75

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH, BACKGROUND FUEL - GUF1

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BACKGROUND FUEL

OVERVIEW

The fuel pulsewidth for each bank of the engine is calculated during

each pass through the background loop. This calculation consists of a base

fuel calculation, BASEFFn, that is a determination of the amount of fuel the

bank would need to remain at or near stoichiometry during steady state engine

operation. Additionally, there is a need to modify this value with other

values that reflect the fuel needs of the engine under non-steady conditions.

Under all operating conditions except CRANK mode the fuel equation is:

FUELPWn = D \* (BASEFFn + AEFTRFF) \* PWCF + FN367

As one of the controlling elements, the speed limiter logic turns off the

fuel when the engine speed becomes excessively high. This logic operates as

an overspeed protection, like a software governor. This action reduces the

power output of the engine and causes the speed to drop to a more reasonable

level.

DEFINITIONS

INPUTS

Registers:

- AEFTRFF = The upper word of the sum of (AEFUEL/2) and (EFTRFF/2).

- AEFUEL = Rate of acceleration enrichment fuel delivery (lb/min).

- APT = At Part Throttle - indicates throttle mode; -1 = closed throttle,

0 = part throttle, and 1 = wide open throttle.

- BASEFFn = Base Fuel Flow associated with "n" EGO. (n = 1,2) (lb/min).

- BP = Barometric Pressure (inches of Mercury).

- CRKTMR = Timer indicating time in Crank mode.

- D = Deceleration Fuel Shutoff multiplier.

- ECT = Engine Coolant Temperature.

- EFTRFF = Equilibrium fuel transfer rate for transient fuel compensation

(lb/min).

- EFTRFFL = The lower word of the sum of (AEFUEL/2) and (EFTRFF/2).

- N = Engine speed in revolution per minute.

- VBAT = Battery voltage inferred from IIVPWR, volts.

6-76

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH, BACKGROUND FUEL - GUF1

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Bit Flags:

- BFULSW = Force Background Fuel Switch (1 = Do not calculate fuel

pulseswidth in foreground at any time).

- CRKFLG = Engine mode flag. (1 = Crank Mode, 0 = Not in Crank Mode).

- FAM\_FLG = Indicates that the engine is in the operating region where a

filter is being applied to the air mass value to reduce fluctuations and

that filtered value is to be used in the fuel pulsewidth as a replacement

for AM.

- FOFFLG = Alternate injector fire enable flag; 1 = fire alternate

injectors.

- HSPFLG = High speed mode flag; 1 = High speed alternate fuel/spark.

- IMFMFLG = Instantaneous mass air flow sensor FMEM flag.

- MFMFLG = Air Meter failure flag.

- NLMT\_FLG = Engine Speed Limiter Flag - (1 = limit engine speed by turning

off the fuel; 0 = normal engine speed).

- UNDSP = Run/Underspeed Engine Mode Flag. (1 = Underspeed/Crank, 0 = Run

Mode).

Calibration Constants:

- AHISL = High fuel flow injector slope (lb/sec).

- ALOSL = Low fuel flow injector slope (lb/sec).

- ENGCYL = Number of cylinders per engine revolution.

- FN306(CRKTMR) = Cranking fuel pulsewidth as a function of time in crank.

- FN348(ECT) = Crank fuel pulsewidth as a function of ECT.

- FN367(VBAT) = Injector offset as a function of VBAT.

- FN387(ECT) = Fuel pulsewidth muliplier as a function of ECT.

- FN389(VBAT) = Dual slope injector breakpoint. Input = VBAT, volts and

Output = lb/rev.

- INJOUT = Number of injectors fired by each output port.

- MTCF = Milliseconds to clock ticks conversion factor.

- NLMT = Overspeed RPM.

- NLMTH = Hysteresis for overspeed RPM.

- NUMOUT = Number of injector output ports.

- PIPOUT = Number of PIP's between injector outputs on each injector port.

6-77

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH, BACKGROUND FUEL - GUF1

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OUTPUTS

Registers:

- BGFULn = Background Fuel Pulsewidth for bank "n" (n = 1,2).

- FFULCn = The value that is added in the foreground fuel pulsewidth.

- FFULMn = The value that is multiplied by the ratio of air charges in the

foreground fuel pulsewidth equation for bank "n".

- FUELFLOWn = Desired fuel flow for the "n" bank (n = 1,2).

- LBMF\_INJn = The pounds mass of fuel per injection that is calculated for

summing to be sent out on the Data Output Link (DOL).

- PWCF = Computed value to convert amount of fuel for the engine to amount

of fuel to be delivered by each injector.

- PWOFF = Injector pulsewidth offset (clock ticks).

- PWOFS = Injector pulsewidth offset (milliseconds).

Bit Flag:

- FFULFLG = Foreground Fuel Flag - (1 = compute fuel pulsewidth in

foreground using latest integrated air charge, 0 = use background

calculated fuel pulsewidth.

6-78

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH, BACKGROUND FUEL - GUF1

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Calculate the value of the pulsewidth conversion factor (PWCF):

1 2 \* PIPOUT

PWCF = ---------- \* ---------------

N \* ENGCYL NUMOUT \* INJOUT

Determine the value of the underspeed and deceleration fuel multipliers:

UNSPD = 1 -----| fuel\_a = FN387(ECT) \* D

|

| --- ELSE ---

|

| fuel\_a = D

Determine the intersection point, in fuelflow, of the two slopes of the injector

flow vs time transfer functions.

fuel\_f = FN389(VBAT) \* N / 2

NOTE: Lower case designators indicate temporary registers that are

not accessible. (i.e. fuel\_a)

6-79

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH, BACKGROUND FUEL - GUF1

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Calculate the crank fuel and dechoke pulsewidth, and the underspeed/run fuel

flow amounts:

CRKFLG = 1 ----|

|AND ------------| BGFUL1 = BGFUL2 = 0

APT = 1 -------| |

(Wide Open |

Throttle) |

|

| --- ELSE ---

|

CRKFLG = 1 ---------------------| BGFUL1 = FN348 \* (BP/29.875) \*

| FN306(CRKTMR)

|

| BGFUL2 = BGFUL1

|

| --- ELSE ---

|

NLMT\_FLG = 1 -------------------| BGFUL1 = 0

| BGFUL2 = 0

|

| --- ELSE ---

|

| FUELFLOW1 = fuel\_a \* (BASEFF1 + AEFTRFF)

|

| FUELFLOW2 = fuel\_a \* (BASEFF2 + AEFTRFF)

6-80

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH, BACKGROUND FUEL - GUF1

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Determine on which slope the injector is operating and calculate the fuel

pulsewidth (BGFULn) and foreground fuel intermediate values (FFULMn and

FFULCn).

FUELFLOW1 <OR=

fuel\_f -| BGFUL1 = FUELFLOW1 / ALOSL \* PWCF

|

| FFULM1 = fuel\_a \* BASEFF1 / ALOSL \* PWCF

|

| FFULC1 = fuel\_a \* AEFTRFF / ALOSL \* PWCF

|

| --- ELSE ---

|

| { fuel\_f FUELFLOW1 fuel\_f }

| BGFUL1 = { ------ + --------- - ------ } \* PWCF

| { ALOSL AHISL AHISL }

|

| FFULM1 = (fuel\_a \* BASEFF1 / AHISL) \* PWCF

|

| {fuel\_f fuel\_f (fuel\_a \* AEFTRFF)}

| FFULC1 = {------ - ------ + ---------------- } \* PWCF

| {ALOSL AHISL AHISL }

FUELFLOW2 <OR=

fuel\_f -| BGFUL2 = FUELFLOW2 / ALOSL \* PWCF

|

| FFULM2 = fuel\_a \* BASEFF2 / ALOSL \* PWCF

|

| FFULC2 = fuel\_a \* AEFTRFF / ALOSL \* PWCF

|

| --- ELSE ---

|

| { fuel\_f FUELFLOW2 fuel\_f }

| BGFUL2 = { ------ + --------- - ------ } \* PWCF

| { ALOSL AHISL AHISL }

|

| FFULM2 = (fuel\_a \* BASEFF2 / AHISL) \* PWCF

|

| {fuel\_f fuel\_f (fuel\_a \* AEFTRFF)}

| FFULC2 = {------ - ------ + ---------------- } \* PWCF

| {ALOSL AHISL AHISL }

6-81

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH, BACKGROUND FUEL - GUF1

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Compute the pounds mass per injector for use by the Data Output Link (DOL):

CRKFLG = 1 ---------| LBMF\_INJ1 = ALOSL \* BGFUL1

| LBMF\_INJ2 = ALOSL \* BGFUL2

|

| --- ELSE ---

|

| LBMF\_INJ1 = FUELFLOW1 \* 2 / (ENGCYL \* N)

| LBMF\_INJ2 = FUELFLOW2 \* 2 / (ENGCYL \* N)

Determine the state of the flag which allows updates to fuel pulsewidth using

the latest computed air charge in foreground:

BFULSW = 1 ------------------------|

|

IMFMFLG = 1 -----------------------|

|

MFMFLG = 1 ------------------------|

|

CRKFLG = 1 ------------------------|

|

FAM\_FLG = 1 -----------------------|

|OR ------| FFULFLG = 0

NLMT\_FLG --------------------------| |

| | --- ELSE ---

FOFFLG = 1 ------------------------| |

| | FFULFLG = 1

HSPFLG = 1 ------------------------|

Calculate the injector pulsewidth offset:

PWOFF = PWOFS \* MTCF = [FN367(VBAT)] \* MTCF

6-82

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH, FOREGROUND FUEL - GUF0

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FOREGROUND FUEL

OVERVIEW

This module is designed to calculate an updated fuel pulsewidth using

the latest air charge value upon the completion of the air charge computation

during the PIP interrupt. Included within this module is a a check for a 10%

change in computed pulsewidth, a determination of whether to update the fuel

pulsewidth, and a new request for a new computation of the injector timing.

DEFINITIONS

INPUTS

Registers:

- ARCHFG = The integrated value of air charge as computed at each PIP

interrupt (lb).

- ARCHG\_BG = The value of air charge that was used to compute the

intermediate values for the foreground fuel calculation and additionally,

the air charge value that is divided into the latest air charge to scale

the new fuel pulsewidth (lb).

- BGFULn = The fuel pulsewidth that is calculated in background for each

bank. (n = 1,2).

- DT12S = The period of time between two adjacent rising edges of PIP.

- FFULCn = The computed value that is added in the foreground fuel

pulsewidth calculation.

- FFULMn = The computed value that is multiplied by the scaled value of

ARCHI divided by ARCHG\_BG in the foreground fuel pulsewidth calculation

for each bank.

- PWOFF = The offset in the transfer function for injector fuel delivered

versus time in clockticks.

Bit Flag:

- FFULFLG = Foreground Fuel Flag (1 = compute fuel pulsewidth in foreground

using the latest integrated air charge, 0 = use background computed fuel

pulsewidth).

Calibration Constants:

- PIPOUT = The number of PIP periods between the start of consecutive

injections.

Constant:

- STCF = Seconds to clock ticks conversion factor.

6-83

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH, FOREGROUND FUEL - GUF0

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OUTPUTS

Register:

- FUELPWn = The injector pulsewidth in clock ticks (n = 1,2).

Bit Flag:

- CHANGE\_FUELPW = A flag that indicates that the desired pulsewidth for

in-progress fuel injections needs to be modified because the latest

calculated value for that injection has changed by more than 10 percent.

6-84

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH, FOREGROUND FUEL - GUF0

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Following the completion of the ARCHFG calculation in foreground, determine if

the foreground fuel flag (FFULFLG) is set, and if so, calculate the fuel

pulsewidth at that time, otherwise use the background computed pulsewidth.

PROCESS

FFULFLG = 1 --------| fuelpw1 = [(FFULM1 \* ARCHFG) / ARCHG\_BG] + FFULC1

| fuelpw2 = [(FFULM2 \* ARCHFG) / ARCHG\_BG] + FFULC2

|

| --- ELSE ---

|

| fuelpw1 = BGFUL1

| fuelpw2 = BGFUL2

then convert into clockticks:

FUELPW1 (ticks) = fuelpw1 \* STCF

FUELPW2 (ticks) = fuelpw2 \* STCF

Determine if the fuel requested is greater than the amount that can be

delivered when the injectors are on full time, and if so, clip the fuel

pulsewidth to a full-on pulsewidth.

DT12S < 65536 ticks ------|

|AND ---| fgbeta = PIPOUT - 0.03125

(FUELPWn / DT12S) | | FUELPWn = fgbeta \* DT12S

>OR= PIPOUT -------------| |

Determine if the latest pulsewidth calculated for each bank is a change of

more than 10% from the previous pulsewidth for that bank. If so, set the

flag CHANGE\_FUELPW, which will cause any injection in progress for that bank

to be altered to reflect the latest calculated pulsewidth.

/ \

| |(new FUELPWn - old FUELPWn)| |

| ----------------------------- | > 0.010 ----| CHANGE\_FUELPW = 1

| old FUELPWn |

\ /

6-85

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH - GXX0

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DUAL SLOPE BREAKPOINT DETERMINATION

FN389 CALIBRATION

1. Plot fuel flow per pulsewidth as a function of

Pulsewidth at various battery voltage.

(see Fuel Mass versus Fuel Pulsewidth figure on

next page)

2. Make a table of fuel flow breakpoints, at which

the injector slope changes.

NOTE: The breakpoint is the FUELFLOW -- not

the pulsewidth.

3. Convert the breakpoints into FN389-y parameters.

FN389 y-value = BREAKPOINT \* NUMOUT\*INJOUT \* ENGCYL

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

PIPOUT

The BREAKPOINT is equal to the fuel flow at which the injector slope changes

for the corresponding battery voltage, lb/pulsewidth.

For example, the injectors used on a 5.0L engine have two slopes. These

slopes intercept at 3.0 mg/pw at VBAT = 13.5V. Thus,

FN389 = 3.0 lb 8\*1

----- \* ----- \* ------ \* 4 = 2.64\*10E-5 lb/rev.

1000 454g 8

NOTE: FN367 breakpoints may require recalibration.

6-86

FUEL CONTROL STRATEGY - FUEL PULSEWIDTH - GXX0

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FUEL MASS VERSUS FUEL PULSEWIDTH DIAGRAM

|

|

6|

| AHISL--> \*

| . .

| . .

| . .

4.5| . .

Fuel | . .

Mass | . .

| . .

Mg/Pulse | . .

3| FN389(VBAT1) . .

| | . .

(f(x)) | V . .

| ALOSL --> \* .

| . \* <--FN389(VBAT2)

1.5| . .

| . .

| . .

| . .

| . .

| . .

0 -----|------|-------------|------------|-----------|--

.5 | 1.5 2.5 3.5 4.5

|

V

FN367(VBAT1) FUEL PULSEWIDTH (msec) (x)

6-87

FUEL STRATEGY - SPEED LIMITER - GUE0

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SPEED LIMITER

The speed limiter logic protects vehicle function in three stages, depending

upon the engine speed and vehicle speed (inferred from AM). 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 the fuel if the engine RPM exceeds its

"red-line" limit.

NOTE: NLM\_SH should approximate the engine's "red line" limit.

6-88

FUEL STRATEGY - SPEED LIMITER - GUE0

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DEFINITIONS

INPUTS

Registers:

- N = Engine RPM

- VSBAR = Filtered Vehicle Speed.

Bit Flag:

- FOFFLG = Alternate INJ fire enable flag.

Calibration Constants:

- HVS\_CL = Disable Stage 1 Speed Limiter.

- HVS\_SH = Enable Stage 1 Speed Limiter.

- VVS\_CL = Disable Stage 2 Speed Limiter.

- VVS\_SH = Enable Stage 2 Speed Limiter.

- NLM\_SH = Overspeed RPM, sets stage 3 fuel limiter.

- NLM\_CL = RPM to clear Stage 3 Fuel Limiter, RPM.

- VSTYPE = Vehicle speed sensor/Cruise control H/W present switch 0 = No

integrated cruise control and no Vehicle Speed Sensor. 1 = Vehicle speed

sensor present (VSS) 2 = Integrated cruise control and Vehicle Speed

Sensor (VSS+VSC)

OUTPUTS

Bit Flags:

- FOFFLG = Alternate INJ fire enable flag.

- HSPFLG = High Speed Mode Flag, = 1 means High Speed Alt. Fuel/Spark

Speed Limit.

- NLMT\_FLG = Overspeed limiter flag, stage 3.

6-89

FUEL STRATEGY - SPEED LIMITER - GUE0

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EXAMPLE OF SPEED LIMITER

NORMAL FUEL

---- ----

| | | |

INJ-1 | | | |

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

---- ----

| | | |

| | | |

INJ-5 ----- -------------------------------- ---------

---- ----

| | | |

| | | |

INJ-4 ---------- --------------------------------- ----

----

| |

| |

INJ-2 --------------- --------------------------------------

. .

. .

. .

----

| |

| |

INJ-8 -------------------------------- ----------------------

6-90

FUEL STRATEGY - SPEED LIMITER - GUE0

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SPEED LIMITED FUEL

---- ----

| | | |

INJ-1 | | | |

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

INJ-5 ----------------------------------------------------------

---- ----

| | | |

| | | |

INJ-4 ---------- --------------------------------- ----

INJ-2 -----------------------------------------------------------

. .

. .

. .

----

| |

| |

INJ-7 --------------------------- --------------------------

INJ-8 -----------------------------------------------------------

6-91

FUEL STRATEGY - SPEED LIMITER - GUE0

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ALTERNATE FUEL/SPARK LOGIC AND

ALTERNATE INJECTOR FIRING LOGIC

(Vehicle Overspeed Protection)

N > NLM\_SH --------------------|S Q ---------| STAGE 3

| | Set NLMT\_FLG

N < NLM\_CL --------------------|C

VSTYPE = 0 ------------------------------------| HSPFLG = 0

(No VSS sensor) | FOFFLG = 0

|

| --- ELSE ---

|

VSBAR > VVS\_SH -----------|S Q ---------------| STAGE 2

(Very High Speed) | | Fire Alternate

| | Injectors using

VSBAR < VVS\_CL -----------|C | Normal Fuel strategy

| FOFFLG = 1

|

| --- ELSE ---

|

VSBAR > HVS\_SH -----| |

(High Speed) |OR --|S Q ---------------| STAGE 1

| | | Do Fuel Enrichment

FOFFLG = 1 ---------| | | and Spark Retard

| | HSPFLG = 1

VSBAR < HVS\_CL -----------|C | FOFFLG = 0

|

| --- ELSE ---

|

| HSPFLG = 0

6-92

FUEL CONTROL STRATEGY - INJECTOR TIMING, BACKGROUND - GUAA

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BACKGROUND CALCULATION

INJECTOR TIMING

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

0 degrees TDC to 720 degrees ATDC with 4 degree 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 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.

When the system is in sync (SYNFLG = 1), injector timing is calculated from

the following equation:

FUEL\_IN\_SYNC = 0 --------------| Signature PIP is recognized

| but fuel timing has not

| yet SYNC'ed. INJDLY is set

| by the EOS

|

DNDSUP = 0 -----------| | --- ELSE ---

| |

CINTSW = 1 -----------|AND ----| Neutral Timing

| | INJDLY =

"A" ------------------| | UROLAV (CINTV,TCINJD)

|

| --- ELSE ---

IDLFLG = 1 -----------| |

|AND ----| Idle Timing (in drive)

CIDRSW = 1 -----------| | INJDLY =

| UROLAV (MIDTV,TCINJD)

|

| --- ELSE ---

|

MFAFLG = 1 --------------------| MFA Mode Injector Timing

| INJDLY =

| UROLAV (MINTV,TCINJD)

|

| --- ELSE ---

|

| temp = IDKMUL \* FN1315 + IDKADD

| INJDLY = UROLAV (temp,TCINJD)

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FUEL CONTROL STRATEGY - INJECTOR TIMING, BACKGROUND - GUAA

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STARTUP\_DELAY LOGIC FOR FIXED IDLE INJECTOR TIMING

TCSTRT >OR= CTHIGH -------------|

|AND --|

ATMR1 >OR= NITMR3 --------------| |

|

CTLOW < TCSTRT < CTHIGH --------| |

|AND --|OR --| "A"

ATMR1 >OR= NITMR2 ------| | |

|AND ---| |

ATMR2 >OR= NITMR5 ------| |

|

TCSTRT <OR= CTLOW --------------| |

|AND --|

ATMR1 >OR= NITMR1 ------| |

|AND ---|

ATMR2 >OR= NITMR4 ------|

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FUEL CONTROL STRATEGY - INJECTOR TIMING, FOREGROUND - GUAA

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FOREGROUND INJECTOR TIMING

OVERVIEW

Each time a new fuel pulse start time is calculated and the delay from

the current PIP edge is between 0.5 and 1.5 PIP periods, a request for a new

delay calculation is requested.

DEFINITIONS

INPUTS

Registers:

- INJDLY = Delay in degrees from the reference PIP to the referenced edge

in the fuel pulse.

- TOTAL\_DELAYn = Delay in percent of PIP period from the reference PIP to

the starting edge of the fuel pulse.

Calibration Constants:

- DEGPIP = Engine degrees per PIP period.

- INJREF = Indicates which edge of the fuel pulse is the reference edge for

fuel timing, INJDLY. (0 = start edge).

- NUMCYL = Number of cylinders in the engine.

OUTPUTS

Register:

- TOTAL\_DELAYn = Same as above.

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FUEL CONTROL STRATEGY - INJECTOR TIMING - GUAA

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NOTES:

1. The change in injector timing between consecutive injector firings is

limited to a maximum of 45 degrees. This has the effect of walking the

injector timing for large timing changes.

2. The final value of injector delay is limited to the range 0 degrees to

720 degrees. Intermediate calculations and results are maintained in an

unlimited fashion.

3. 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 CONTROL STRATEGY - INJECTOR TIMING - GUAA

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DEFINITIONS

- RUN = Engine strategy designed to operate normal engine running.

INPUTS

Registers:

- ACT = Air Charge Temperature, deg F.

- ATMR1 = Time since exiting crank mode, sec.

- ATMR2 = Time since engine coolant temperature became greater

than TEMPFB, sec.

- CID = Camshaft Cylinder Number 1 identification

sensor.

- ECT = Engine Coolant Temperature, deg F.

- HFDLTA = Latest elapsed time from PIP\_UP\_EDGE to PIP\_DOWN\_EDGE,

clock ticks.

- INJDLY = Injector delay in degrees.

- LOAD = Normalized ARCHG divided by SARCHG.

- N = Engine speed, RPM.

- PIP = Profile Ignition Pickup (RPM sensor)

- SYNCTR = Counter which counts PIP signals until its value

is equal to NUMCYL (Number of cylinders). SYNCTR is

initialized to 0.

- TCSTRT = Temperature of engine coolant (ECT) at initial startup, deg F.

Bit Flags:

- FUEL\_IN\_SYNC = Fuel synchronized with PIP.

- IDLFLG = Flag indicating transmission in Drive and at Idle.

- MFAFLG = Managed Fuel Air State flag.

- NDSFLG = Neutral/Drive flag 1 = Drive.

- NEW\_IDELAY = Flag controlled by EOS. If set (1) this flag

triggers injector delay calculation in the background

loop; if clear (0), no injector delay calculation is done.

- SIGPIP = Flag which is set if Signature PIP has occurred;

Flag which is cleared if Signature PIP has not.

This flag is initialized to 0.

- UNDSP = Run/Underspeed flag. (1 = Underspeed (or CRANK),

0 = RUN).

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FUEL CONTROL STRATEGY - INJECTOR TIMING - GUAA

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- WMEGOL = Flag set if WRMEGO set.

Calibration Constants:

- CIDRSW = Calibration switch to enable Special Fuel Timing at

Idle, unitless. If set to 1, Enable; 0, Disable.

- CINTSW = Cal Switch to enable special fuel timing in

Neutral, unitless.

- CINTV = Injector Timing Value in Neutral, deg.

- 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 cyl;120 deg = 6; 180 = 4 cyl)

- ENGCYL = Number of PIPs per engine revolution. 2,3 & 4 for

4,5, & 6 respectively.

- FKINJD = Filter constant for INJDLY, (NOTE: This filter

may require treating INJDLY as a word during

the actual filtering), unitless.

- FN070 = Normalizing function for engine speed N as

X-input to FN1315.

- FN082 = Load normalizing function; generates table entry

point. Input = LOAD and Output = Normalized Load.

- FN083 = RPM Normalizing function; generates table entry

point. Input = N and Output = Normalized N.

- FN085 = Normalizing function for LOAD as Y-input to FN1315.

- FN131 = Wide Open Throttle base spark advance versus

engine speed to provide base WOT Spark advance.

Input = Engine speed, RPM and Output = spark advance.

- FN1315 = An 10x8 table which gives injector delay as

a function of engine speed and load.

X-input = FN070 - Normalized Engine Speed (N).

Y-input = FN085 - Normalized Load.

- HP\_CID = A flag indicating cylinder # Identification Hardware

is present.

- HP\_CIDSEL = A flag indicating type of hardware present,

0 = Hall Effect; 1 = VRS.

- IDKADD = Injector delay timing adder.

- IDKMUL = Injector delay timing multiplier.

- INJREF = Reference edge for injector timing:

0 = indicates the start of the fuel pulse.

1 = indicates the end of the fuel pulse.

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FUEL CONTROL STRATEGY - INJECTOR TIMING - GUAA

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- MHPFD = Signature PIP difference check value.

- MIDTV = Injector timing value for Idle in Drive, deg.

Range of 0 to 720.

- MINTV = Injector Timing value for Lean Cruise Mode, Deg.

(Enabled by MFAFLG) 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.

- NUMCYL = Number of cylinders.

- PIPOUT = Number of PIPs between injector outputs on each

injector port.

OUTPUTS

Registers:

- HFDLTA = Latest elapsed time from PIP\_UP\_EDGE to PIP\_DOWN\_EDGE,

clock ticks.

- INJDLY = Injector delay in degrees.

- SYNCTR = Counter which counts PIP signals until its value

is equal to NUMCYL (Number of cylinders). SYNCTR is

initialized to 0.

Bit Flags:

- FUEL\_IN\_SYNC = Fuel synchronized with PIP.

- SYNC\_UP\_FUEL = Fuel synchronization request.

- SIGPIP = Flag which is set if Signature PIP has occurred;

Flag which is cleared if Signature PIP has not.

This flag is initialized to 0.

- SYNFLG = Flag indicating whether AE fuel is synchronous

(set = 1) or asynchronous (set = 0). Initialized to 0.

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FUEL CONTROL STRATEGY - INJECTOR TIMING - GUAA

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INJECTOR TIMING EXAMPLES

INJDLY = 400 DEGREES

ENGINE CYCLE

TDC BDC TDC BDC

| | | | |

| | | | |

|<----POWER--->|<---EXHAUST-->|<---INTAKE---->|<-COMPRESSION-->|

| STROKE | STROKE | STROKE | STROKE |

| | | | |

360 540 720 180 360

| 1ST PIP

PIP SIGNAL

| #1 PIP

|

\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*

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\* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \*

\*\* \*\*\*\* \*\*\*\*\*\* \*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\*\*

| | | | | | |

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 CONTROL STRATEGY - INJECTOR TIMING - GUAA

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INJECTOR SYNCHRONIZATION

There are two possible mechanisms for recognition of cylinder number one for

purposes of fuel synchronization: Signature PIP or Camshaft I.D. The

Signature PIP is a narrow pulsewidth from the Hall Effect Sensor on the

Distributor. The CID is a signal timed to the number-one cylinder cam. CID

is designed for use with distributorless Ignition Systems.

A. CID EDGE PROCESSING

(HP\_CID = 1)

HP\_CID is the flag set by the calibrator to indicate which kind of fuel

synchronization system is being used. If HP\_CID is set to 1, CID hardware is

present and SIGPIP will ALWAYS be set to zero. If HP\_CID is set to 0, then

Signature PIP logic is utilized.

When HP\_CID is set to 1 then the HP\_CIDSEL is the flag set by the calibrator

to indicate which kind of CID hardware is present, Hall Effect sensing or

Variable Reluctance sensing (Hall = 0 and VRS = 1).

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FUEL CONTROL STRATEGY - INJECTOR TIMING - GUAA

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B. SIGNATURE PIP DETECTION

This portion of the strategy is only activated if the HP\_CID is set equal to

0. The system is allowed to synchronize during RUN MODE only. (The SYNFLG

is cleared during CRANK or UNDERSPEED.)

Note: MHPFD is a calibration constant which is dependent only on the number

of cylinders and the Signature PIP Duty Cycle. The user must calibrate MHPFD

to the appropriate value, as shown in the table below.

CYLINDERS SIGNATURE DUTY CYCLE MHPFD

8 =OR< 35 percent .20

6 =OR< 30 percent .24

4 =OR< 30 percent .29

NOTE: If Signature PIP Distributor is NOT present,

then MHPFD = .99.

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FUEL STRATEGY - INJECTOR OUTPUT CONTROL - GUE0

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INJECTOR OUTPUT CONTROL PHILOSOPHY

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.

5. Each time a fuel PW is outputted or corrected, the Data Output Link Fuel

Summation, FUEL\_SUM is updated. FUEL\_SUM = FUEL\_SUM + LBMF\_INJn (N=1, if

FUELPW1 is outputted; n=2 if FUELPW2 is outputted.)

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FUEL STRATEGY - INJECTOR OUTPUT CONTROL - GUE0

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INJECTOR OUTPUT CONTROL

DEFINITIONS

REGISTERS/FLAGS:

- CRANK = Strategy for Start up mode of engine.

- CRKFLG = Flag indicating status of engine mode. (Set to 1, when in

Crank)

- FGFFLG = Toggle flag for alternate Injector Firing, = 1 No firing on this

injector.

- FOFFLG = Alternate Injector Firing enable flag.

- FUELPW1/FUELPW2 = EGO-1 (or EGO-2) injector pulse- width, clock ticks.

- PWOFF = Injector pulsewidth offset (clock ticks).

- RUN = Normal engine operation strategy.

- SYNFLG = Flag indicating synchronous fuel, if set = 1; asynchronous if

set = 0. It is initialized to 0.

- UNDERSPEED = Strategy used to make the transition between CRANK and RUN.

It is also used when the engine stalls or stumbles.

CALIBRATION CONSTANTS:

- CRKPIP = Number of PIP periods per Injector(s) firing(s). (NOTE: Must

be INTEGER value.)

- EDSEL = Switch for selective Crank Fuel Timing at Falling- Edge of PIP.

- ENGCYL = Number of PIPs per engine revolution, or Number of cylinders/2.

- FN1327 = Fuel pulsewidth register map, used to determine which fuel

register is used. Output = Fuel Register-left offset. X-input =

Injector output number. Y-input = Null.

- FN1329 = Injector firing order used for correcting Inj\_Fank to correct

the firing order. Output = fuel injector to be fired. X-input =

INJ\_BANK Y-input = Null

- NUMEGO = Number of EGO sensors present; mono or stereo.

- NUMOUT = Number of injector output ports.

- OUTINJ = Calibration switch to select between sequential and simultaneous

injections (OUTINJ = 1 for sequential, OUTINJ = 2 for simultaneous).

- PIPOUT = Number of PIPs between injector outputs on each injector port.

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FUEL STRATEGY - INJECTOR OUTPUT CONTROL - GUE0

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INJECTOR OUTPUT CONTROL

CRKFLG = 1 ----|

(CRANK) |

|AND --| WOT CRANK DE-CHOKE FUNCTION

FUELPW1 = 0 ---| | .No injector output.

|

| --- ELSE ---

|

CRKFLG = 1 ---| | NORMAL CRANK - Falling Edge Timing

(CRANK) |AND ---| .Fire NUMOUT injector outputs every CRKPIP

EDSEL = 0 ----| | number of PIP's, upon receiving the falling

| edge of the proper PIP signal.

| .Outputs included are INJ-1 thru INJ-NUMOUT.

| .FN1327 governs the use of FUELPW1 or FUELPW2

| as the injector pulsewidth.

| .The injector offset PWOFF is included in

| the actual injector pulse output.

| .Add FUELPWn to FUEL\_SUM; increment

| PULSCT

|

| --- ELSE ---

|

CRKFLG = 1 -----------| NORMAL CRANK - Rising Edge Timing

| .Fire NUMOUT injector outputs every CRKPIP

| number of PIP's, upon receiving the rising

| edge of the proper PIP signal.

| .Outputs included are INJ-1 thru INJ-NUMOUT.

| .FN1327 governs the use of FUELPW1 or FUELPW2

| as the injector pulsewidth.

| .The injector offset PWOFF is included in

| the actual injector pulse output.

| .Add FUELPWn to FUEL\_SUM; increment

| PULSCT

|

| --- ELSE ---

|

| ...continued next page...

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FUEL STRATEGY - INJECTOR OUTPUT CONTROL - GUE0

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|

| ...continued from previous page...

|

| RUN OR UNDERSPEED, NOT IN SYNC

| .Fire the appropriate injector outputs upon

| receiving the rising edge of the proper PIP

| signal. Injector timing is random.

| .If OUTINJ = 1, the outputs are fired

SYNFLG = 0 -----------| sequentially. If OUTINJ = 2, NUMOUT outputs

(NOT IN SYNC) | are fired simultaneously.

| .Outputs included are INJ-1 thru INJ-NUMOUT.

| .PIPOUT and NUMOUT define the firing pattern.

| .FN1329 governs the firing order.

| .FN1327 governs the use of FUELPW1 or FUELPW2

| as the injector pulsewidth.

| .The injector offset PWOFF is included in

| the actual injector pulse output.

| .Add FUELPWn to FUEL\_SUM; increment

| PULSCT

|

| --- ELSE ---

|

| RUN IN SYNC, SINGLE FIRE

| .Fire the appropriate injector outputs at the

| desired injector timing. Injector timing is

| defined by strategy and calibration.

| .If OUTINJ = 1, the outputs are fired

| sequentially. If OUTINJ = 2, NUMOUT outputs

| are fired simultaneously.

| .Outputs included are INJ-1 thru INJ-NUMOUT.

PIPOUT=ENGCYL --------| .PIPOUT and NUMOUT define the firing pattern.

(SINGLE FIRE) | .FN1329 governs the firing order.

| .FN1327 governs the use of FUELPW1 or FUELPW2

| as the injector pulsewidth.

| .The injector offset PWOFF is included in

| the actual injector pulse output.

| .Upon the "not in sync" to "sync" transition,

| injector timing is initialized to match

| the pre-sync random timing. Injector timing

| then walks to desired timing.

| .Add FUELPWn to FUEL\_SUM; increment

| PULSCT

|

| --- ELSE ---

|

| ...continued next page...

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FUEL STRATEGY - INJECTOR OUTPUT CONTROL - GUE0

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|

| ...continued from previous page...

|

| RUN, IN SYNC, DOUBLE FIRE

| .Fire the appropriate injector outputs upon

| receiving the rising edge of the proper PIP

| signal. Injector timing is random.

| .If OUTINJ = 1, the outputs are fired

| sequentially. If OUTINJ = 2, NUMOUT outputs

| are fired simultaneously.

| .Outputs included are INJ-1 thru INJ-NUMOUT.

| .PIPOUT and NUMOUT define the firing pattern.

| .FN1329 governs the firing order.

| .FN1327 governs the use of FUELPW1 or FUELPW2

| as the injector pulsewidth.

| .The injector offset PWOFF is included in

| the actual injector pulse output.

| .Upon the "not in sync" to "sync" transition,

| the injector firing pattern is adjusted to

| line up INJ-1 with signature PIP.

| .Add FUELPWn to FUEL\_SUM (for the DOL\_COUNT

| Calculation

|

| .Increment PULSCT

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FUEL STRATEGY - INJECTOR OUTPUT CONTROL - GUE0

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During the Fuel Pulsewidth output routine, the Speed Limiter flag is checked

to see if alternate injectors should be turned off. This strategy reduces

the power output of the engine without a sudden drop in RPM.

FOFFLG = 0 ------------------| Output pulse to appropriate

(Normal Engine Operation) | injector.

| FGFFLG = 0

|

| --- ELSE ---

|

FGFFLG = 0 ------------------| Output pulse to appropriate

| injector.

| Set Flag to disable next

| fuel pulse output.

| FGFFLG = 1

|

| --- ELSE ---

|

| Do NOT output pulse.

| Clear flag to enable

| next fuel pulse.

| FGFFLG = 0

NOTE: the appropriate output is determined by FN1329.

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FUEL STRATEGY - INJECTOR OUTPUT CONTROL - GUE0

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INJECTOR OUTPUT LOAD

On stereo EGO applications, each injector output must be linked to the proper

EGO sensor. FN1327 is a 1x9 table that is used to match injector output to

EGO 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 = 0, use FUELPW1.

IF FN1327 = 2, use FUELPW2.

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 NUMOUT, which

is the number of injector ports. The user must fill the table locations to

match NUMOUT.

The FN1327 table must be calibrated for all applications, regardless of the

EGO type (stereo or mono). NOTE that if NUMEGO = 1 (mono-EGO), all values in

FN1327 must be zero (corresponding to FUELPW1), or no fuel will be sent to

Bank 2.

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FUEL STRATEGY - INJECTOR OUTPUT CONTROL - GUE0

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5.0L INJECTOR OUTPUT LOAD EXAMPLES

2 CHANNEL CFI

SEFI BANK TO BANK EFI

STEREO EGO STEREO EGO

NUMOUT=8,NUMEGO=2 NUMOUT=2,NUMEGO=2

TABLE INJECTOR ------------------ ------------------

SLOT OUTPUT FN1327 PULSEWIDTH FN1327 PULSEWIDTH

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

0 NOT USED 0 FILLER 0 not used

1 INJ-1 2 FUELPW2 2 FUELPW2

2 INJ-2 2 FUELPW2 0 FUELPW1

3 INJ-3 2 FUELPW2 X not used

4 INJ-4 2 FUELPW2 X not used

5 INJ-5 0 FUELPW1 X not used

6 INJ-6 0 FUELPW1 X not used

7 INJ-7 0 FUELPW1 X not used

8 INJ-8 0 FUELPW1 X not used

2 CHANNEL CFI

SEFI BANK TO BANK EFI

MONO-EGO MONO-EGO

NUMOUT=8,NUMEGO=1 NUMOUT=2,NUMEGO=1

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

FN1327 PULSEWIDTH FN1327 PULSEWIDTH

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

0 FILLER 0 not used

0 FUELPW1 0 FUELPW1

0 FUELPW1 0 FUELPW1

0 FUELPW1 X not used

0 FUELPW1 X not used

0 FUELPW1 X not used

0 FUELPW1 X not used

0 FUELPW1 X not used

0 FUELPW1 X not used

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FUEL STRATEGY - INJECTOR OUTPUT CONTROL - GUE0

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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 EXAMPLES

2 CHANNEL CFI

SEFI BANK TO BANK EFI

FN1329 NUMOUT = 8 NUMOUT =2

TABLE --------------- ---------------

SLOT FN1329 OUTPUT FN1329 OUTPUT

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

0 1 INJ-1 1 INJ-1

1 5 INJ-5 2 INJ-2

2 4 INJ-4 X not used

3 2 INJ-2 X not used

4 6 INJ-6 X not used

5 3 INJ-3 X not used

6 7 INJ-7 X not used

7 8 INJ-8 X not used

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FUEL STRATEGY - FUEL PUMP CONTROL - MXD0

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FUEL PUMP CONTROL LOGIC

EFI vehicles are equipped with an electric fuel pump controlled by the

computer via a relay. The fuel pump relay is energized according to the

logic below;

TSLPIP < 1 SECOND -----------------| ENABLE PUMP

|

| --- ELSE ---

|

| DISABLE PUMP

PIP interrupt ---------------------| TSLPIP = 0

|

| --- ELSE ---

|

| Count up TSLPIP

DEFINITIONS

TSLPIP = Timer which track time since last PIP, msec.

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CHAPTER 7

IGNITION TIMING STRATEGY

7-1

IGNITION TIMING STRATEGY - GUE0

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IGNITION TIMING STRATEGY

The base engine spark advance strategy provided by the computer depends on

the engine operating mode. The base spark advance for each engine mode can

then be adjusted for unusual engine conditions by one or more spark

modulators.

The spark strategy is divided into four modes:

1. CRANK/UNDERSPEED mode

2. CLOSED THROTTLE mode

3. PART THROTTLE mode

4. WIDE OPEN THROTTLE mode

7-2

IGNITION TIMING STRATEGY - GUE0

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DEFINITIONS

INPUTS

Registers:

- ACT = Air Charge Temperature, deg F.

- APT = Throttle Mode Flag.

(Set = -1 = Closed Throttle)

(Set = 1 = Wide Open Throttle)

(Set = 0 = Part Throttle)

- ATMR1 = Time since start (time since exiting CRANK

mode), sec.

- DIFCTR = Counter for TL0FLG state changes.

- DIFF0 = Steady State Spark TL0 error.

- DIFF1 = Transient Spark TL0 error.

- DSDRPM = Idle speed control desired RPM.

- DT12S = Last PIP period.

- DT23S = Previous PIP period before DT12S.

- DTPCYC = PIP period ENGCYL \* 2 + 1 cylinders previous.

- DTSIG = PIP period of last signature PIP.

- ECT = Engine Coolant Temperature, deg F.

- HFDLTA = Last period from PIP up-edge to down-edge.

- HFPCYC = Period from PIP up to down-edge ENGCYL \* 2 cylinders

previous.

- KAYCTR = A counter to indicate how often to update MKAY.

- LOAD = Universal normalized load parameter.

- LUGTMR = Load transition timer defined in the TIMER

section.

- MFAMUL = MFA table ramp-in multiplier, unitless.

- MKAY = Half period multiplier to correct for average error caused by

hall effect sensor in distributor and armature.

- N = Engine RPM, RPM.

- PHFDLT = Previous time elapsed between up-edge to

down-edge of PIP.

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IGNITION TIMING STRATEGY - GUE0

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- PIPACL = Percentage of PIP that PIP will decrease

under Maximum Acceleration, Beta. Initial

value = 14%.

- PSGDLT = Previous uncorrected signature PIP half period.

- SAF = Final spark advance in degrees.

- SAPW = Spark Angle Pulse Width, msec.

- SIGDC = Signature PIP Duty Cycle.

- SIGDLT = Uncorrected signature PIP half period.

- SIGKAL = Signature PIP half period multiplier

- initial value = 1.66666 for 30% duty cycle signature PIP

= 1.42857 for 35% duty cycle signature PIP.

- SPKAD(n) = Spark adder for the nth cylinder. It is added to

SAF and may be positive or negative degrees.

- SPKMUL = Spark Feedback multiplier used to enhance idle

speed control. It is used in closed throttle mode

only and is calculated within the Idle Speed

Control Strategy.

- TCSTRT = Temperature of ECT at startup, deg. F.

- TEMDWL = Time required for coil to charge to 100% percent

of desired voltage.

- TIPRET = Tip in retard, degrees.

- TL0FLG = Transient Spark calculation flag.

- TSLPIP = Timer indicating time since last PIP Low-to

High transition, sec.

- VBAT = Time-dependent rolling average filter of

instantaneous battery voltage.

- VSBAR = Filtered vehicle speed.

Bit Flags:

- CRKFLG = Flag indicating Engine in Crank mode if set

to one.

- DOUBLE\_EDGE FLAG = Foreground (EOS) flag used to indicate

current spark output calculation method.

- HSPFLG = High Speed Mode flag; 1 = High Speed alternate fuel/spark.

- MFAFLG = Managed Fuel Air State Flag.

- NDSFLG = Neutral/Drive flag, 1 = Drive.

7-4

IGNITION TIMING STRATEGY - GUE0

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- NFLG = Neutral Idle flag.

- SIGPIP = A flag that indicates that signature PIP half period

has been identified.

- SYNFLG = Flag when set indicates Signature PIP

has been identified; else Signature PIP not

yet seen. It is initialized to 0.

- UNDSP = Flag indicating engine in Underspeed Mode or

Crank.

Calibration Constants:

- CCDSW = Calibration Switch to select Computer Controlled

Dwell. (1 = Computer Controlled Dwell;

0 = TFI Controlled Dwell)

- CTHIGH = Coolant Temperature at Hot start, deg F.

- DELTA = Closed throttle/Part throttle breakpoint value

above RATCH.

- DFMIN0 = Minimum number of TS0FLG 1 to 0 state changes.

- DFMIN1 = Minimum number of TS0FLG 0 to 1 state changes.

- DWLTBP = Temperature switch point that controls

function use, Deg F.

- DWLTSW = Switch point for change of maximum

permitted DWELL,sec.

- DWLWF = Weighting factor determining effect of ECT

and ACT on Base Dwell, unitless.

- ENGCYL = The number of cylinders in one engine revolution.

- FKMKAY = Filter constant of update rate to MKAY.

- FKSKAY = Filter constant of update rate to SIGKAL.

- FN033 = ECT normalizing function.

- FN071 = Load normalizing function; used for table lookup.

Input = LOAD and Output = Normalized Load.

- FN082 = Load normalizing Function; generates table entry

point. Input = LOAD and Output = Normalized Load.

- FN083 = RPM Normalizing function ;generates table entry

point. Input = N and Output = Normalized N.

- FN111 = Closed Throttle Base spark advance as a function

of engine speed N. Input = Engine speed, RPM and

Output = spark advance, deg BTDC.

7-5

IGNITION TIMING STRATEGY - GUE0

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- FN112 = Closed Throttle Spark advance adder as a

function of Engine Coolant Temperature ECT (to

generate cold temperature spark advance).

Input = ECT, deg F and Output = spark adder.

- FN115 = Spark adder as a function of Barometric Pressure BP.

Input = BP and Output = spark adder.

- FN125 = LOM Load function, used to activate LOM spark

strategy, RPM.

- FN126 = Spark advance adder as a function of ACT (Air

Charge Temperature).

- FN129A = LOMALT table multiplier as a function of

Barometric Pressure, BP.

- FN131 = Wide Open Throttle Base spark advance as a

function of engine speed N, DEG BTDC.

- FN133 = Wide Open throttle Spark advance adder as

a function of BP (Barometric Pressure), Deg.

- FN134 = Wide Open throttle Spark advance adder as a

function of ECT, Deg.

- FN135 = Wide Open Throttle Spark Adder as a function

of ACT, Deg.

- FN160A = Minimum DWELL time versus VBAT (below

77 deg F, sec.

- FN160B = Minimum DWELL time versus VBAT (above 77

deg F, sec.

- FN179A = High Speed Spark retard, mph.

- FN180(CTNTMR) = Idle Spark subtractor, deg.

- FN212A = LOMSEA table multiplier as a function of

Barometric Pressure, BP.

- FN311 = MFA altitude multiplier, unitless.

- FN396A = High Speed Fuel enrichment, mph.

- FN400 = Time since startup kicker time delay, sec.

It's input is TCSTRT and has a maximum

repetition of 6.

- FN839 = Spark multiplier vs. DASPOT.

Input = Dashpot air flow adder (DASPOT)

Output = Multiplier (SPKMUL)

- FN841D = Spark Multiplier vs. RPM Error to provide spark

feedback for Idle Speed Control, in Drive

Input = Speed Error (DSDRPM (word) - N)

Output = Multiplier (SPKMUL)

7-6

IGNITION TIMING STRATEGY - GUE0

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- FN841N = Spark Multiplier vs. RPM Error to provide spark

feedback for Idle Speed Control, in Neutral

Input = Speed Error (DSDRPM (word) - N)

Output = Multiplier (SPKMUL)

- FN901 (SPKSEA) = Base sea level table.

X-input = FN070 - Normalized Engine speed, RPM

Y-input = FN071 - Normlized load

- FN904A (LOMSEA) = Sea level LOM table.

X-input = FN070 - Normalized engine speed, RPM

Y-input = FN071 - Normalized load

- FN905A (LOMALT) = Altitude LOM table.

X-input = FN070 - Normalized engine speed, RPM

Y-input = FN071 - Normalized load

- FN1119 = Torque Truncation Table.

- FN1121 = Spark advance adder for EGR as a function of RPM and LOAD;

X-input = Normalized engine speed on RPM - FN070,

Y-input = Normalized LOAD - FN071,

Output = Spark advance adder for EGR, deg per 1 percent EGR.

- FN1124 = 4 x 3 table of spark adders as a function of

engine speed N and LOAD. The (X-input) normalizing

function for N is FN083 and the (Y-input)

normalizing function for LOAD is FN082.

- FN1133(ECT,LOAD) = Part throttle spark modifier table.

X-input = Normalized ECT (FN033)

Y-input = Normalized LOAD (FN071).

- FN1223 = Managed fuel Air EGR Table.

X-input = FN083 - Normalized Engine Speed, RPM

Y-input = FN082 - Normalized load.

Output = Multiplier.

- FN1328 = Managed fuel air fuel table.

X-input = Normalized engine speed, RPM - FN070

Y-input = Normalized Perload - FN072A

- FRCBFT = ACT Fraction for FN1305 lookup.

- FRCSFT = ACT fraction for FN1306 lookup.

- HCSD = Minimum RPM for High CAM Spark Retard.

- HCSDH = Hysteresis for HCSD.

- HP\_HIDRES = Hardware present - High Data Rate Electronic Spark.

- KCS1 = Closed throttle spark adder.

- KLLIM = Lowest value for MKAY multiplier - initial value = 0.9.

- KULMT = Highest value for MKAY multiplier - initial value = 1.1.

7-7

IGNITION TIMING STRATEGY - GUE0

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- KPS1 = Part throttle spark advance adder.

- KWS1 = Wide Open Throttle spark advance adder, Deg.

- LUGTIM = Engine load transition time, sec.

- MHPFD = Calibration constant dependent on number of

cylinders and Signature PIP Duty Cycle.

- MINDLA = Minimum DWELL clip above 20 msec PIP

period, Beta.

- MINDLB = Minimum DWELL clip below 20 msec PIP

period, Beta.

- NSADD = Neutral spark adder, deg.

- NTIP = Maximum RPM to enable Tip-in retard (restricted

to less than or equal to 2000 to assure TIPRET

ramp back function.)

- NUMCYL = Number of cylinders in the engine.

- PACLIM = Maximum limit of PIP acceleration in

percent of PIP period, Beta.

- PACOFF = Offset for linear equation describing PIP

Period and percent of PIP period for

acceleration, (Units = (Beta - cyl)/Rev).

- PACPER = PIP period when equation for PIPACL changes,

(Units = (Rev - seconds)/cyl).

- PACSLO = Slope for linear equation describing PIP

period and percent of PIP period for

acceleration, (Units = Beta/second).

- SIGKLL = Lowest value for signature PIP multiplier

- initial value = 1.42857 for 30% duty cycle signature PIP

= 1.25000 for 35% duty cycle signature PIP.

- SIGKLU = Highest value for signature PIP multiplier

- initial value = 1.99996 for 30% duty cycle signature PIP

= 1.66666 for 35% duty cycle signature PIP.

- SPKLIM = Maximum allowable advance in spark timing

between spout outputs, Beta.

- SPKSWH = Value (in clock ticks) equivalent to a minimum

RPM threshold, at which the strategy will time the

next SPOUT during the previous Rising-Edge of PIP

without any adjustments during the Falling-Edge.

- SPKSWL = Value (in clock ticks) equivalent to maximum RPM

at which the strategy will correct the timing of

the next SPOUT during the Falling-Edge of PIP. The

difference between SPKSWH and SPKSWL provides

hysteresis. (NOTE: SPKSWL is longer than SPKSWH).

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IGNITION TIMING STRATEGY - GUE0

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- SPLCLP = Lower limit spark clip for rotor registry.

- SPTADV = Percentage of PIP that spark may be advanced,

(Percent of PIP).

- SPUCLP = Upper limit spark clip for rotor registry.

- SSFCTR = Steady state factor for MKAY and signature KAY

calculations.

- TICKS\_DOUBLE = Value (in clock ticks) when there is

insufficient time to put out spark from Rising-Edge

Calculation to put out spark from Falling-Edge.

(Current value = 0.0012 seconds).

- TICKS\_SINGLE = Value (in clock ticks) indicating there is

insufficient time to put out spark from Falling-Edge

of PIP (Current value = 0.0010 seconds).

- TRSRPM = Minimum RPM to enable transient spark routine.

- TRSRPH = Hysteresis for TRSRPM.

- TTNOV = RPM - Vehicle Speed (N/V) ratio corresponding

to first gear.

- Y = Normal Part throttle spark multiplier.

OUTPUTS

Registers:

- DIFCTR = Counter for TL0FLG state changes.

- DTPCYC = PIP period ENGCYL \* 2 + 1 cylinders previous.

- DTSIG = PIP period of last signature PIP.

- DWLBSE = Base amount of DWELL as a function of VBAT and

TEMDWL, sec.

Initial value = 0.005.

- HFDLTA = Last period from PIP up-edge to down-edge.

- HFPCYC = Period from PIP up to down-edge ENGCYL \* 2 cylinders

previous.

- KAYCTR = A counter to indicate how often to update MKAY.

- MKAY = Half period multiplier to correct for average error caused by Hall

effect sensor in distributor and armature.

- PIPACL = Percentage of PIP that PIP will decrease

under Maximum Acceleration, Beta. Initial

value = 14%.

7-9

IGNITION TIMING STRATEGY - GUE0

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- PSGDLT = Previous uncorrected signature PIP half period.

- SAF = Final spark advance in degrees.

- SAFTOT = Total spark advance, including knock and tip-in

retard, deg BTDC.

- SIGDLT = Uncorrected signature PIP half period.

- SIGKAL = Signature PIP half period multiplier

- initial value = 1.66666 for 30% duty cycle signature PIP

= 1.42857 for 35% duty cycle signature PIP.

- TL0FLG = Transient Spark calculation flag.

SAFTOT, a DAC-able parameter has been added to the Spark Chapter. SAFTOT

allows dac'ing of total spark advance. It is updated each background loop

and will NOT display every SPKAD/TIPRET term if the background loop time is

longer than a PIP period. (NOTE: SPKAD(n) refers to the current SPKAD

referenced by the PIP\_Counter [being added to Spark]) The equation for SAFTOT

is as follows:

SAFTOT = SAF + SPKAD(n) + TIPRET

7-10

IGNITION TIMING STRATEGY - GUE0

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1. CRANK/UNDERSPEED MODE SPARK:

In the crank or underspeed mode, spark advance is fixed at 10 deg BTDC.

Spark is fired when the rising edge of the PIP signal is received.

2. CLOSED THROTTLE MODE SPARK:

Normal Closed Throttle Spark is a function of RPM and ECT, modified by the

Spark Feedback Multiplier, SPKMUL. During High Cam (as determined by RPM and

Startup Timer ATMR1), the spark advance is reduced by FN115 to light off the

catalysts (by heating up the exhaust gas). Spark is adjusted by a function

of BP, which can only occur when the Engine RPM rises above a set value. If

the Engine RPM dips below the value set by HCSD - HCSDH (these values are

calibratible), then BP correction is no longer required. FN400 provides a

maximum time for altitude compensation to spark.

APT = -1 (CLOSED THROTTLE) ----|

|

N > HCSD ------------|S Q------| | "Hi Cam" Spark

| |AND ---| SAF = (FN111 + FN112

N < HCSD - HCSDH ----|C | | - FN115 + KCS1-'C')

| | \* SPKMUL

| |

ATMR1 < FN400 -----------------| | --- ELSE ---

|

NFLG = 1 ------------------------------| Normal Closed Throttle

(Closed Throttle, Neutral) | Spark

| SAF = (FN111(N) + FN112(ECT)

| + NSADD - FN180(CTNTMR)

| + KCS1-'C') \* SPKMUL

|

| --- ELSE ---

|

APT = -1 ------------------------------| SAF = (FN111 + FN112 + KCS1

| - 'C' \* SPKMUL)

SPKMUL is a calibratible constant which is set in the Idle Speed Logic to one

of two possible functions (FN839 and FN841N/D), giving it a range of 0 to

0.996. The input to FN839 is the Dashpot Air flow Adder (DASPOT) and the

input to FN841 is the speed error (DSDRPM minus N). SPKMUL provides a

correction factor to the spark advance. FN841N and FN841D are separately

calibratible for neutral or drive. (See Idle Speed Duty Cycle calculations

at the end of ISC chapter).

'C' Logic is defined in Part Throttle Spark Section.

7-11

IGNITION TIMING STRATEGY - GUE0

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3. PART THROTTLE MODE SPARK:

Normal Part throttle is (FN904A \* FN212A + FN905A \* FN129A).

During normal part throttle operation, the logic "interpolates" between sea

level table (FN904A) and altitude table (FN905A) to calculate base spark.

Tip-in Spark (LOM) is (1 - LUGTMR/LUGTIM) \* FN901

On accelerating from a standstill, the strategy uses a more aggressive spark

table (FN901) for improved performance. Over a period of time (LUGTIM), the

spark shifts from LOM spark to normal part throttle spark. The LUGTMR logic

is described in the Timer Chapter.

BASE SPARK - LOM SPARK RELATIONSHIP

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

| |

| |

LOAD | Use FN904A |

| or |

FN125 -> |----- FN905A |

BOUNDARY | \ |

| \ |

| LOM \ |

| Use \ |

| FN901 \ |

| \ |

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

N

Actual percent EGR, EGRACT, modifies spark via FN1121 (RPM,LOAD) and high air

charge temperature via FN126(ACT).

7-12

IGNITION TIMING STRATEGY - GUE0

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TEMPERATURE COMPENSATION - [FN1133(ECT,LOAD)]

The temperature compensation serves these functions:

1. Provide spark advance for improved fuel economy (at very cold

temperatures);

2. Provide cold start spark retard to light off the catalysts for

improved emissions.

3. Adjust spark during engine overtemp.

4. Adjust temperature compensated spark for LOAD.

MANAGED FUEL AIR - 'B' LOGIC (FN1124 \* FN311)

During MFA mode, the strategy may use Open Loop Fuel FN1328 (usually lean of

stoichiometry) and modified EGR (FN1223). The base spark is further advanced

by FN1124. The amount of spark advance increment is reduced at altitude by

FN311. To avoid spark jumps during the transition from normal mode to MFA

Mode, the strategy ramps the MFA spark using MFAMUL (defined in the Fuel

Strategy).

TORQUE TRUNCATION SPARK - 'C' LOGIC (FN1119)

If the AXOD (or AOD) transmission is in 1st gear or reverse, the torque of

the engine may exceed the capacity of the transmission. Therefore, the

torque truncation strategy is designed to reduce the engine torque by

retarding the spark. FN1119 should be calibrated to achieve this torque

reduction for all speed-load points.

Because the strategy is unable to directly distinguish between first and

second gear, first gear is inferred from N/V, TTNOV. TTNOV should correspond

to the RPM-Speed ratio for first gear.

OVERSPEED PROTECTION

If the vehicle speed is too high, the spark advance is reduced by FN179A.

Under these circumstances, the Fuel Strategy forces Open Loop Fuel enrichment

(FN396A).

Note: FN396A should be calibrated to 0.996 if FN179A is equal to 0.

7-13

IGNITION TIMING STRATEGY - GUE0

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SAF LOGIC

SAF = Y \* ['S' + B - C + FN1133(ECT,LOAD)] + KPS1

HSPFLG = 1 -----------------------| SAF = SAF - FN179A(VSBAR)

'B' LOGIC

MFAFLG = 1 ------------------------| Managed Fuel Air Mode

| 'B' = FN1124 \* FN311

| \* MFAMUL

|

| --- ELSE ---

|

| 'B' = 0

'C' LOGIC

(Used in all Throttle modes)

N > TTNOV \* VSBAR ---------------------------| Torque Truncation Spark

| 'C' = FN1119

|

| --- ELSE ---

|

| 'C' = 0

7-14

IGNITION TIMING STRATEGY - GUE0

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NOTE: 1) FN212A should be equal to 1.0 at Sea Level and 0

at high altitudes;

2) FN129A should be equal to 1.0 at high altitudes

and 0 at Sea Level;

3) LUGTIM should be non-zero;

4) LOM spark may be calibrated out by setting

FN125 = 0.

4. WIDE OPEN THROTTLE MODE SPARK:

At Wide Open throttle, SAF is determined from the following equation. It is

the combined result of FOUR VARIABLE Spark Advance Adders based upon the

functions of engine speed (N), BP, ECT, ACT, and ONE CONSTANT spark advance

adder (KWS1).

SAF = FN131 + FN133 + FN134 + KWS1 + FN135 - 'C'

HSPFLG = 1 -----------------------| SAF = SAF - FN179A(VSBAR)

7-15

IGNITION TIMING STRATEGY - GUE0

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NOTE

1. The displayed SAF does not include the output of the

individual cylinder knock strategy. The knock registers,

SPKAD(n) and TIPRET may be displayed separately and are added

to SAF by the EOS when the waiting time is calculated. Refer

to the knock strategy documentation within this chapter for

additional information.

2. The final value of spark advance, [SAF + SPKAD(n) +

TIPRET], is limited to the range:

SPLCLP <OR= [SAF + SPKAD(n) + TIPRET] <OR= SPUCLP

SPLCLP is the lower spark clip. SPUCLP is the upper spark

clip. SPLCLP and SPUCLP are calibrated to match the rotor

registry of the distributor. Intermediate spark calculations

and results are maintained in an unlimited fashion.

3. The software allows the lower spark clip, SPLCLP, to be

calibrated to values down to -10 deg (10 deg ATC). This

feature has been initially provided for the sole use of the

Ignition Department in performing rotor registry tests.

Unless prior approval has been received from the Ignition

Department, Engine Systems engineers are hereby requested to

refrain from calibrating SPLCLP to a value which is less than

the minimum value of the "Spark Range" which is shown on the

Rotor Registry page of this Chapter. Otherwise, such a

calibration may result in mis/crossfire.

4. Due to physical time constraints for arming the coil and

firing the next spark, the largest spark advance increase

allowed between consecutive spark events is limited to

SPKLIM\*360/ENGCYL degrees. There is no limit on the amount

of spark advance decrease allowed on consecutive spark

events. NOTE: SPKLIM is set to .06 and should not be

increased without the prior approval of the Ignition

Department.

Final SAF <OR= Previous SAF + SPKLIM \* 360/ENGCYL

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IGNITION TIMING STRATEGY - GUE0

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SPOUT CALCULATIONS

Two Spout calculation routines are used in the strategy:

1. RISING-EDGE SPARK

2. FALLING-EDGE SPARK

RISING-EDGE SPARK

This method calculates the Spout output time based upon the times of the last

two Pip rising edges and assumes that the next Pip rising edge will occur at

the same delta-time.

SPOUT

:

: : :

:.......DT12S.......: :

: : :

:

.---------. .---------. : .----

| | | | : |

PIP | | | | : |

SIGNAL | | | | : |

| | | | : |

----. .---------. .---------.

: : :

: :..WAITING TIME..:

: : :

RE1 RE2

(10 deg B) (10 deg B)

SPOUT = RE2 + WAITING TIME

= RE2 + {[(360/ENGCYL) + 10 - SAF] / (360/ENGCYL)} \* DT12S

7-17

IGNITION TIMING STRATEGY - GUE0

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2. FALLING-EDGE SPARK

This method calculates the spout output time based upon the delta-time

between the rising edge and falling edge of the current Pip and assumes that

the next Pip rising edge will occur at the same delta-time after the falling

edge.

However, a problem exists with the Hall Effect sensor which results in an

inaccurate recognition of the falling edge. The accuracy varies as a

function of the sensor's temperature and voltage. To compensate for this

inaccuracy, an adaptive correction factor, MKAY, is continuously calculated

and applied to the observed falling edge time to create a corrected falling

edge time, FEC, as shown in the sketch below. The MKAY/SIGKAL calculations

are shown on the next page.

SPOUT

: : :

:......HFDLTA.....: :

: : :

:

.-----------------... : .----

| | : : |

PIP | | : : |

SIGNAL | | : : |

| | : : |

----. .---------------------.

: : : :

: : :.....WAITING....:

: : : TIME :

RE FE FEC

(10 deg B)

where,

RE = Rising Edge Time

FE = Falling Edge Time

FEC = Corrected Falling Edge Time

SPOUT = FEC + WAITING TIME

= FE + {{[(180/ENGCYL) + 10 - SAF] / (180/ENGCYL)} \* MKAY

- (1-MKAY)} \* HFDLTA

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IGNITION TIMING STRATEGY - GUE0

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MKAY/SIGKAL CALCULATIONS

1.a. At every PIP down-edge transition, clear SIGPIP. (existing)

b. PIP down-edge transition ----------|

|AND --| Set SIGPIP

Signature half period identified --|

c. SIGPIP is set ------------------|

| | PSGDLT = SIGDLT

SYNFLG is set ------------------|AND ---| SIGDLT = HFDLTA

| | HFDLTA = (HFDLTA\*SIGKAL)/MKAY

PIP down-edge transition -------|

2. PIP up-edge transition -----------|

| |

SIGPIP is set --------------------|AND ---| Do Signature Kay

| | Calculation

SYNFLG is set --------------------|

3. Signature Kay Calculation

|DT12S - DTSIG| < SSFCTR \* DT12S -----| | DTSIG = DT12S

| | sigkal' = DT12S/(SIGDLT\*2)

|DT12S - DT23S| < SSFCTR \* DT12S -----|AND ---| SIGKAL = FKSKAY\*sigkal' +

| | (1 - FKSKAY)\*SIGKAL

|SIGDLT - PSGDLT| < SSFCTR \* SIGDLT --| | SIGKLL < SIGKAL < SIGKLU

|

|--- ELSE ---

|

| DTSIG = DT12S

4. PIP up\_edge transition ---------------| | Increment KAYCTR

|AND ---| Do MKAY Calculation

KAYCTR <OR= ENGCYL \* 2 ---------------| |

|- - - ELSE - - - - -

|

PIP up\_edge transition -----------------------| Set KAYCTR = 1

| Set DTPCYC = DT12S

| Set HFPCYC = HFDLTA

5. MKAY Calculation

SIGPIP = 0 ------------------------------|

|

KAYCTR > ENGCYL \* 2 ---------------------| | mkay' =

| | 0.5\*(DT12S+DTPCYC)/

|DT12S - DTPCYC| <or= SSFCTR \* DT12S ----|AND ---| (HFDLTA + HFPCYC)

| | MKAY =

|HFDLTA - HFPCYC| <or= SSFCTR \* HFDLTA --| | FKMKAY \* mkay' +

| | (1 - FKMKAY) \* MKAY

mkay' < 1.2 -----------------------------| |

| KLLIM < MKAY < KULMT

(NOTE: KAYCTR must be incremented prior to MKAY calculation!)

7-19

IGNITION TIMING STRATEGY - GUE0

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RISING-EDGE vs FALLING-EDGE DECISION

The decision of which method to use is based upon the real time which is

available to do the Spout calculation and scheduling after the falling edge

of PIP is recognized. If sufficient time is available, the falling-edge

calculation will be used. Otherwise, the rising-edge calculation will be

used.

The available time to send Spout after receiving the falling edge of PIP is

equal to the distance in degrees between the two events divided by the

velocity in degrees/second, or;

DISTANCE (180/ENGCYL) + 10 - SAF

AVAILABLE TIME = -------- = -----------------------

VELOCITY ENGINE RPM \* 6

SPKSWH and SPKSWL are provided to allow the switch to Rising-Edge spark

calculation above some RPM when the error in detection of the Falling-Edge of

PIP or other factors will cause excessive spark scatter using the

Falling-Edge spark calculation. Because SPKWSH and SPKSWL are used in

foreground, the value entered in VECTOR for each must be in clock-ticks. To

convert the desired values of RPM into clock-ticks, perform the following

conversions:

SPKSWH = 60/(ENGCYL \* "Clock\_Frequency" \* upper switch RPM)

SPKSWL = 60/(ENGCYL \* "Clock\_Frequency" \* lower switch RPM)

Where Clock\_Frequency is 3.0E-6 for 12 MHz and 2.4E-06 for 15 MHz. The lower

switch RPM should be a minimum of 25 RPM and and a maximum of 250 RPM below

upper switch RPM, if used. Both SPKSWL and SPKSWH are normally set to the

equivalent of 6375 RPM, which will disable this portion of the decision

routine.

NOTE: SPKSWH and SPKSWL should not be changed without consultation with the

ESD Strategy Section.

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IGNITION TIMING STRATEGY - GUE0

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The following logic is used for the Falling versus Rising-Edge decision.

All values in ticks.

Dual\_Edge -----------------------------| | Use Single Edge

(In Falling-Edge Mode) |AND -------| (Rising-Edge)

| |

DT12S < SPKSWH ------------------| | |

|OR --| | --- ELSE ---

AVAILABLE TIME < Ticks\_Single ---| |

| Use Dual\_Edge

Single\_Edge ----------------------------| | (Falling-Edge)

(In Rising-Edge Mode) | |

AVAILABLE TIME > Ticks\_Double ----------|AND ------|

|

DT12S > SPKSWL -------------------------|

Based upon this logic, if the desired spark advance, SAF, is assumed to be 30

degrees, then the maximum RPM at which the Falling-edge spark calculation can

be used is 11667, 6667, and 4167 for the 4, 6, and 8-cylinder engines,

respectively. The Rising-edge calculation is used at higher engine speeds.

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IGNITION TIMING STRATEGY - GUE0

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HIGH DATA RATE ELECTRONIC SPARK (HIDRES) SYSTEM

(HP\_HIDRES = 1)

The High Data Rate Electronic Spark System consists of three components:

a) EEC-IV processor

b) HESC 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 one cylinder to allow signal reference.

The HESC 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 HESC 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 and a

high-to-low transition occuring at 100 degrees BTDC for each cylinder. The

module also provides LOS function whenever the EEC-IV processor fails to

provide a Spark Angle Pulse Width (SAPW) within the accepted window for each

cylinder.

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 HESC should be

transitioned from low-to-high, (with a targeted position of 20 degrees ATDC);

2) The SAPW; and 3) The time of the SPOUT high-to-low transition.

The following strategy modules are disabled in the EEC-IV processor when

HIDRES is in use.

a) Dwell Calculation

b) MKAY Calculation

c) Transient Spark Determination and Calculation

d) Rising Edge/Falling Edge decision logic

e) Double Edge Spark Calculation

f) PIP echoed SPOUT during CRANK and UNDERSPEED

g) 6% spark advance limit

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IGNITION TIMING STRATEGY - GUE0

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The "desired\_spark" calculated in the EEC-IV processor is composed of SAF,

Tip-in retard, and Knock Spark Adder. "Desired\_spark" is checked to ensure

that it is within the HESC module limits, (-10 to +57.5), and then converted

into SAPW by the following:

a) Calculate and schedule SPOUT low-to-high transition at:

up\_transition\_time = LAST\_HI\_PIP + (30 \* ENGCYL / 360) \* DT12S

where:

LAST\_HI\_PIP is the time of the latest PIP up-edge

ENGCYL is the number of cylinders firing per engine revolution

DT12S is the time between the last two PIP up-edges

30 is the number of degrees after PIP up-edge to start pulsewidth

360 is the number of degrees per revolution

b) Calculate and schedule SPOUT high-to-low transition at:

down\_transition\_time = up\_transition\_time + SAPW

where:

SAPW = 1540 - ((256 \* "desired\_spark") / 10)

and

68 usec <OR= SAPW <OR= 1796 usec

SPOUT is initialized low on EEC-IV processor power-up and will remain low

through CRANK and UNDERSPEED engine modes causing spark to be delivered at 10

degrees BTDC. Upon transition into RUN mode, the EEC-IV processor will

schedule a low-to-high transition of the SPOUT line to occur at 20 degrees

ATDC of each cylinder followed by a high-to-low transition SAPW microseconds

later. If the SPOUT line remains in either a high or low state for more than

one PIP period or if the pulsewidth of the signal is outside the clip limits,

the HESC module will assume an EEC-IV processor failure and revert to spark

placement at 10 degrees BTDC.

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IGNITION TIMING STRATEGY - GUE0

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EEC-CONTROLLED DWELL (CCDSW = 1)

In the past, the EEC only provided spark timing to the Thick Film Ignition

(TFI) module, which, in turn, controlled the Dwell. This algorithm provides

a software replacement to the TFI Dwell with opportunities for improved spark

control and shorter coil-on time. The following strategy can be used with a

distributorless ignition system.

Perform the following calculations in background:

The following determines the minimum time required for the coil to charge to

100% of desired voltage. The charging time is a function of battery voltage

and coil temperature. The values for FN160A, FN160B and the temperature

switch point between them has been determined by the Ignition Department and

should NOT be changed without their approval.

TEMDWL = DWLWF \* ACT + (1 - DWLWF) \* ECT

TEMDWL <OR= DWLTBP -------------| DWLBSE = FN160A (VBAT)

|

| --- ELSE ---

|

| DWLBSE = FN160B (VBAT)

NOTE: If CCDSW = 0, the TFI module determines the

dwell. The output will then transition from High

to Low at SPOUT time and HFDLTA.

The following logic and calculations are performed in foreground:

DWLTOT (Dwell turn-on time) is the time when the coil should start charging

to allow sufficient charging time (DWLBSE) as well as time for maximum engine

acceleration movement of PIP (PIPACL) and maximum change of requested spark

advance allowed (6% of PIP) (SPTADV).

DWLTOT = SPOUT - DWLBSE + [1 - (SPTADV + PIPACL)] \* DT12S

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IGNITION TIMING STRATEGY - GUE0

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PIPACL is set by the following conditions and calculations:

PIPACL (a function of Engine Speed) is the maximum possible rate of PIP

acceleration. The latest engine speed is available as DT12S (PIP Period),

PIPACL is described as two equations to produce an approximation to the

expontential function describing the initial engine speed and the percentage

of a PIP period that PIP may change.

DT12S >OR= PACPER/ENGCYL -----------| PIPACL = PACSLO \* DT12S

| - (PACOFF / ENGCYL)

| Clip PIPACL to PACLIM

|

| --- ELSE ---

|

| PIPACL = 2(BETAs/seconds)

| \* DT12S

DWLTOT LOGIC

DWLTOT is clipped to 50% of PIP period (MINDLA) at low RPMs and to 20% of PIP

period (MINDLB) at ALL other times, to prevent excess coil charge time. The

spout output is sent low at DWLTOT only in Run mode. In Crank and

Underspeed, Spout is sent low on PIP-down edge.

(DWLTOT - SPOUT)/DT12S <OR=

MINDLA ------------------| | DWLTOT = SPOUT + MINDLA

|AND ----| \* DT12S

DT12S > DWLTSW --------------| |

| --- ELSE ---

|

(DWLTOT - SPOUT)/DT12S <OR= MINDLB ---| DWLTOT = SPOUT + MINDLB

| \* DT12S

7-25

IGNITION TIMING STRATEGY - GUE0

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TSLPIP > 800 msec ------------|

|OR ---| Set SPOUT\_OUTPUT

CRKFLG = 1 -------------------| | to High

|

CRKFLG = 1 --------------| | --- ELSE ---

|AND-| |

PIP High-to-Low | | | Set SPOUT\_OUTPUT

transition -------------| | | to Low on

|OR ---| PIP High-to-Low

CRKFLG = 0 --------------| | | transition

| | |

UNDSP = 1 ---------------|AND-| |

| |

PIP High-to-Low | |

transition -------------| |

| --- ELSE ---

CRKFLG = 0 -------------------| |

|AND --| Set SPOUT\_OUTPUT

UNDSP = 0 --------------------| | to Low at

| time DWLTOT

Note the diagrams below.

----- ----- ----- ----- /

PIP | | | | | | | | | FIRST PIP

\_\_\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_\_\_--> | INTERRUPT IS

| UP EDGE

|

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

SPOUT | | | | | | | |

|\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_\_\_--> |

\_\_\_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ /

| | | | | | | | | |

PIP | | | | | | | | | |

|\_\_\_| |\_\_\_| |\_\_\_| |\_\_\_| |\_\_\_\_\_\_--> | FIRST PIP

| INTERRUPT

| IS DOWN EDGE

\_\_\_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ |

| | | | | | | | | |

SPOUT| | | | | | | | | |

|\_\_\_| |\_\_\_| |\_\_\_| |\_\_\_| |\_\_\_\_\_\_--> |

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IGNITION TIMING STRATEGY - GUE0

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TRANSIENT SPARK COMPENSATION LOGIC

:<---------DT23S----------->:<-----------DT12S---------->:

:<- PHFDLT ->: :<- HFDLTA ->:

.------------. .------------. .---

| | | | |

| | | |<-----TL0----->|

| | | | |

----. .--------------. .---------------.

:<--TSPKUP-->:

: :

TPPLW SPOUT

After a PIP up-edge occurs, the following logic is executed:

DIFF0 <OR= DIFF1 ---|

|AND ---|

TL0FLG = 1 ---------| |

|OR -----| DIFCTR = DIFCTR + 1

DIFF0 > DIFF1 ------| | |

|AND ---| | --- ELSE ---

TL0FLG = 0 ---------| |

| DIFCTR = 0

DIFF0 <OR= DIFF1 ---|

|AND ---| TL0FLG = 0

DIFCTR >OR= DFMIN0 -|

DIFF0 > DIFF1 ------|

|AND ---| TL0FLG = 1

DIFCTR >OR= DFMIN1 -|

DIFF0 = |DT12S - 2 \* HFDLTA \* MKAY|

DIFF1 = |DT12S - HFDLTA - (HFDLTA \* (DT23S - PHFDLT))/PHFDLT|

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IGNITION TIMING STRATEGY - GUE0

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After a PIP down-edge occurs, TL0FLG is checked and the appropriate TL0

calculation is included for SPOUT.

TL0FLG = 1 ---------------------|

|

N > TRSRPM -----------|S Q ---|AND ---| TL0 = HFDLTA \* (DT12S

| | - PHFDLT \* MKAY)/

N < TRSRPM - TRSRPH --|C | PHFDLT

|

| --- ELSE ---

|

| TL0 = HFDLTA \* MKAY

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IGNITION TIMING STRATEGY - GUE0

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SIGNATURE PIP DISTRIBUTOR

The Signature Pip Distributor has a unique duty cycle on the shutter used to

fire cylinder #1. The purpose of this unique shutter is to allow the fuel

injectors to be fired at some optimum time relative to intake valve position.

This is accomplished by first identifying the cylinder #1 Pip and then

synchronizing the fuel injectors to it as described in the fuel section.

The engineer must indicate which type of distributor is used as follows:

If a Signature Pip Distributor is used, then set MHPFD to the appropriate

value as defined in the injector synchronization routine.

If a Conventional Pip Distributor is used, then set MHPFD = .99.

When MHPFD < .99, then another consideration in the FALLING-EDGE vs

RISING-EDGE decision is the state of SYNFLG. As described in the fuel

section, when SYNFLG = 0, then the Signature Pip has not yet been identified.

Only the RISING-EDGE calculation is allowed during this time.

When SYNFLG = 1, then the Signature Pip has been identified and its

delta-time, HFDLTA, can be normalized. Signature PIP may not be exactly 30

or 35%; thus, any error from these values will introduce error in the output

spark. To prevent this error, the Signature PIP will be normalized by

replacing the HFDLTA with the HFDLTA from the previous PIP period (PHFDLT).

HFDLTA (for Sig Pip) = HFDLTA / (2 \* SIGDC)

The normalized falling edge, FE, is generated as follows:

FE (for Sig Pip) = RISING EDGE + HFDLTA

When SYNFLG = 1 and the RPM is low enough, then the FALLING-EDGE calculation

is performed in the standard manner except that the times generated by the

Signature Pip are first normalized.

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IGNITION TIMING STRATEGY - GUE0

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EEC DISTRIBUTOR ROTOR REGISTRY

Although the computer signals the ignition module and the ignition coil when

to fire the spark, the computer does not know which cylinder it is trying to

ignite. In order to get the spark from the ignition coil to the correct

cylinder, it is necessary for the distributor rotor to be lined up with the

correct terminals on the cap so that only a small air gap need be jumped.

This condition is achieved by adjusting mechanically the orientation of the

distributor rotor and cap with respect to the crank position sensor which may

be a part of distributor or remote from it.

A slight error in registry may cause mis/crossfire at one end of the spark

range.

The range of rotation in which the spark will go to the correct cylinder is

given in the chart below

ENGINE TOTAL PIP SENSOR SPARK LOS

SIZE REGISTRY LOCATION RANGE SPARK

4-CYL 60 10 BTDC 0-60 10

6-CYL 50 10 BTDC 0-50 10

8-CYL 42 10 BTDC 5-47 10

All values are in Engine Degrees. LOS spark is BTDC.

It is also necessary that the distributor adjustments be specified with these

values. For this reason, the Ignition Department must be notified of any

changes in these clip values or pip sensor location (initial timing), so that

production distributors will be correct. It is important that the 543 chart

affecting rotor alignment be updated by the engine design activity involved.

ADJUSTMENT PROCEDURE:

The Universal Distributor will be assembled with the correct rotor registry,

and the Hall Effect Sensor (PIP Sensor) located at the correct position in

relation to the rotor registry constants. It is necessary to locate the

distributor correctly, in relation to the crankshaft position of the engine.

When a Universal Distributor is installed in the engine, it is held in place

by two screws. To set the initial timing of 10 deg BTDC unplug the EEC from

memory or disconnect the SPOUT wire and adjust distributor angular location

by rotating the body till 10 deg BTDC is observed with a timing light.

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IGNITION TIMING STRATEGY - GUA0

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INDIVIDUAL CYLINDER KNOCK STRATEGY

KNOCK HARDWARE DESCRIPTION

The knock sensor is a piezo-electric accelerometer that resonates at engine

knock frequencies of approximately 5.45, 5.7, 6.0 or 8.05 kHz. The bandwidth

of the resonant frequency is quite narrow (<+/- 150 Hz) to avoid resonance

due to noise from other sources. The resonation causes the sensor to

transmit a positive voltage, KNOCK, to the EEC hardware circuit. This

hardware circuit compares the KNOCK voltage to a threshold voltage, NOISE.

When KNOCK > NOISE, the hardware circuit sends a KNOCK INPUT signal to the

EEC software. This event is represented on the next page as KI = 1. The EEC

software stores this information until the next rising edge of PIP is

received. At that time, the information is used by the KNOCK LOGIC as

described in the remainder of this document.

NOISE, the threshold voltage, is a positive voltage in an RC circuit which is

proportional to the Knock Input level at the time that a charging pulse, KTS,

is output. This threshold voltage is established to avoid treating rod

knock, piston slap, valve train noise and other noise as spark knock.

During normal engine operation, the software opens and closes a window once

per PIP period. While the window is open, KTS charges up the capacitor in

the RC circuit. While the window is closed, the NOISE level decays

(decreases) at a steady rate determined by the time constant of the RC

circuit.

NOISE ~ (D.C. Bias + KNOCK(A))\*(1-exp(-KTS/RC)) + LAST NOISE

where, NOISE is the noise threshold level

KNOCK(A) is the Knock input level at the time

KTS is being output.

KTS is the pulsewidth (secs) of the charging pulse.

KTS Start time is calculated as follows:

NEWTIME = LAST\_HIPIP + (WINDOW\_BETA\*MKAY\*2\*HFDLTA)

RC is the RC time constant.

LAST NOISE is the noise level at the time

KTS is output.

WARNING: To avoid raising the NOISE threshold level too high, the KTS pulse

should charge the RC circuit only during that portion of the PIP period

wherein no Knock is indicated, normally late in the current PIP period or

early in the following PIP period. The calibration of the pulsewidth and

timing of the window is described in the Knock Threshold Sense Logic section

of this strategy.

Since the noise level is a function of RPM, the NOISE threshold tends to

increase with increasing RPM. At high RPM and heavy detonation conditions,

knock usually continues well into the following PIP period. To avoid opening

the window during the knock period, the software withholds KTS for WINCLD PIP

periods to avoid raising the noise threshold too high.

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IGNITION TIMING STRATEGY - GUA0

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INDIVIDUAL CYLINDER KNOCK STRATEGY

DEFINITIONS

INPUTS

Registers:

- APT = Throttle Mode Flag.

(Set = -1 = closed throttle)

(Set = 1 = wide open throttle)

(Set = 0 = part throttle)

- ECT = Engine coolant temperature, deg F.

- KI = Knock indicated, knock level is higher than noise level;

called KNK\_HIGH in code.

- KNK\_HIGH = Knock level input flag.

- KWCTR = Cancel window counter incorporated each PIP period.

- LOAD = Universal normalized load parameter.

- N = Engine speed, RPM.

- N\_BYTE = Low resolution RPM.

- RETINC = Calculated as a function of RPM and is subtracted

from each SPKAD corresponding to a knocking

cylinder. (positive degree)

- SAF = Final spark advance in degrees.

- SPKADn = Spark adder terms for the nth cylinder. It is added

to SAF, may be positive or negative degrees.

- TBART = Average Filtered Throttle Position = UROLAV (TP,TCTPT)

- TCF = Value of the difference between Throttle position

(TP) and TBART.

- TIPRET = 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.

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IGNITION TIMING STRATEGY - GUA0

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Bit Flags:

- CTFLG = Flag set to 1 to indicate closed throttle Tip-in.

- KNOCK\_DETECTED = Flag set to 1 if Knock occured in current

PIP half period.

- KNOCK\_ENABLED = Knock Strategy enabled.

- KNOCK\_OCCURED = Flag set to 1 (in the knock routine), if

knock occured in the current or last PIP

period.

- TIPFLG = Flag set to 1 to indicate a Tip-in.

Calibration Constants:

- ADVLIM = Maximum degrees of advance control.

- ECTIP = Minimum ECT to enable Tip-in Retard, deg F.

- ECTNOK = Disable Knock control below this value of ECT.

- ENGCYL = Number of cylinders per engine revolution

(NUMCYL/2); or number of PIPs per engine revolution.

- FN143A = Retard increment versus RPM, deg.

- FN144A = Variable knock Threshold window open time,

msec. Input is Engine speed in RPM; output

is fraction of PIP Period.

- FN145A = Variable Knock threshold window position.

Input = Engine Speed in RPM, output =

fraction of PIP period.

- FN146B = Spark advance Rate versus RPM, sec/deg.

- KACRAT = Change in TP equivalent to a

Tip-in Retard, counts.

- KIHP = Knock Hardware Present Switch.

1 = Knock sensor present.

- KNKCYL = Change in TP equivalent to a Tip-in Retard,

counts.

- LODNOK = Minimum load for knock control.

- NTIP = Maximum RPM to enable Tip-in retard (restricted

to less than or equal to 2000 to assure TIPRET

ramp back function.)

- RETLIM = Maximum degrees of retard control.

- RPMCNL = Threshold RPM below which the window is

always open.

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IGNITION TIMING STRATEGY - GUA0

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- RPMMIN = Disable Knock control below this RPM.

- TCTPT = Time constant for TBART (TP filter).

- TIPHYS = TIPLOD Hysteresis term to prevent multiple Tip-in

retards, unitless.

- TIPINC = Advance per PIP following a Tip-in retard.

(Must be a positive number; units are degrees)

- TIPLOD = Minimum Load to clear CTFLG for Tip-in Retard.

- TIPMAX = Initial amount of retard following a Tip-in.

(Must be a negative number; units are degrees)

- WINCLD = Number of PIPs threshold window is to be closed.

- WINLEN = Minimum amount of time threshold window is open,

msec.

- WOPEN = Position of window opening, Beta.

- Y = Normal Part throttle spark multiplier.

OUTPUTS

Registers:

- KWCTR = Cancel window counter incorporated each PIP period.

- RETINC = Calculated as a function of RPM and is subtracted

from each SPKAD corresponding to a knocking

cylinder. (positive degree)

- SPKADn = Spark adder terms for the nth cylinder. It is added

to SAF, may be positive or negative degrees.

- TIPRET = Tip-in retard.

- TSLADV = Free-running millisecond timer which counts the

time since the spark was last advanced by the

KNOCK Strategy.

Bit Flags:

- CTFLG = Flag set to 1 to indicate closed throttle Tip-in.

- KNOCK\_DETECTED = Flag set to 1 if Knock occured in current

PIP half period.

- KNOCK\_OCCURED = Flag set to 1 (in the knock routine), if

knock occured in the current or last PIP

period.

- TIPFLG = Flag set to 1 to indicate a Tip-in.

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IGNITION TIMING STRATEGY - GUA0

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KNOCK SIGNAL DETECTION

: :

:............. PIP PERIOD ..............:

: :

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

| | |

PIP | | |

| | |

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

: :

:<-- (WOPEN + FN145(N)) \* PIP PERIOD --> :

: :

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

| | | |

KTS --->| |<--- WINLEN+FN144(N)\*PIP PERIOD | |

| | | |

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

: : : :

: : : :

: : : :

: : \*\* : :

: : \* \* : :

: : \* \* : :

: : \* \* : :

: :------- \* \* : :---

NOISE : /: ----\*-- \* : /:

- : / : \* ------- \* : / :

---- : / : \* : ---\*--- : / :

-------/ : \* : \* -------/ :

: : \* : : \* : :

: : \* : : \* : :

: : \* : : \* : :

KNOCK : : \* : : \* : :

SENSOR : : \* : : \* : :

\*\*\*\*\*\*\*\*\*\*\*\*\* : : \*\*\*\*\*\*\*\*\*\*\*\*

: :

: :

: :

: :

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

| |

KI | |

| |

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

(IF KNOCK > NOISE, KI=1; OTHERWISE, KI=0)

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IGNITION TIMING STRATEGY - GUA0

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STRATEGY DESCRIPTION

The Individual Cylinder Knock Strategy consists of four major sub-strategies:

1. KNOCK STRATEGY ENABLE LOGIC

2. KNOCK THRESHOLD SENSE LOGIC

3. SPARK RETARD LOGIC

1. KNOCK STRATEGY ENABLE LOGIC

The following logic is checked every background loop:

KIHP = 1 ------------|

|

LOAD > LODNOK -------|

|

ECT > ECTNOK --------|AND ----| ENABLE KNOCK STRATEGY

| |

N\_BYTE > RPMMIN -----| | --- ELSE ---

|

| DISABLE KNOCK STRATEGY

| SET SPKAD (ALL) = 0

| SET TSLADV = 0

LODNOK, ECTNOK, and RPMMIN define the minimum engine operating conditions to

enable the Knock Control Strategy. These are calibration parameters accessible

through VECTOR and through the calibration console.

SPKAD(ALL) are spark adder terms; SPKAD1, SPKAD2, SPKAD3, .... SPKADn; where n =

KNKCYL. If KNKCYL is calibrated to be equal to the number of cylinders, then

there is a unique SPKAD term for each cylinder -- INDIVIDUAL CYLINDER KNOCK. If

KNKCYL is calibrated to 1, the Knock Strategy functions as a Multi-Cylinder Knock

Strategy; i.e., there is only one SPKAD term. It is applied to all cylinders. If

one cylinder knocks, then all cylinders get retarded an equal amount. Negative

values for SPKAD mean that spark is being retarded.

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IGNITION TIMING STRATEGY - GUA0

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2. KNOCK THRESHOLD SENSE (KTS) LOGIC

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:

WINLEN + FN144 (N) \* ("LAST PIP PERIOD")

Where, WINLEN is minimum KTS pulsewidth, clock ticks.

FN144(N) is fraction of pip period, BETA Units.

"LAST PIP PERIOD" is equal to 60/(ENGCYL\*N).

ENGCYL is number of PIPs per revolution.

The timing of KTS is equal to:

(WOPEN + FN145(N))\*("LAST PIP PERIOD")

Where, WOPEN is the minimum delay after the rising edge of PIP before the KTS

pulse will be output.

FN145(N) is a fraction of PIP period, BETA Units.

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 - GUA0

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The following logic is checked every PIP UP edge before calculating spout.

KIHP = 0 ---------------------------| NO KNOCK SENSOR

| Do not output KTS

|

| --- ELSE ---

|

N <OR= RPMCNL ---------------| |

| |

KWCTR > WINCLD --------------|OR ---| SET KWCTR = 0

| | OPEN WINDOW AT

KNOCK\_DETECTED = 0 ---|AND --| | CALCULATED TIME

| |

| | --- ELSE ---

(no KNOCK in current | |

PIP half period) | | INCREMENT KWCTR

| | DO NOT OPEN WINDOW

NOT SIGNATURE PIP ----|

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.

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

The following line of logic is executed "almost in real time".

KIHP = 0 ----------------| Prevent knock interrupts

| from occuring

|

| --- ELSE ---

|

| Allow knock interrupts

| to occur

NOTE: KNOCK\_DETECTED & VIP\_KNOCK are both set in the Knock Interrupt Routine.

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IGNITION TIMING STRATEGY - GUA0

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|<--"LAST PIP PERIOD"-->|

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

| | | | |

| | | | |

| | | | |

PIP \_\_\_| |\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_|

|<-----------A------->|

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

| | | |

|<B>| | | | | | |

| | | |

KTS \_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

| |

| | | | | | |

| |

KI ---------| |------------------------------------

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

| |

| |

| | | | |

KNOCK \_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|\_\_\_\_

DETECTED

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

| |

| | | | |

| |

KNOCK \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_

OCCURRED

Where A = (WOPEN + FN145)\*("LAST PIP PERIOD")

B = WINLEN + FN144\*("LAST PIP PERIOD") = KTS

Note: Range of A is typically 90 - 110 % of PIP period.

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IGNITION TIMING STRATEGY - GUA0

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3. SPARK RETARD LOGIC

Whenever the Knock strategy is enabled, the software calculates RETINC as a

funcion of RPM. RETINC is subtracted from each SPKAD that corresponds to a

"knocking" cylinder. The software keeps track of the cylinders by means of a "PIP

counter". The "PIP counter" is incremented once per PIP period and is set to 1

every time it exceeds KNKCYL. To prevent excessive retard (perhaps due to

erroneous knock sense) each SPKAD is clipped to RETLIM.

RETINC = FN143A (N)

During a particular PIP period ("PIP counter" = n), the software makes adjustments

to SPKAD(n-1) based on whether Knock was sensed during the previous PIP period and

uses SPKAD(n), calculated during the previous engine cycle (KNKCYL PIP periods

ago) to determine the final value of spark advance for the next spark output.

KNOCK STRATEGY ENABLED -|

|

KNOCK\_OCCURRED = 1 -----|

(knock sensed |

during last PIP |AND --| SET SPKAD(n-1) = SPKAD(n-1)

Period) | | - RETINC

| | (Clip min. SPKAD(n-1) to RETLIM)

TIPRET = 0 -------------|

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IGNITION TIMING STRATEGY - GUA0

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THROTTLE POSITION FILTER (TBART)

The TBART calculation is a time-dependent rolling average filter of instantaneous

throttle position (TP). It is updated each background pass while in RUN or

UNDERSPEED mode. The TBART time constant TCTP, is a calibratable parameter.

TBART = UROLAV (TP,TCTPT)

A separate part of the retard 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.

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IGNITION TIMING STRATEGY - GUA0

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The following Tip-in logic is checked every background loop:

ECT > ECTIP ----------|

|

TCF >OR= KACRAT ------|AND -----| SET TIPFLG = 1

| |

N < NTIP -------------| | --- ELSE ---

|

| TIPFLG = 0

APT = -1 --------|AND ----|S Q--| SET CTFLG = 1

| | |

LOAD < TIPLOD ---| | | --- ELSE ---

| |

LOAD > TIPLOD + TIPHYS ---|C | SET CTFLG = 0

NOTE: The Sum of TIPLOD + TIPHYS is clipped to 1.99

The following Tip-in logic is checked before SPOUT issues (rising

or falling edge of PIP):

TIPRET = 0 --------------------|

|

TIPFLG = 1 --------------------|AND --| SET TIPRET = TIPMAX

| | TBART = TP

KNKCYL NOT=1 ---------|AND-| | |

| | | |

| | | |

KNOCK\_ENABLE = 1 -----| | | |

| | | |

KNOCK\_OCCURRED = 1 ---| |OR-| | --- ELSE ---

(knock sensed) | |

| |

CTFLG = 1 -----------------| | SET TIPRET = TIPRET + TIPINC

| (CLIP MAX TIPRET TO 0)

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IGNITION TIMING STRATEGY - GUA0

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4. SPARK ADVANCE LOGIC

The following logic is checked every rising edge of PIP:

KNOCK STRATEGY ENABLED -|

|AND --| SET SPKAD(ALL) = SPKAD(ALL) +

TSLADV >OR= FN146B/4 ---| | 0.25 deg. (CLIP MAX

| SPKAD(ALL) TO ADVLIM)

| SET TSLADV = TSLADV - FN146B/4

If the Knock Strategy is enabled, all of the spark adders, SPKAD1 through SPKADn

are incremented 0.25 degrees every FN146B/4 seconds. Each of the SPKADn's is

clipped to ADVLIM. If ADVLIM = 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 + ADVLIM. 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 - GUA0

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SUMMARY AND EXAMPLE

The final value of spark advance is calculated by the EOS immediately prior to

calculating the waiting time:

CALCULATED SPARK OUT (n+1) = SAF + SPKAD(n+1) + TIPRET

The table shown below is included as an illustration of the Individual Cylinder

Knock Control adjustment to the Spark Advance.

Example of Individual Cylinder Knock Control (4 cyl)

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

| | | | |

PIP Counter | 1 | 2 | 3 | 4 |

|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|

| TIPRET+ | TIPRET+ | TIPRET+ | TIPRET+ |

Adjustment | SPKAD1 | SPKAD2 | SPKAD3 | SPKAD4 |

to Spark | = +2 | = +4 | = -6 | = +6 |

|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|

| | | | |

Base Spark | 24 | 24 | 24 | 24 |

(SAF) |\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|

| | | | |

Calculated | 26 | 28 | 18 | 30 |

Spark Out |\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|

| | | | |

Actual | 26 | 28 | 18 | 28.8 |

Spark Out |\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|

Due to the physical time constraints for arming the coil and firing the next

spark, the maximum spark advance increase between consecutive spark events must be

no more than SPKLIM\*360/ENGCYL degrees.

In this example, SPKLIM = .06 and ENGCYL = 2. Therefore, the largest spark

advance increase allowed between cylinders is 10.8 deg. There is no limit on the

amount of spark advance decrease allowed between cylinders.

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CHAPTER 8

EGR STRATEGY

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EGR STRATEGY - GUF0

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DEFINITIONS

INPUTS

Registers:

- AM = Air mass flow (lb/min).

- AMPEM = Air mass flow plus EGR mass flow.

- APT = Throttle Mode Flag.

(Set = -1 = Closed Throttle)

(Set = 1 = Wide Open Throttle)

(Set = 0 = Part Throttle)

- ATMR1 = Time since start (time since exiting

Crank mode), sec.

- ATMR2 = Time since ECT became greater than TEMPBF

sec.

- BP = Barometric pressure.

- DELOPT = Filtered desired EGR valve position.

- EGRERR = DELOPT - EVP

- EM = EGR mass flow.

- EOFF = The EGR valve reading when the valve is

fully closed in A/D counts.

- EVP = EGR valve position reading in A/D counts.

- ISCFLG = Mode Indicator Flag

-1 = Dashpot, 0 = Pre-pos.

1 = RPM Control, 2 = MAP RPM Control

- MFAMUL = MFA table ramp-in multiplier, unitless.

- PEXH = Absolute exhaust pressure (in Hg).

= FN074A(AM)\*29.875/BP + BP

- TCSTRT = Temperature of ECT at cold start, deg F.

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, set to 1 if

in Crank mode.

- EFMFLG = Flag indicating that EVP EGR sensor has failed (This

flag performs for both Sonic and PFE EGR).

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EGR STRATEGY - GUF0

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- EGREN = Flag which indicates EGR enabled if set

to 1.

- EGRFLG = Flag that indicates whether DCOFF has been

added to EGRDC.

- MFAFLG = Managed Fuel/Air Ratio Flag. This is

set to one if MFA is being used.

- MFMFLG = Flag indicating that MAF sensor has failed.

- TFMFLG = Flag indicating that TP sensor has failed.

Calibration Constants:

- CTHIGH = Hot Start Minimm Engine Coolant Temperature,

Deg F.

- CTLOW = Cold Start maximum ECT, deg F.

- DCOFF = Duty cycle required to start to open the valve

equivalent to LGA0O in the Vent/Vac system.

- EGRDED = Deadband value for EVP - DELOPT, counts.

- EGRMPT = Calibration time delay to ramp EGR in, sec.

(EGRATE Ramp time for TCSTRT <or= CTLOW)

- EGRTD1 = EGR time delay (TCSTRT <or= CTLOW) for low

mileage.

- EGRTD2 = EGR time delay (CTLOW < TCSTRT < CTHIGH) for

low mileage.

- EGRTD3 = EGR time delay (TCSTRT >or= CTHIGH) for low

mileage.

- EGRTD4 = EGR time delay (TCSTRT <or= CTLOW) for high

mileage or NO IMS hardware.

- EGRTD5 = EGR time delay if CTLOW < TCSTRT < CTHIGH for

high mileage or no IMS hardware.

- FN070 = Engine speed N normalizing function for FN908A and

FN908B, generates table entry point. Input = N and

Output = table entry point.

- FN074 = EGR Valve upstream pressure. Input: AM \* KAMRF1 and

Output = H2O.

- FN082 = LOAD normalized function for FN1223. Input =

LOAD and Output = Row Number (table entry point).

- FN083 = RPM normalizing function; generates table entry

point. Input = N and Output = Normalized N.

- FN211 = Part throttle EGR multiplier as a function of

Engine Coolant Temperature ECT.

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EGR STRATEGY - GUF0

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- FN212A = EGRSEA multiplier as a function of Barometric

Pressure BP.

- FN217A = EGRALT multiplier as a function of Barometric

Pressure BP.

- FN219A = EGR mass flow as a function of EGR valve

position (EVP-EOFF).

- FN220 = Multiplier as a function of Air Charge Temperature ACT.

- FN221 = EGR valve position as a function of desired mass flow.

- FN239 = Change in EVR duty cycle as a function of

the position error, EGRERR (IF PFEHP = 0);

or as a function of Pressure Error PRESER

(If PFEHP = 1).

- FN246 = EGR Mass flow as a function of DELPR, lb/min.

- FN247 = Desired Pressure Drop as a function of Desired

EGR Mass flow, inches H2O.

- FN311 = MFA altitude multiplier, unitless.

- FN908A (EGRSEA) = Sea level EGR table.

X-input = FN070 - Normalized engine speed, RPM

Y-input = FN071 - Normalized load.

Output = Percent EGR

- FN908B (EGRALT) = Altitude EGR table.

X-input = FN070 - Normalized engine speed, RPM

Y-input = FN071 - Normalized load.

- FN1223 = (Managed fuel air EGR table) 4 x 3 table of

multipliers.

X-input = FN083 - Normalized engine speed, RPM

Y-input = FN082 - Normalized Load

- KPEI = Part throttle EGR adder.

- PFEHP = Switch to select EGR strategy. 1 = PFE; 0 = Sonic;

2 = No EGR.

- TCDLOP = Time constant for DELOPT, sec.

- TCDP = Time constant fpr DESDP, sec.

- TCEACT = Time constant for EGRACT, sec.

- TSEGRE = Accumulated time EGR is enabled.

- X = EGR table multplier.

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EGR STRATEGY - GUF0

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OUTPUTS

Registers:

- DELOPT = Filtered desired EGR valve position.

- DESEM = Desired EM, lb/min. (EGRATE \* AMPEM /100)

- EGRACT = Actual EGR percent = 100\*EM/AMPEM.

- EGRATE = Desired EGR rate in percent.

- EGRDC = Duty cycle of the EVR output, fraction.

- EM = EGR mass flow.

Bit Flags:

- EGREN = Flag which indicates EGR enabled if set

to 1.

- EGRFLG = Flag that indicates whether DCOFF has been

added to EGRDC.

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EGR STRATEGY - GUF0

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EGR STRATEGY

OVERVIEW

The GX strategy provides the capability to select one of two EGR systems:

Sonic EGR or PFE EGR.

The EGR strategy is divided into:

1) Enable/Disable Logic - Common

2) EGRATE Calculation - Common

3) EM Calculation - Unique

4) EGR Error Calculation - Unique

5) EGRDC Update - Unique

6) EVR Output Routine - Common

The calibrator selects the desired EGR system by setting PFEHP equal to 1

(for PFE EGR - Pressure Feedback EGR); or, to zero (for Sonic EGR); or to 2,

to disable both EGR strategies. The Switch logic is described below.

EGR SELECT LOGIC

PFEHP = 0 -------------------------| Do SONIC EGR Control

|

| --- ELSE ---

|

PFEHP = 1 -------------------------| Do PRESSURE FEEDBACK EGR

| Control

|

PFEHP = 2 -------------------------| --- ELSE ---

|

| EGR disabled, NO EGR Control

| required

|

| Set EM = 0

| Set EGRACT = 0

|

| Return

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EGR STRATEGY - GUF0

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EGR ENABLE LOGIC - COMMON

The following logic describes the operating conditions during which EGR is

enabled (When PFEHP = 2, no EGR is required and the EGR strategy is always

disabled).

TCSTRT >OR= CTHIGH ---------|

|AND --|

ATMR1 >OR= EGRTD3 ----------| |

|

|

CTLOW < TCSTRT < CTHIGH ----| |

|AND --|OR -|AND -| ENABLE EGR

ATMR1 >OR= EGRTD2 ----| | | | | EGREN = 1

|AND -| | | |

ATMR2 >OR= EGRTD5 ----| | | | --- ELSE ---

| | |

| | | EGREN = 0

TCSTRT <OR= CTLOW ----------| | | | DISABLE EGR

| | | | EGRATE = 0

|AND --| | | DESEM = 0

ATMR1 >OR= EGRTD1 ----| | | | EGRACT = 0

|AND -| |

ATMR2 >OR= EGRTD4 ----| |

|

APT = 0 (PART THROTTLE) ----------------|

|

EVP >OR= EOFF - EGRDED ----| |

|OR ---------|

PFEHP = 0 -----------------| |

|

CRKFLG = 0 -----------------------------|

|

AFMFLG = 0 ------------| |

| |

CFMFLG = 0 ------------| |

| |

EFMFLG = 0 ------------|AND ------------|

|

MFMFLG = 0 ------------|

|

TFMFLG = 0 ------------|

|

BFMFLG = 0 ------------|

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EGR STRATEGY - GUF0

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DESIRED EGR FLOW RATE EQUATIONS - COMMON

If EGR is enabled, the base amount of EGR to be added is determined from two

10 x 8 tables the format of which is identical to that used for the PART

THROTTLE spark timing determinations.

The table values are a function of engine speed N and LOAD.

The base amount can be adjusted by several EGR modulators to reflect special

engine operating conditions.

The amount of EGR to be added is determined as shown below.

MFAFLG = 1 -------| EGRATE = ['E' \* (1 - {FN1223

| \* MFAMUL \* FN311})] + KPEI

|

| --- ELSE ---

|

| EGRATE = 'E' + KPEI

'E' is defined below.

'E' = X\*'R'\*[FN211 \* FN220 \* (FN908A \* FN212A + FN908B \* FN217A)]

'R' is defined below.

'R' = TSEGRE/EGRMPT (CLIPPED AT 1.0)

TSEGRE LOGIC

TCSTRT > CTLOW -------------| SET TSEGRE = EGRMPT ('R' = 1)

|

| --- ELSE ---

|

EGR ENABLED ----------------| INCREMENT TSEGRE

| (CLIP AT EGRMPT)

|

| --- ELSE ---

|

| FREEZE TSEGRE

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EGR STRATEGY - GUF0

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SONIC EGR VALVE STRATEGY (PFEHP = 0)

The Sonic Exhaust Gas Recirculation (EGR) system offers a high degree of

flexibility. The chief benefit is improved drive and fuel economy. The

abilities are:

1. EGR flow can be precisely varied depending upon engine operating

conditions.

2. Spark advance can be precisely adjusted to compensate for the actual

EGR flow.

The Sonic EGR system consists of:

1. Sonic EGR valve

2. EGR valve position (EVP) sensor

3. Electronic Vacuum Regulator (EVR)

The EGR valve controls the flow of exhaust gases to the intake manifold. The

pintle valve and seat assembly are designed such that EGR flow is

proportional to pintle position. Further, the output of the EVP sensor is

directly proportional to the pintle position. This design allows direct

calculation of EGR flow.

The EGR valve is operated by manifold vacuum. The EVR:

1. Applies vacuum to the EGR valve (increases EGR flow).

2. Holds in existing EGR valve vacuum (maintains EGR flow).

3. Vents EGR valve vacuum to atmosphere (decreases EGR flow).

The strategy enables EGR during various engine operating modes. These modes

are calibration items. Typical calibrations will enable EGR when these

conditions are met:

1. Time since start is greater than a calibration value.

2. Engine is in part throttle mode.

3. Current EGR valve position is not less than the fully closed

position.

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EGR STRATEGY - GUF0

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ACTUAL EGR MASS FLOW EQUATIONS - SONIC (PFEHP = 0)

For interactive spark and EGR control:

1. The EGR mass flow is calculated based upon actual valve position.

2. The percent EGR is then calculated and used to modify the spark

advance.

EM CALCULATION - SONIC (PFEHP = 0)

ISCFLG = 1 OR 2 ----------|

(Idle RPM Control) |AND -|OR --| (EGR is OFF)

| | | EM = 0

DELOPT = 0 ---------------| | |

| | --- ELSE ---

| |

AFMFLG = 1 ---------------| | | EM = FN219A \*

| | | BP/29.875

CFMFLG = 1 ---------------| |

| |

EFMFLG = 1 ---------------|OR --|

|

MFMFLG = 1 ---------------|

|

TFMFLG = 1 ---------------|

Percent EGR = EGRACT = (EM/AMPEM)\*100

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EGR STRATEGY - GUF0

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DESIRED EGR MASS FLOW - SONIC (PFEHP = 0)

The desired EGR mass flow = 0.01 \* EGRATE \* AMPEM \* 29.875/BP

To enhance the control of the EGR valve, the valve is controlled to a

filtered desired position as follows:

EGREN = 1 ------------| DELOPT =

(EGR Enabled) | UROLAV (FN221+EOFF,TCDLOP)

|

| --- ELSE ---

|

| DELOPT = 0

Notes:

1. When the desired EGR rate EGRATE equals zero, DELOPT is then set to zero.

This action will close the EGR valve when zero EGR is requested.

2. When the desired EGR rate EGRATE is nonzero and DELOPT is zero, then

DELOPT is set to EOFF before the DELOPT filter is run. This makes the DELOPT

filter start at the closed EGR valve position when EGR is desired.

3. DELOPT is clipped to 922 counts (90% of VREF).

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EGR STRATEGY - GUF0

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SONIC EGR VALVE OUTPUT CONTROL (PFEHP = 0)

The EGR valve is controlled in a closed loop manner using proportional

control, and the EGR valve position, EVP, as the feedback variable. The

valve is moved to the desired EGR position DELOPT through output commands to

the Electronic Vacuum Regulator, EVR.

EGR FLOW EVR OUTPUT

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

HOLD MAINTAIN DUTY CYCLE

INCREASE INCREASE DUTY CYCLE

DECREASE DECREASE DUTY CYCLE

NONE DUTY CYCLE = 0

(FULLY CLOSED)

The change in the EVR duty cycle is a function of the sign and magnitude of

the error in control pressure according to the following logic.

DELOPT = 0 ------------------------| EGRDC = 0

| CLEAR EGRFLG

|

| --- ELSE ---

EVP <OR= EOFF + EGRDED -| |

|AND ------| EGRDC = DCOFF +

EGRFLG CLEAR -----------| | FN239(EGRERR)

| SET EGRFLG

|

| --- ELSE ---

|

EVP > EOFF + EGRDED ---------| |

|OR --| EGRDC = EGRDC +

EVP <OR= EOFF + EGRDED-| | | FN239(EGRERR)

|AND -|

EGRFLG SET ----------- |

EGRDC is clipped to 0.90

An EVR calibration method, EVR.MEM, is available in the Strategy group user

area. Copies can be made by exercising the Xerox option as explained on page

2 of this Strategy Book.

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PFE EGR STRATEGY - GUA0

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PRESSURE FEEDBACK ELECTRONIC (PFE) EGR STRATEGY (PFEHP = 1)

The PFE EGR system was developed as a subsonic alternative to the Sonic EGR

system. The PFE EGR provides a projected reliability improvement over the

Sonic system while still providing the flexibility and spark compensation

characteristics of Sonic EGR.

Like the Sonic EGR subsystem, PFE EGR precisely regulates the EGR flow

according to calibrated Tables and fox functions. However, the PFE EGR

strategy uses pressure (EPT) as the feedback signal rather than pintle

position (EVP).

The PFE\_EGR system consists of:

1) Tapered pintle ported EGR valve.

2) Downstream pressure sensor (EPT).

3) Control orifice.

4) Electronic Vacuum Regulator (EVR).

Since PFE EGR is a subsonic flow system, the EGR flow is proportional to the

pressure drop across a sharp-edged orifice (PE - DP). PE, the upstream

pressure, is calculated by the software. DP, the downstream pressure, is

measured by means of a piezo-resistive transducer (EPT). 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.

Fig. 1

Control EGR

Orifice Valve

| |

V V

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

| \ /

| \ / Intake

PE, "H20 DP, "H20 \/ Manifold

| /\ Vacuum

| Control chamber / \

| / \

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

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PFE EGR STRATEGY - GUA0

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The EEC operates the EGR valve by outputting a variable duty cycle to the

EVR. The EVR applies a vacuum signal, which is proportional to the duty

cycle, to the EGR valve. The frequency of the duty cycle ranges from 90-180

Hz. The operation of the EVR is described near the end of this Chapter.

The strategy enables EGR during various engine operating modes. These modes

are calibration items. Typical calibrations will enable EGR when the

following conditions are met:

1) Time since start is greater than a calibration value.

2) Engine is in part throttle mode.

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PFE EGR STRATEGY - GUA0

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PRESSURE FEEDBACK ELECTRONIC (PFE) EGR STRATEGY (PFEHP = 1)

DEFINITIONS

INPUTS

Registers:

- AM = Air mass flow, (lb/min).

- AMPEM = Air mass plus EGR mass flow.

- BP = Barometric pressure, "Hg.

-

BPCOR = BP corrected = FN004(BP). FN074 should be calibrated at sea

level since the altitude correction is made by the (29.875/BPCOR) term.

Note that the altitude correction used to be (29.875/BP) however actual

data obtained from the altitude chamber disagreed with the calculated

correction. Therefore FN004(BP) was added to allow an empirical

correction. If no correction is desired, calibrate FN004 on a diagonal,

that is (0,0), (31.875,31.875). Actual data indicates that backpressure

does not increase linearly with BP, but at about half that rate, roughly

(0,8), (31.875,31.875). This will generate a corrected BP to be used in

calculating a more accurate PEXH and PE (PFE EGR only).

-

DELPR = Pressure drop across the control orifice, " H20

= PE - DP

- DESEM = Desired EM, lb/min. (EGRATE \* AMPEM/100)

- DESDP = Filtered desired downstream pressure, " H2O.

= ROLAV (DP',TCDP)

- DP = Downstream pressure, " H2O (gauge).

= XFREPT \* (EPTBAR - EPTZER)

DP' = PE - DESDEL

- EGRACT = Actual EGR percent = 100\*EM/AMPEM.

- EGRATE = Desired EGR rate in percent.

- EGRCNT = Background EGR ON-TIME counter.

- EGRDC = Duty cycle of the EVR output, fraction.

- EGRERR = Error in EGR valve position (DELOPT-EVP).

- EGRPER = Foreground EGR period.

- EM = Actual EGR mass Flow.

- EPTBAR = Rolling average of the synchronously sampled

EPT sensor (time constant = TCEPT), secs.

- EPTZER = Rolling average of the synchronously sampled

EPT sensor at idle (time constant = TCEPT),

stored in Keep Alive Memory, counts.

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PFE EGR STRATEGY - GUA0

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- PE = Upstream pressure, " H2O (gauge).

= (29.875/BPCOR) \* FN074.

- PRESER = EPTBAR - CONPR, counts.

Bit Flags:

- EGREN = Flag which indicates EGR enabled if set

to 1.

- EGRFLG = Flag that indicates whether DCOFF has been

added to EGRDC.

Calibration Constants:

- DCOFF = Duty cycle required to start to open the valve

equivalent to LGA0O in the Vent/Vac system.

- FN004 = BP correction for exhaust backpressure calculation, "Hg.

- FN074 = Upstream pressure as a function of (AM \* KAMREF).

(KAMREF = Adaptive fuel correction factor), "H20.

- FN211 = Multiplier as a function of ECT.

- FN212A = Multiplier as a function of BP.

- FN239 = Change in EVR duty cycle as a function of

the pressure error, PRESER (if PFEHP = 1).

- FN246 = EGR mass flow as a function of DELPR, lb/min.

- IXFRPR = Transfer function = 1/XFREPT, Counts/" H2O.

- KPEI = Constant EGR adder.

- PFEHP = Switch to select EGR strategy. 1 = PFE; 0 = Sonic;

2 = No EGR.

- SQRT (BP/29.875) = Altitude compensation represented by

a linear approximation for 21 < BP <OR= 31.875.

= (0.1\*BP + 2.50)/5.47

- TCDP = DP filter time constant.

- X = Multiplier.

- XFREPT = Transfer function of EPT sensor, " H20/counts.

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PFE EGR STRATEGY - GUA0

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OUTPUTS

Registers:

- CONPR = Desired PRT sensor value.

- DESEM = Desired EM, lb/min. (EGRATE \* AMPEM/100)

- DESDP = Filtered desired downstream pressure, " H2O.

- EGRCNT = Background EGR ON-TIME counter.

- EGRDC = Duty cycle of the EVR output, fraction.

- EGRPER = Foreground EGR period.

- EM = Actual EGR mass Flow.

Bit Flags:

- EGRFLG = Flag that indicates whether DCOFF has been

added to EGRDC.

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PFE EGR STRATEGY - GUA0

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ACTUAL EGR MASS FLOW EQUATIONS (PFEHP = 1)

For interactive spark and EGR control:

1) The EGR mass flow is calculated based upon the pressure drop across

the control orifice.

2) The percent EGR is then calculated and used to modify the spark

advance.

EGREN = 1 ------------------| EM = SQRT (BP/29.875)

(EGR enabled) | \* FN246

|

| --- ELSE ---

|

| EM = 0

EGRACT' = 100 \* EM/AMPEM

EGRACT = UROLAV (EGRACT',TCEACT)

DESIRED EGR MASS FLOW (PFEHP = 1)

The PFE EGR system achieves the desired EGR flow by controlling it to a

particular downstream pressure. The desired flow, DESEM, is calculated from

the desired EGR rate and actual airflow. To promote control stability, the

strategy avoids operation in the low flow non-linear region of the EGR

transfer function.

EGREN = 1 -------------------| | EGR ON

|AND --| DESEM = EGRATE \* AMPEM/100

EGRATE \* AMPEM/100 | | DESDEL = FN247

>OR= MINDES + DESHYS --|S Q -| | DP' = PE - DESDEL

| | DESDP = ROLAV (DP',TCDP)

EGRATE \* AMPEM/100 | | CONPR = (IXFRPR \* DESDP)

< MINDES -----------|C | + EPTZER

|

| --- ELSE ---

|

| DESEM = 0

| DESDEL = 0

| DESDP = PE

| CONPR = EPTBAR

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PFE EGR STRATEGY - GUA0

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EVR OUTPUT CONTROL (PFEHP = 1)

The downstream pressure, DP, is controlled in a closed loop manner using the

EPT sensor as the feedback signal. The valve pintle is moved until CONPR

(the control pressure) is equal to the EPTBAR (measured downstream pressure)

by means of output commands to the EVR. The output commands take the form of

a variable duty cycle voltage output.

EGR FLOW EVR OUTPUT

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

HOLD MAINTAIN DUTY CYCLE

INCREASE INCREASE DUTY CYCLE

DECREASE DECREASE DUTY CYCLE

NONE DUTY CYCLE = 0

(FULLY CLOSED)

The change in the EVR duty cycle is a function of the sign and magnitude of

the error in control pressure according to the following logic.

DESEM = 0 --------------------------| EGRDC = 0

| CLEAR EGRFLG

|

| --- ELSE ---

|

EGRFLG CLEAR -----------------------| EGRDC = DCOFF

| + FN239

| SET EGRFLG

|

| --- ELSE ---

|

| EGRDC = EGRDC

| + FN239

NOTE: During On-Demand Self-Test, EGRDC is to zero.

The Sonic EGR and PFE EGR strategies BOTH

use FN239

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PFE EGR STRATEGY - GUA0

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PFEHP = 1 ----------------------| Use PRESER as input

| to FN239

|

| --- ELSE ---

|

| Use EGRERR as input

| to FN239

WARNING: The Control Algorithm was designed for use with EPT Sensors which

have a POSITIVE sloped transfer function.

Calibration Guides for both PFE and EVR are available. Xerox copies may be

obtained in the same manner as Strategy Books. The file names are PFE1.MEM

and EVR.MEM.

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PFE EGR STRATEGY - GUA0

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EVR CONTROL ALGORITHM - COMMON

The EVR Control Routine was designed to operate the EVR within a 90-200 Hz

frequency range. The algorithm selects an "ON" time, EGRCNT, based on the

desired duty cycle, EGRDC. The period is calculated by dividing the ON-time

by the duty cycle. (All definitions for this section will be listed in the

beginning of Chapter 8.)

0 <OR= EGRDC <OR= 0.08 ----------------| EGRCNT = 0

| (Turn EVR off)

|

| --- ELSE ---

|

0.08 < EGRDC <OR= 0.18 ----------------| EGRCNT = 1

|

| --- ELSE ---

|

0.18 < EGRDC <OR= 0.31 ----------------| EGRCNT = 2

|

| --- ELSE ---

|

0.31 < EGRDC <OR= 0.46 ----------------| EGRCNT = 3

|

| --- ELSE ---

|

0.46 < EGRDC <OR= 0.59 ----------------| EGRCNT = 4

|

| --- ELSE ---

|

0.59 < EGRDC <OR= 0.74 ----------------| EGRCNT = 5

|

| --- ELSE ---

|

| EGRCNT = 6

0 <OR= EGRDC <OR= 0.08 -------| EGRPER = 0

|

| --- ELSE ---

|

EGRPER <OR= 0 ----------------| EGRPER = (EGRCNT/EGRDC)

| + EGRPER

| Clip EGRPER to 12 as

| a maximum

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PFE EGR STRATEGY - GUA0

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EXAMPLE (EGRDC = 0.40)

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

| | | | |

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

Clip EGRPER to maximum of 12.

EGRCNT > 0 ----------------------------| Turn EVR on

| EGRCNT = EGRCNT - 1

| EGRPER = EGRPER - 1

|

| --- ELSE ---

|

| Turn EVR off

| EGRPER = EGRPER - 1

NOTE: This Algorithm was intended to minimize real-time execution. In

the experimental version, the EGRCNT and EGRPER calculations are done in

the background. The foreground merely toggles the EVR output.

(Reference: ENQDA version)

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CHAPTER 9

IDLE SPEED CONTROL STRATEGY

9-1

IDLE SPEED CONTROL STRATEGY - GUF0

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ADAPTIVE BYPASS AIR IDLE SPEED CONTROL

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

quality on engines utilizing a speed density determined air mass requires a

coupling of the ISC logic with both fuel (adaptive fuel, transient fuel, special

AM filtering routine) and spark control strategies.

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IDLE SPEED CONTROL STRATEGY - GUF0

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An overview description is illustrated below:

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

(enter ISC)

---------

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

| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

| | CRANK MODE | --------------

| |----------------| | FMEM |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | FN884(TCSTRT) | | |

|-calculate DSDRPM| ------------------ | ISCDTY = |

|-predict DESMAF | | | FMMISC |

|-update FAM | \_\_\_\_\_\_\_\_\_ --------------

|-calc DSTPBR | (exit ISC ) |

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

| (exit ISC)

| --------

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

(decrement DASPOT)

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

| (Mode Select)

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

| | | |

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

|DAS\_PRE\_POS | | DASHPOT | | RPM CONTROL | | RPM LOCKOUT |

| ISCFLG=0 | | ISCFLG=-1 | | ISCFLG = 1 | | ISCFLG = 2 |

|-calc DASPOT| |-calc spark | |-calc airflow| |-calc airflow |

|-elim spark | | vs airflow | | correction | | correction |

| feedback | | (FN839) | |-calc spark | |-calc spark |

-------------- -------------- | mult vs RPM | | mult vs RPM |

| | | (FN841) | | (FN841) |

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

| | | |

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

|

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

| -fold in airflow |

| corrections to DESMAF |

| -calc actual ISC actuator |

| airflow DEBYMA |

| -calc ISCDTY |

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

|

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

| -update KAM for |

| corrected airflows |

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

|

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

(exit ISC)

--------

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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ISC MODE SELECT

DEFINITIONS

REGISTERS/FLAGS/TIMERS:

- CTPTFG = Closed throttle to Part/WOT transition flag, unitless.

- FLG\_DASMNQ = VSBAR flip-flop flag for minimum Daspot.

CALIBRATION CONSTANTS:

- DASCTK = A background-driven decrement to the dashpot pre-

position airflow register (DASPOT).

- It provides a time based dashpot. Calculate

dashpot time as follows: If the maximum allowed

dashpot pre-position (DASPOT) = 0.5 ppm; the DASCTK

value = 0.004 ppm; and, assuming a 0.012 background

time or 83.3 background slices per second, then

(83.3 \* 0.004) = 0.33 ppm/sec; and therefore, a

0.5 ppm dashpot will last 1.5 seconds. ..Typical

value - 0.004 ppm.

- DASMPH = Minimum VSBAR for declutch Daspot Clip, mph.

- DASMHYST = Hysteresis for DASMPH, mph.

- DASMIN = Minimum Daspot Clip for declutch, ppm.

- DELTA = Closed throttle/Part Throttle breakpoint value above

RATCH.

- DNDSUP = Flag used to delay Strategy response to PRNDL

change. If Change occurs, then DNDSUP is set

equal to NDSFLG.

- ENGCYL = Number of PIPs per engine revolution; or number

of cylinders/2.

- FAMINC = FAM increment/decrement when entering FAM region,

lb/min.

- FMMDSD = Failure Mode Management default desired RPM.

- FN884(TCSTRT) = ISC Duty Cycle in Crank, deg.

- MINMPH = Minimum speed to enter C/L RPM control.

- MINMPH applies to systems having VSS only.

Resolution of the VSS (3 mph) makes it undesirable

at this time to remove the lockout logic.

..Typical value - 0.5 mph.

- RPMCTL = Deadband above desired Idle RPM for recognition of

Normal Closed Loop Idle.

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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- 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.

- ISCTM = Time interval over which the rate of change in engine

speed is evaluated.

- 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.

- NDIF = The deviation in engine speed allowed over the ISCTM

specified time interval. NDIF 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.

- LOWLOD = LOWLOD is a key parameter which is engine specific.

Selected value must differentiate between deceleration

and idle conditions over the expected range of operating

conditions.

- ACLOD = An adder to LOWLOD when A/C is on.

- ACLOD should be based on observed differences

between A/C on & A/C off idle LOAD readings.

..Typical value - 2" Hg (engine specific parameter).

- DELRAT = Throttle position adder to RATCH. Should be

set equal to DELTA + HYSTS (See throttle mode select

logic). ..Typical value - 15 counts.

- FMMISC = Default Duty cycle to ISC, fraction.

- NDDELT = Time before N/D, D/N switch registers.

- TRLOAD = Transmission Load.

0 = Manual Transmission, no clutch or gerar 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 - MODE SELECT - GUFA

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ISC MODE SELECT

This section describes the mode select logic for the air bypass idle speed

control system. There are basically four distinct modes in which the ISC

system functions; however, two modes: Closed Loop RPM and Lock-out of Closed

Loop RPM, are identical with respect to actual Idle Speed Control. A flag is

used to identify the three primary ISC modes for both calibrator convenience

and required interaction with fuel control strategy.

- ISCFLG = -1 DASHPOT CONTROL (Note: Cal. console will show 255).

- ISCFLG = 0 DASHPOT PRE-POSITION.

- ISCFLG = 1 CLOSED LOOP RPM CONTROL.

- ISCFLG = 2 CLOSED LOOP RPM CONTROL (Lock-out entry to RPM control).

-ENGINE CRANK MODE

Entry/exit conditions for this mode are defined in the engine mode select

logic of the strategy book. In engine crank mode, the ISC duty cycle (ISDTY)

is a function of temperature at start, TCSTRT. If the time between PIP

signals exceeds two seconds, it is assumed that the operator is not cranking

and the duty cycle is set to 0%.

-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 calibratible 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 (Hydrocarbon) 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) and calibration

dependent. 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).

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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-CLOSED LOOP RPM CONTROL (ISCFLG = 1 OR 2) NORMAL CLOSED LOOP RPM CONROL

(ISCFLG = 1)

For normal entry into Closed Loop (C/L) RPM control, the following conditions

must be satisfied:

. If VSS hardware used it must indicate a speed less than MINMPH.

. If a manual trans. with gear/clutch switches, must indicate neutral.

- 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 throttle position be less than or equal to

(RATCH + DELRAT).

-DASHPOT LOCKOUT OF RPM CONTROL (ISCFLG = 2)

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, and/or ISC learning in an unusually high state of engine load (400

psi A/C head pressure, etc.), the ISC actuator may pass 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.

CALIBRATION HINTS:

This task is easy should you have a VSS or a manual calibration with

gear/clutch switches. If this hardware is not present, then it is difficult

to differentiate between a constant deceleration (as in a coast down a

mountain) and a true locked-out of Idle condition. Most of the logic in the

Dashpot and RPM lockout Mode Selection deals with recognition of

distinguishing features of each.

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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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 LOAD 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 calibration parameter; and all true deceleration conditions, including

the same variabilities, will yield lower LOAD. To avoid incorrect

interpretation of the LOAD value, great care must be taken in selecting the

correct LOWLOD value.

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 then 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 - GUFA

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ISC MODE SELECT

CRKFLG = 1 -------------| | Set DSTPBR = RATCH

(in crank mode) | | (set dashpot filtered TP

|AND ----------| to RATCH)

TSLPIP >OR= 2 sec. -----| | Set SPKMUL = 0.99

(no PIPs yet or stall) | Set ISCDTY = 0

| (ISC duty cycle = 0%)

|

| --- ELSE ---

|

| Set SPKMUL = 0.99

CRKFLG = 1 ----------------------------| Set DSTPBR = RATCH

(in crank mode) | Set ISCDTY = FN884(TCSTRT)

|

| --- ELSE ---

MFMFLG = 1 -------------| |

|AND ----------| Set DSDRPM = FMMDSD

TFMFLG = 1 -------------| | Set ISCDTY = FMMISC

| Set SPKMUL = 0.99

|

| --- ELSE ---

|

| GO TO DSD\_RPM

| (calculate desired RPM and

| base airflow requirements)

VSBAR > DASMPH + DASMHYST -------|S Q --| SET FLG\_DASMNQ = 1

| | (prepare to add dashpot

VSBAR <OR= DASMPH ---------------|C | to prevent declutch stall)

|

| --- ELSE ---

|

| SET FLG\_DASMNQ = 0

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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APT = 0 OR 1 --------------------------| Enter Dashpot Preposition

(not closed throttle - dashpot | Set ISCFLG = 0

pre-position mode) | NLAST = N (Save last RPM

| value)

| ISCTMR = 0 (Reset RPM

| sampling timer)

| SPKMUL = 0.996

|

| --- ELSE ---

|

| Check Other ISC Modes

RPM CONTROL MODE (ISCFLG = 1)

TRLOAD NOT= 3 ---------|

(auto trans or manual |

trans w/o both |

switches) |

|OR --|

TRLOAD = 3 ------| | |

(manual trans |AND -| |

with both | |

switches) | |

| |

DNDSUP = 0 ------| |

(In Neutral) |AND -|

| |

N <OR= DSDRPM + RPMCTL ------| |

(RPM within control range) | |

| |

DASPOT = 0 ------------------| |

| |OR -| Set ISCFLG = 1

VSBAR <OR= MINMPH -----------| | | (RPM control mode)

(vehicle speed | |

almost zero) | | (RPM within control

| | range and TP near

RUNNING = 1 -----------------| | | closed throttle)

(In Running Self-Test) | | |

|AND -|

DASPOT = 0 ------------------|

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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RPM LOCKOUT MODE (ISCFLG = 2)

VSBAR <OR= MINMPH -------------------------------|

(vehicle speed almost zero) |

|

DASPOT = 0 --------------------------------------|

|

N > DSDRPM + RPMCTL -----------------------------|

(RPM too high for RPM control) |

|

ISCFLG = -1 OR 0 ------------| |

(last mode was dashpot | |

or pre-position) | |

|AND ---| |

ISCTMR >OR= ISCTM -----------| |OR --------|

(OK to sample RPM) | | |

| | |AND -|Set ISCFLG=2

|NLAST-N| < NDIF ------------| | | | (RPM LOCKOUT

(RPM indicates steady state) | | | MODE)

| | | (RPM is steady

ISCFLG = 1 OR 2 ---------------------| | | state, LOAD

(last mode was RPM | | indicates idle

control or lockout) | | TP near closed

| | throttle, but

TRLOAD >OR= 3 ------------| | | rpm is too high)

(auto trans or man. with | | |

both switches) |AND -| |

| | |

DNDSUP = 1 ---------------| | |

(in drive,in gear) |OR -| |

| | |

TRLOAD < 3 ---------------------| | |

(manual w/o both switches) | |

| |

ACCFLG = 1 ---------------| | |

(A/C clutch engaged) | |AND -| |

|AND -| | | |

LOAD >OR= LOWLOD | | | | |

+ ACLOD -----------------| | | | |

(LOAD near idle) | | | |

|OR -| | |

ACCFLG = 0 ---------------| | |OR --|

(A/C off) | | |

|AND -| |

LOAD >OR= LOWLOD ---------| |

(LOAD near idle) |

|

TRLOAD >OR= 3 -----------------------| |

(auto trans or manual | |

with both switches) |AND -|

|

DNDSUP = 0 --------------------------|

(in neutral)

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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DASHPOT MODE (ISCFLG = -1)

VSBAR > MINMPH -----------------|

(vehicle speed high) |

|

DASPOT > 0 ---------------------|

|

TRLOAD = 3 -------------| |

(Manual Trans with | | |

both switches) |AND----| | Set ISCFLG = -1

| | | (dashpot mode)

DNDSUP = 1 -------------| | |

(in gear) | |

| |

TRLOAD NOT= 3 -----------| |OR ----| Set SPKMUL = FN839

(not manual trans | | | (spark feedback)

with both switches) | | |

| | | (Dashpot not bled

N > DSDRPM + RPMCTL -----|AND --| | down, not OK to

(RPM too high for RPM | | sample RPM)

control) | |

| |

ISCFLG = -1 OR 0 --------| |

(last mode was dashpot | |

or pre-position) | |

| |

ISCTMR < ISCTM ----------| |

(Not OK to |

sample RPM) |

| --- ELSE ---

(Continued on the next page)

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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(Continued from the previous page)

VSBAR <OR= MINMPH --------------| |

(vehicle speed almost zero) | |

| |

DASPOT = 0 ---------------------| |

| |

TRLOAD = 3 -----| | |

(manual with | | |

both switches)|AND ---| | |

| | | |

DNDSUP = 0 -----| |OR ----| |

(in neutral) | | |

| | |

TRLOAD NOT= 3 ----------| | |

(not manual with both |AND ---| Set ISCFLG = -1

switches) | | (dashpot mode)

| |

N > DSDRPM + RPMCTL ------------| | Set SPKMUL = FN839

(RPM too high for RPM control) | | (spark feedback)

| |

ISCFLG = -1 OR 0 ---------------| | Set NLAST = N

(last mode was dashpot or | | Set ISCTMR = 0

pre-position) | | (continue RPM check)

| |

DASPOT = 0 ---------------------| |

(Dashpot has bled down) | | (Dashpot has bled down, but

| | RPM indicates decel)

ISCTMR >OR= ISCTM --------------| |

(OK to sample RPM) | |

| | --- ELSE ---

|NLAST - N| > NDIF -------------| |

(RPM Indicates Decel)

(continued on the next page)

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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(continued from the previous page)

VSBAR <OR= MINMPH ---------------| |

(vehicle speed almost zero) | |

| |

DASPOT = 0 ----------------------| |

| |

TRLOAD = 3 ---------| | |

(manual trans with |AND -| | |

both switches) | | | |

| |OR ---| |

DNDSUP = 0 ---------| | | |

(in neutral) | | |

| | |

TRLOAD NOT= 3 ------------| | |

(not manual with both | |

switches) | |

| |

N > DSDRPM + RPMCTL -------------| |

(RPM too high for RPM control) | |

| |

ISCFLG = -1 OR 0 ---| | |

(last mode was | | |

dashpot or pre-pos)| | |

|AND -| | | Set ISCFLG = -1

ISCTMR >OR= ISCTM --| | | | (dashpot mode)

(due to sample RPM)| |OR ---|AND ---|

| | | | Set NLAST = N

|NLAST-N| <OR=NDIF -| | | | Set ISCTMR = 0

(RPM indicates | | | (continue RPM check)

steady state) | | |

| | | (Dashpot has bled down,

ISCFLG = 1 OR 2 ----------| | | RPM is steady state

(last mode was RPM | | but LOAD indicates

control or lockout) | | decel)

Continued on the next page

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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Continued from the previous page

TRLOAD >OR= 3 --| | |

(auto trans or | | |

man. with |AND -| | |

both switches | | | |

| |OR -| | |

DNDSUP = 1 -----| | | | |

(In Drive, in gear) | | | |

| | | |

TRLOAD < 3 -----------| | | |

(manual w/o both | | |

switches) | | |

| | |

ACCFLG = 1 ----| |AND -| |

(A/C clutch |AND -| | |

engaged) | | | |

| | | |

LOAD <OR= | | | |

LOWLOD+ACLOD --| | | |

(decel LOAD) |OR --| |

| |

ACCFLG = 0 ----| | |

(A/C off) | | |

|AND -| |

LOAD < LOWLOD -| |

(LOAD indicates decel) |

|

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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DSTPBR CALCULATION

The DSTPBR calculation 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 calibratible. TCDASU is

used when DSTPBR is filtering UP to TP. TCDASD is used to filter DSTPBR DOWN

to TP.

TP > DSTPBR ------------------| DSTPBR = UROLAV (TP,TCDASU)

(TP increasing) |

| (Filter TP w/increasing TP)

|

| --- ELSE ---

|

| DSTPBR = UROLAV (TP,TCDASD)

|

| (Filter TP w/decreasing TP)

TCDASU = Time constant used when TP is greater than the filtered TP value

(TP > DSTPBR). The smaller the time constant the more rapidly

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

DASPTO without the potential runaway feel that may come with too fast a

time constant/airflow gain (DASPTK) combination. ..Typical value - 0.49.

TCDASD = Time constant used when TP is less than or equal to the filtered

TP value (TP <OR= DSTPBR). Should be calibrated such that part throttle

backouts, where closed throttle is not entered, do not exhibit a run-on

feel. Too small a time constant can have the effect of greatly reducing

dashpot airflow prior to entry into dashpot control. ..Typical value -

0.93.

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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DASPOT CALCULATION

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 (Hydrocarbon) 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 a throttle position equal to the Closed Throttle breakpoint (RATCH +

DELHYS). This value is clipped to zero as a minimum, if this difference

becomes a negative value. DELHYS should be set equal to DELTA + HYSTS

(Closed Throttle breakpoint). DASPOT can be clipped to DASMIN as a

minimum if vehicle speed is high enough to prepare for declutch.

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, unless clipped to DASMIN.

When vehicle speed falls below DASMPH, normal bleed off will resume.

APT = -1 --------------------| Bleed off DASPOT

(Closed throttle - |

determine ISC mode) | Set DASPOT = DASPOT - FN879

| (Bleed down dashpot)

| Clip DASPOT to 0 as minimum

| Continue through the ISC Mode

| select logic

|

| --- ELSE ---

|

| Filter DASPOT to Preposition

| Idle speed airflow for next

| decel.

| DASPOT = [DASPTK \* (DSTPBR

| - RATCH + DELHYS)] + DASPTO

| Clip DASPOT at FN882(N) as

| maximum

| (Clip (DSTPBR-RATCH+DELHYS) to

| zero if negative.)

FLG\_DASMNQ = 1 ---------------| Clip DASPOT to DASMIN as a minimum

| (add additional minimum airflow

| to prevent declutch stall)

|

| --- ELSE ---

|

| Allow normal computation and bleed

| down of dashpot

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IDLE SPEED CONTROL - MODE SELECT - GUFA

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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. Separate filter constants are available

(TCDASU/TCDASD) to control the response of DSTPBR as described above.

The following calibration constants control operation of the dashpot

pre-position strategy:

DASPTO = An offset term applied to the DASPOT calculation. Insures at

least some dashpot airflow on rapid tip-in/tip-outs. ..Typical value -

0.10 lbs/min.

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 DASPTO from FN882 and divide

the result by the throttle delta between RATCH and this maximum dashpot

airflow to determine the DASPTK value. ..Typical value - 0.002 Lbs per

min/TP count.

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.

...Typical vaues - (0, 0.001) (.1, .002) (.3, .006) (.75, .05) (2.00,

.10)

FN882 = Maximum allowed dashpot pre-position airflow. DASPOT calculation

clipped at this value. ..Typical value - 100% of base idle airflow

requirement.

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION - GUFA

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DESIRED RPM CALCULATION

OVERVIEW

This section describes the ISC logic designed to perform the DSDRPM

calculation each background pass

- Calculate the desired engine speed: The desired engine speed (DSDRPM) is

used to determine the correct ISC mode; used as the control speed for

closed loop RPM ISC; used by the filtered air mass logic to determine

entry/exit conditions for filtering.

. Desired engine speed (DSDRPM = [base desired speed (NUBASE for

neutral DRBASE for drive) + RPM adder (DNAC) if A/C is on + RPM adder

(DNPOWS) if a power steering pressure switch is used and power

steering load is high + ECT and ACT and start-up modulator functions

(FN825A, FN825B & FN826)].

- Calculate the initial idle airflow requirement: An open loop prediction

of idle airflow required vs. the various requested idle operating

conditions is calculated as follows:

. Desired idle airflow (DESMAF) = [base desired airflow (FN875N for

neutral; FN875D for drive)) \* an airflow modulator as a function of

ATMR3 and ECT (FN1861)] + discrete airflow increments for A/C (ACPPM)

and power steering (PSPPM) if either load is present.

- Provide a feed foward mechanism for fuel control: The filtered air mass

value (FAM) is incremented a calibrated amount when unloaded to loaded

engine transitions are noted to avoid speed sags related to manifold

filling delays.

. Neutral to drive change; FAM = (FAM + NDPPM)

. Drive to Neutral change, FAM = FAM - DNPPM

. A/C off to on change; FAM = (FAM + ACPPM)

. Power steering switch off to on; FAM = (FAM + PSPPM)

- Control a flag (ISFLAG) which indicates the engine load state at idle:

Flag tracks state transitions at idle and is used to:

. Point to the correct adaptive fuel cell at idle (LTMTBnrc). The

first four cells of the first column in the adaptive fuel table are

dedicated to idle operation eg. ( ISFLAG = 0 points to adaptive cell

Row 8/Col. 0; ISFLAG = 1 points to Row 8/Col. 1; etc).

. Point to a corresponding adaptive ISC correction (ISCKAMn). Each

idle load state has a unique correction cell which indicates the

increment or decrement to a predicted airflow necessary to control to

the desired engine speed.

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION - GUFA

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. Track changes in the load state at idle. When state changes are

noted compensating actions involving fuel and ISC may be made.

DEFINITIONS

INPUTS

Registers:

- ACCTMR = A/C state transition timer. Timer is reset to 0 on every A/C

state change.

- ATMR1 = Timer which counts up in run/underspeed mode.

- ATMR3 = Timer which counts up in run mode. (Reset to 0 only at powerup).

- DSDRPM = Desired engine speed. See overview section for definition of

the various uses of this register.

- DESMAF = The desired airflow necessary to operate at a specified idle

condition. This register is fed with the base calibrated airflow

requirements in the desired RPM calculation routine each pass through the

background. It is later modified in the ISC duty cycle output routine to

account for the C/L ISC corrections (IPSIBR & ISCKAM) and any dashpot

component (DASPOT). DESMAF is then used in calculating the input to the

ISC transfer function (FN800).

- DESNLO = High cam portion of the DSDRPM register. Used to filter DSDRPM.

DESNLO + NUBASE or DRBASE = DSDRPM. TCDESN is the time constant.

Bit Flags:

- ACCFLG = A/C engaged flag: 1 -> A/C engaged; 0 -> A/C disengaged.

- ACIFLG = A/C engagement impending flag: 1 -> A/C about to engage -

adjust airflow and fuel immediately; 0 -> A/C not about to engage.

- DNDSUP = Delayed neutral/drive flag: 0 -> in neutral, no load; 1 -> in

drive, loaded.

- HWFLAG = Heated windshield flag: 0 -> heated windshield off; 1 -> heated

windshield on.

- HWFLGL = Latched heated windshield flag: 0 -> heated windshield has

never been on; 1 -> heated windshield has been on at least once since

start-up.

- POWSFG = Flag used to indicate that power steering load is high: 1 ->

power steering on.

- PSPSHP = Flag used to indicate if Power Steering Pressure Switch is

present; 1 -> switch used; 0 = no switch.

- PTSCR = Part throttle since crank mode flag: 0 -> driver has not tipped

in since start; 1 -> driver tipped in, kick down desired RPM.

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION - GUFA

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- RUNNING = Flag which indicates that idle speed is being controlled by

Engine Running VIP: 1 -> in Engine Running VIP; 0 -> not in Engine

Running VIP.

Calibration Constants:

- ACCPM = Airflow increment required with A/C on. Value is used to

increment both the desired flow through the ISC actuator (account for

increased load) and the filtered air mass - FAM. ..Typical value - 0.15

ppm

- 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. ..Typical value - 300 RPM.

- BZZTM = Time for which BZZRPM adder is in effect. ..Typical value - 3

seconds.

- DACTM = Time to maintain A/C rpm adder after A/C has been disengaged.

Used to prevent RPM changes when A/C cycles rapidly. ..Typical value -

30 sec.

- DNAC = RPM increment requested with the A/C on. ..Typical value - 75

RPM.

- DNPOWS = If a power steering pressure switch is used, this parameter

increments the desired RPM when an increased load is sensed. ..Typical

value - 75 RPM.

- DNPPM = Feed forward mechanism for fuel control. Decrements filtered air

mass for drive/neutral transition.

- DRBASE = Base desired engine speed in drive.

- FN825A(ECT) = RPM adder as a function of ECT. Provides base Hi-Cam

function.

- 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

deleted when either the first part throttle transition since exiting

crank is observed or the time since start exceeds a calibrated value

(TKDTM).

- 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 (FN1861)

will automatically adjust calibrated airflow to account for increased

requirements at low ambients).

Data can be collected using two methods. A hot wire can be

remotely mounted to measure airflow directly over the desired speed

range. Equipment is available at APTL to perform this procedure. A

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION - GUFA

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second approach is to use adaptive fuel in combination with the

calculated speed density air mass (AM) to infer the true airflow. In

this case the engine must be stabilized at each speed and remain in

C/L fuel control long enough for LAMBSE to be driven into a deadband

around 1.0 by the adaptive fuel strategy. At this point, readings

can be taken of:

- CALCULATED AIR MASS (AM)

- ADAPTIVE FUEL CORRECTION (KAMREF)

- IDLE SPEED DUTY CYCLE (ISCDTY)

The inferred airflow will equal (AM \* KAMREF). By knowing the

leakage due to the throttle body, PCV, ISC actuator and gaskets, the

above obtained ISC duty cycle information can be used to derive/check

the ISC transfer function accurately. Actual airflow (AM \* KAMREF)

minus the total leakage (ITHBMA - see section on ISC duty cycle

output) should represent the ISC valve flow for the recorded duty

cycle.

- FN875N(DSDRPM) = Airflow required for closed throttle operation in

neutral. Input to this function is absolute DSDRPM.

- FN880(IDLTMR) = DSDRPM adder vs. time at idle (IDLTMR). Used as part of

the inspection/maintenance strategy. Rember that any RPM above base idle

disables ISCKAM adaptive learning via HCAMFG. Also, IDLTMR requires RPM

to be below IDLRPM, an absolute parameter which is not tied to DSDRPM.

Too high an RPM adder in FN880 could disable IDLTMR.

- FN1861(ECT,ATMR3) = Airflow multiplier vs. ECT and ATMR3. Used to

compensate for additional friction at start-up as a function of time in

addition to normal ECT compensation. Increased friction effects tend to

go away after about one minute. Inputs are ECT normalizing by FN020C,

ATMR3 normalizing by FN018B.

- HWPPM = Airflow increment required when heated windshield load is sensed,

ppm.

- HWRPM = Minimum neutral idle speed when heated windshield is on (first

time on only). ..Typical value - 1400.

- 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 mi. on

a cold start. ..Typical value - 1100 RPM.

- NDPPM = Expected change in airflow between engine in neutral and in

drive. Used as a feed forward mechanism for fuel control (increments the

filtered air mass on neutral/drive transition). ..Typical value - 0.15

ppm. NUBASE = Base desired engine speed in neutral.

- PSPPM = Airflow increment required when power steering load is sensed.

Value increments both the desired flow through the ISC actuator (account

for increased speed/load) and the filtered air mass - FAM. ..Typical

value - 0.10 ppm.

- RVIPRPM = Desired RPM controlled by Engine Running VIP strategy.

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION - GUFA

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- TCDESN = Time constant for DESNLO, secs.

- TKDTM = Time since start after which FN826A is eliminated as a desired

RPM adder. ..Typical value - 20 seconds.

- TRLOAD = Transmission Load. 0 = Manual Transmission, no clutch or gerar

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.

OUTPUTS

Registers:

- DSDRPM = See INPUTS above.

- DESMAF = See INPUTS above.

- DESNLO = See INPUTS above.

Bit Flags:

- HCAMFG = Flag indicating the completion of Hi-Cam. HCAMFG = 0 indicates

no desired engine speed adder exists; HCAMFG = 1 indicates 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 CALCULATION - GUFA

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PROCESS

DSDRPM AND PREDICTED DESMAF CALCULATION

The desired idle RPM, DSDRPM, calculation is divided into three parts:

A) START-UP HI-CAM,

B) NEUTRAL/DRIVE, and

C) ACCESSORY LOAD.

The predicted desired airflow, DESMAF is also calculated based on

transmission and accessory load.

The Hi-Cam adjustments are the electronic equivalent of an electric

choke. The engine idles at a higher RPM to compensate for the friction due

to higher viscosity of cold oil, as well as to warm up the catalyst and EGO

sensor.

A) START-UP HI-CAM

RUNNING = 1 -------------------------| DSDRPM = RVIPRPM - NUBASE

(in VIP) | FILTER CONSTANT = VKDESN

|

| --- ELSE ---

ATMR1 < BZZTM -----------------| |

(time for engine cleanout) | |

|AND -| DSDRPM = FN825A(ECT) + FN825B(ACT)

| | + FN826A(TCSTRT) + BZZRPM

| | + FN880(CTNTMR)

ATMR1 < TKDTM -----------------| | (start-up kicker +

(time for RPM kickdown) | Hi-Cam + Buzz Up RPM)

|

|--- ELSE ---

PTSCR = 0 ---------------------| |

(no driver kickdown) | |

|AND -| DSDRPM = FN825A(ECT) + FN825B(ACT)

ATMR1 < TKDTM -----------------| | + FN826A(TCSTRT)

(time for RPM kickdown) | + FN880(CTNTMR)

| (start-up kicker + Hi-Cam RPM)

|

|--- ELSE ---

|

ATMR1 < BZZTM -----------------------| DSDRPM = FN825A(ECT) + FN825B(ACT)

(time for engine cleanout) | + BZZRPM + FN880(CTNTMR)

| (Hi-Cam + Buzz Up RPM)

|

|--- ELSE ---

|

| DSDRPM = FN825A(ECT) + FN825B(ACT)

| + FN880(CTNTMR)

| (Base Hi-Cam desired RPM increment)

NOTE: FN880(CTNTMR) is added to DSDRPM only when CTNFLG = 1. This means

that FN880 is never used in drive even though CTNTMR = 0.

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION - GUFA

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HEATED WINDSHIELD MINIMUM CLIP

HWFLAG = 1 ------|

|

HWFLGL = 1 ------|AND -----| Clip DSDRPM at (HWRPM - NUBASE)

| | as a minimum

DNDSUP = 0 ------|

(Heated Windshield is on for the first time)

DESIRED RPM FILTER

DESNLO > DSDRPM -------------| Set DESNLO = ROLAV (DSDRPM,TCDESN)

(filtered RPM > actual RPM |

| (filter RPM when RPM is dropping)

|

| --- ELSE ---

|

| Set DESNLO = DSDRPM

(do not filter when RPM is increasing)

"HI-CAM FLAG CHECK"

DSDRPM = 0 -------------------------| Set HCAMFG = 0

(Hi-Cam desired RPM = 0) | (not on Hi-Cam)

|

| --- ELSE ---

|

| Set HCAMFG = 1

| (on Hi-Cam, this disables the

| adaptive airflow update)

This is the end of the start-up calculation of Desired RPM. Next check

for neutral or drive.

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION - GUFA

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B) NEUTRAL/DRIVE

TRLOAD <OR= 3 -----| | NEUTRAL

(manual trans) |OR ----| -------

| |

DNDSUP = 0 --------| | Set DSDRPM = DSDRPM + NUBASE

(auto trans in neutral) |

|

| --- ELSE ---

|

|

DNDSUP = 1 ----------------| DRIVE

(auto trans in drive) | -----

| Set DSDRPM = DSDRPM + DRBASE

C) ACCESSORY LOAD

1) If A/C is on add A/C adder to desired RPM

ACCFLG = 1 -----------|

(A/C clutch engaged) |

|

ACIFLG = 1 -----------|OR --------| Set DSDRPM = DSDRPM + DNAC

(A/C load impending) | ( increase RPM for A/C)

|

ACCTMR < DACTM -------|

(delay to turn off A/C adder)

2) If power steering load is on then add power sterring adder to desired RPM.

PSPSHP = 1 -------------|

|AND ---| Set DSDRPM = DSDRPM + DNPOWS

POWSFG = 1 -------------| | (power steering RPM adder)

(power steering on) | Set HCAMFG = 1

| (Disable Adaptive Airflow Update)

GPAS CLIP

TRLOAD >OR= 4 ----|

(auto trans) |AND -----| Clip DSDRPM to ISCLPD

| | as a maximum

DNDSUP = 1 -------|

(in drive) |

|

ATMR3 > CRKTIM ---|

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION - GUFA

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PREDICTED DESMAF CALCULATION

TRLOAD <OR= 3 -------|

|OR -----| Set DESMAF = FN875N(DSDRPM) \*

DNDSUP = 0 ----------| | FN1861(ECT,ATMR3)

(auto trans in neutral) |

|

| --- ELSE ---

|

DNDSUP = 1 -------------------| Set DESMAF = FN875D(DSDRPM) \*

(auto trans in drive) | FN1861(ECT,ATMR3)

Now check for A/C and power steering adders.

ACCFLG = 1 -----------|

(A/C clutch engaged) |OR -| Set DESMAF = DESMAF + ACPPM

| | (increase DESMAF for A/C)

ACIFLG = 1 -----------|

(A/C load impending)

PSPSHP = 1 ----------|

|AND ---| Set DESMAF = DESMAF + PSPPM

POWSFG = 1 ----------| | (increase airflow for P.S.)

(power steering on)

HWFLAG = 1 ------|

|

HWFLGL = 1 ------|AND -----| Set DESMAF = DESMAF + HWPPM

|

DNDSUP = 0 ------|

(Heated Windshield is on for the first time)

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IDLE SPEED CONTROL, DESIRED RPM CALCULATION - GUFA

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ISFLAG/ISLAST LOGIC

ISLAST reflects the state of ISFLAG on the last program pass. ISFLAG is

set according to the following chart:

MANUAL TRANSMISSION or

AUTO in DRIVE AUTO in NEUTRAL

(DNDSUP = 1) (DNDSUP = 0)

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

A/C off | 0 | 2

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

A/C on | 1 | 3

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

By comparing ISFLAG and ISLAST, you can determine if there were any A/C or

N/D transitions since the last program pass.

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IDLE SPEED CONTROL, DESIRED RPM CALCULATIONS - FAM ADJUSTMENTS - GXZ0

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FAM ADJUSTMENTS

OVERVIEW

The Filtered Air Mass, FAM, is adjusted for load transitions at this

point as a software convenience. Sections A, B, and C are executed each

program pass in order.

DEFINITIONS

INPUTS

Registers:

- BGCNT = Background counter used to pace the filtered AM algorithm. See

SAMRAT.

- FAM = Filtered Air Mass.

- IBGPSI = Background counter used to control pacing of the C/L integrator

value (IPSIBR).

- ISLAST = Register which tracks the state of engine load from the previous

background pass. Used in determing when it is necessary to increment the

filtered air mass (FAM) and clip the C/L idle speed integrator to a

minimum value.

Bit Flags:

- ACCFLG = A/C engaged flag: 1 -> A/C engaged; 0 -> A/C disengaged.

- ACIFLG = A/C engagement impending flag: 1 -> A/C about to engage -

adjust airflow and fuel immediately; 0 -> A/C not about to engage.

- DNDSUP = Delayed neutral/drive flag: 0 -> in neutral, no load; 1 -> in

drive loaded.

- 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:

- ACPPM = Airflow increment required with A/C on. Value is used to

increment both the desired flow through the ISC actuator (account for

increased load) and the filtered air mass - FAM. ..Typical value - 0.15

ppm.

- DACPPM = Filtered air mass decrement used when A/C turns off.

- DNPPM = Feed forward mechanism for fuel control. Decrements filtered air

mass for drive/neutral transition.

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IDLE SPEED CONTROL, DESIRED RPM CALCULATIONS - FAM ADJUSTMENTS - GXZ0

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- NDPPM = Expected change in airflow between engine in neutral and in

drive. Used as a feed forward mechanism for fuel control (increments the

filtered air mass on neutral/drive transition). ..Typical value - 0.15

ppm.

OUTPUTS

Registers:

- FAM = Filtered Air Mass.

Bit Flags:

- 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 CALCULATIONS - FAM ADJUSTMENTS - GXZ0

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PROCESS

FAM ADJUSTMENTS

A) NEUTRAL/DRIVE ADJUSTMENTS

DNDSUP = 1 --|

(in drive) |AND ---------| Set FAM = FAM + NDPPM

| | (immediately increase filtered air mass)

ISLAST > 1 --| |

(last pass was neutral) |--- ELSE ---

|

DNDSUP = 0 ---| |

(in neutral) |AND --------| Set FAM = FAM - DNPPM

| (immediately decrease filtered air mass)

ISLAST < 2 ---|

(last pass was drive)

B) A/C STATE CHANGES

ACCFLG = 1 ----------|

(A/C clutch engaged)|OR -|

| |

ACIFLG = 1 ----------| |

(A/C load impending) |AND -| Set FAM = FAM + ACPPM

| | (immediately increase filtered air mass)

ISLAST NOT= 1 OR 3 -------| |

(A/C on state change) |--- ELSE ---

|

ACIFLG = 0 ---------------| |

| |

ACCFLG = 0 ---------------|AND -| Set FAM = FAM - DACPPM

(A/C clutch not engaged) | (immediately decrease filtered air mass)

|

ISLAST NOT= 0 OR 2 -------|

(A/C off state change)

C) POWER STEERING STATE CHANGES

POWSFG = 1 ----------|

(power steering on) |AND -| Set FAM = FAM + PSPPM

| | (immediately increase FAM)

PSFLAG = 0 ----------| | Set PSFLAG = 1

(P.S. on state change) | (store current state of POWSFG)

| Set IBGPSI = 0

| Set BGCNT = 0

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IDLE SPEED CONTROL, DESIRED RPM CALCULATIONS - FAM ADJUSTMENTS - GXZ0

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EXAMPLE OF ANTICIPATORY FAM CHANGES

TO A/C

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

| |

| |

A3C OFF ----------------- ----------

(Pressure Switch)

1 ----------

| |

| |

ACIFLG 0 ----------------- <-IDLCOT-> -----------------------

ON -----------

| |

| |

ACCFLG OFF ----------------|--|--|--|-| ----------

A/C ON 1 or 3 ----------------------

| |

0 or 2 | |

ISLAST A/C OFF ------------ | | | | | | | | | | | ------------

-->| |<--Background Loop Time

| |

V V

0.6 ACPPM |\* \* \*

FAM 0.4 ------------------ \* \* \*

0.2 \* \* \* \* \* \* \* \*

0.0 | \*

\*\*\*\*\*

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IDLE SPEED CONTROL - DUTY CYCLE OUTPUT - GUFB

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DESIRED IDLE AIRFLOW AND ISC DUTY CYCLE OUTPUT

This section describes the following features of the ISC strategy:

- ISC and fuel responses to state changes at idle: When either the FAM

logic has just been entered or a load change at idle has been sensed

(ISLAST does not equal ISFLAG), the following actions are taken:

. The C/L RPM integrator (IPSIBR) is clipped to 0 as a minimum value to

avoid potential speed dips.

. The pacer for the C/L RPM integrator (IBGPSI) is zero'd to avoid

unnecessary reaction by the ISC system.

. The flag tracking the idle load state (ISLAST) is set to the

appropriate state for use the next background slice.

In addition to the above, if a load state change is sensed, the fuel

control system is in C/L operation, the engine is in closed throttle

operation, and the fuel control integrator (LAMBSE1 and LAMBSE2) is

greater than 1.0, then LAMBSE1 and LAMBSE2 is reset to 1.0. This action

avoids potential lean stall/sag problems should there be significant

differences between the degree of maturation of the adaptive fuel cells

for the various idle states.

- Closed loop ISC control: C/L RPM control logic is entered as described

in the ISC mode selection section. The intent of C/L speed control is to

adjust the ISC valve as necessary to provide the correct desired idle

speed. This is accomplished through integration of a proportionally

derived airflow correction which is added to the predicted airflow

requirement (DESMAF). Integration of this correction factor is paced in

terms of background loop by a calibratible function (FN860). Depending

on the direction of the speed error, and neutal/drive status, separate

gains are used to calculate the proportional correction factor used for

integration. (KPSIND, KPSINU, KPSIDU, KPSIDD are the gains, defined

below) A common function (FN824) is available for gain modulation. The

speed error is driven into a calibrated deadband within which integrator

updates are disabled. Integrator updates are also disabled when the ISC

duty cycle is greater than or equal to 98%.

- ISC duty cycle output; Once the desired mass flow value is finalized, the

appropriate duty cycle is calculated and output. The final DESMAF value

is calculated as follows:

. DESMAF = [DESMAF + DASPOT + IPSIBR + ISCKAM]

Then DESMAF, initial predicted value, is added to the factors noted

above; and the value of ISCKAM is used, where ISFLAG points to the

correct adaptive cells. (See discussion on "ISC\_KAM update).

The calibrated leakage term (ITHBMA) is subtracted from DESMAF to obtain

the actual flow required from the ISC actuator (DEBYMA). This value,

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IDLE SPEED CONTROL - DUTY CYCLE OUTPUT - GUFB

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clipped at DEBYCP as a minimum allowed actuator airflow, becomes the

input to the ISC duty cycle transfer function (FN800). Output from FN800

is the specified ISC duty cycle. The nature of the bypass air solenoid

is such that at high manifold vacuum the device flows less air than at

idle vacuum levels, assuming a constant duty cycle. To account for this

difference, a modulator (FN820B) is available to increment the duty cycle

as necessary to hold constant flow.

- In addition, the closed throttle spark can be aggressively modified via

SPKMUL (See Ignition Timing chapter for definition and usage). Two

functions, FN841N for neutral, and FN841D for drive, are used based on

RPM error, RPMERR.

CALIBRATION CONSTANTS:

The following calibration constants are used in the duty cycle output and C/L

RPM control routines.

- RPMDED = Specifies the engine speed deadband within which the C/L RPM

integrator is frozen. To be in this zone, the absolute value of the

engine speed error cannot exceed RPMDED where the speed error is defined

as RPMERR = (DSDRPM - N). ..Typical value - 25 RPM.

- KPSIDU = Gain for underspeed condition in drive (same as KPSINU for

neutral).

- VPSINU = VIP gain for underspeed conditions.

- KPSINU = Gain for underspeed condition in neutral. When multiplied by

the engine speed error and the gain modulator (FN824), it provides the

input for IPSIBR integration. Using the duty cycle vs. RPM information

generated for the airflow predictions, FN875N / FN875D (see Desired RPM

section), approximate gains can be calculated. On 2.3l OHC EFI Truck

calibrations, a 0.01 ppm change in airflow corresponds to an approximate

30 RPM speed-delta. This assumes a transport delay of about 1.25

seconds. If the pacing requested for the C/L integrator is less than the

actual transport delay (which it should to have a responsive system),

then the gain should be decreased proportionately. Eg., In the case of

the 2.3L OHC, (0.01 ppm/30 RPM) = a calculated gain of 0.00033 ppm/RPM:

If the desired pacing for underspeed conditions is 0.36 seconds (assume

30 background passes 0.012 sec/pass), then the resultant gain would be

[(0.36 / 1.25) \* 0.00033] = 0.000095 ppm/RPM. ..Typical value - 0.00009

ppm/RPM.

- KPSIND = Gain for overspeed condition in neutral. Used same as KPSINU

above. ..Typical value - 0.000075 ppm/RPM.

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IDLE SPEED CONTROL - DUTY CYCLE OUTPUT - GUFB

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- VPSIND = VIP gain for overspeed conditions.

- KPSIDD = Gain for overspeed condition in drive (Same as KPSIND in

neutral).

- ITHBMA = Throttle body idle mass air flow with throttle plate at idle

screw stop and 0% ISC duty cycle.

- PSIBRM = Maximum allowed value for the IPSIBR. Must provide adaquate

range of authority to correct for anticipated errors in the initial

airflow predications. ..Typical value - 0.25 ppm.

- VSIBRM = Maximum allowed value for IPSIBR when in running VIP.

- PSIBRN = Minimum allowed value for IPSIBR. Range is -1.0 to 0.0.

- DEBYCP = Minimum allowed airflow through the ISC actuator.

- VSIBRN = Minimum allowed value for IPSIBR when in running VIP.

- FN860 = Function which paces the integration of the C/L RPM correction.

Input to this function is the engine speed error. Typically the

integration is paced more rapidly the further under the control speed

that the engine speed falls. In overspeed conditions, the pacing is

slowed to provide an overdamped response to a torque disturbance at idle.

..Typical values

- V860 = VIP calibration parameter which sets pacing intergration of the

C/L RPM correction.

RPM ERROR Pacing (BACKGROUND PASS)

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

-500 250

-200 150

-125 125

- 25 125

+ 25 45

+ 75 25

+150 15 RPMERR =

DSDRPM - N

- FN824(N\_BYTE) = Gain multiplier vs. RPMERR (RPMERR = DSDRPM - N) for

KPSINU and KPSIND used to vary the response of the proportional

correction term in C/L RPM control.

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IDLE SPEED CONTROL - DUTY CYCLE OUTPUT - GUFB

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- FN800 = Transfer function for the ISC actuator. Initial values for this

function should come directly from flow data provided by fuel systems.

Data must be generated at the expected idle vacuum setting for each

particular application. Subsequent data generated in the airflow

prediction study, as described in the desired RPM section, can be used to

fine-tune the transfer function as sufficient numbers of vehicles are

sampled.

|

| - FN810 = Adder to DEBYMA vs. RPM. This function is similar to a

| proportional control term. It adds air flow to correct dips in RPM.

- FN820B = ISC duty cycle multiplier vs. LOAD. Used to hold constant

actuator airflow on a decel. after a dashpot action is complete.

- FN841D = ISC Spark Multiplier versus RPM Error in Drive. Input = RPMERR

in RPM.

- FN841N = ISC Spark Multiplier versus RPM Error in Neutral. Input =

RPMERR in RPM.

KEY REGISTERS/FLAGS:

The following registers/flags are used in the duty cycle output and/or C/L

RPM control routines.

- DEBYMA\_FM = DEBYMA without BP correction, for MAF FMEM, units are

lbma/min.

- IBGPSI = Background counter used to control pacing of the C/L integrator

value (IPSIBR).

- IPSIBR = Integrated value of the proportional C/L RPM correction.

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IDLE SPEED CONTROL - DUTY CYCLE OUTPUT - GUFB

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TOTAL DESMAF CALCULATION and LAMBSE CLIP

(DESMAF and DEBYMA)

ISFLAG = ISLAST --------|

(No Idle Load Change) |

|AND ----------------| Set DESMAF = DESMAF

CTPTFG = 0 -------------| | + IPSIBR + DASPOT

(no transition from C.T.) |

| --- ELSE ---

|

| Clip IPSIBR to zero

| as a minimum

|

| DESMAF = DESMAF + IPSIBR

| + DASPOT

| IBGPSI = 0

| BGCNT = 0

ISCKAM QUALIFICATION

KAM\_ERROR = 0 ------------------| DESMAF = DESMAF + ISCKAM(n)

(KAM is ok) | n = ISFLAG

NOTE: LAMBSE resets are done when:

- entering/exiting FAM region

- load state changes at closed throttle at idle

- open loop to closed loop transition

See the LAMBSE RESET LOGIC in the Closed Loop Fuel section.

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IDLE SPEED CONTROL - DUTY CYCLE OUTPUT - GUFB

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ISC DUTY CYCLE CALCULATION

(ISCDTY)

ISCFLG = 1 OR 2 -----------| | Set RPMERR = DSDRPM - N

(RPM control or lockout) | | (determine RPM error)

|AND ------| Set SPKMUL = FN841N

DNDSUP = 0 ----------------| | (spark feedback, neutral)

(neutral) | Set IBGPSI = IBGPSI + 1

| (increment C/L correction

| pacer)

|

| --- ELSE ---

ISCFLG = 1 OR 2 -----------| |

|AND ------| Set RPMERR = DSDRPM - N

DNDSUP = 1 ----------------| | Set SPKMUL = FN841D

(drive) | Set IBGPSI = IBGPSI + 1

|

| --- ELSE ---

|

ISCFLG = -1 OR 0 ---------------------| GO TO DEBYMA calculation

(dashpot or pre-position)

|RPMERR| > RPMDED --------------------| Set ISCTMR = 0

(RPM not within deadband) | (set RPM sampling timer

| to 0)

|

| --- ELSE ---

|

| GO TO DEBYMA calculation

RUNNING = 0 ----------|

(normal strategy) |AND --|

| |

IBGPSI >OR= FN860 ----| |OR -----| Set IBGPSI = 0

(OK to correct RPM) | | (reset C/L correction

| | pacer)

RUNNING = 1 ----------| | |

(in self test) | | |

|AND --| | --- ELSE ---

IBGPSI >OR= V860 -----| |

| GO TO DEBYMA calculation

N < DSDRPM - RPMCTL ----|

(RPM is too low) |

|

RUNNING = 0 ------------|AND ---------| GO TO DEBYMA calculation

(not in VIP) |

|

ISCDTY >OR= 0.98 -------|

(ISC duty cycle

already at maximum)

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IDLE SPEED CONTROL - DUTY CYCLE OUTPUT - GUFB

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RPMERR < 0 ---------------------------| Set ISCPSI = "B" \*

(overspeed error) | RPMERR \* "F"

| (determine C/L overspeed

| air mass correction)

|

| --- ELSE ---

|

RPMERR >OR= 0 ------------------------| Set ISCPSI = "C" \*

| RPMERR \* "F"

| (determine C/L

| underspeed air mass

| correction)

| Set IPSIBR = IPSIBR

| + ISCPSI

| (update C/L air mass

| correction)

|

| Clip IPSIBR to

| "D" as a maximum

| "E" as a minimum

|

| GO TO DEBYMA calculation

| Enter DEBYMA calculation ---| Set DEBYMA = ((DESMAF - ITHBMA) +

| (calculate corrected, | FN810) \* (29.92/BP)

| actual airflow) | DEBYMA\_FM = (DESMAF - ITHBMA) + FN810

| (calculate airflow through

| the bypass solenoid)

| Clip DEBYMA and DEBYMA\_FM

| at DEBYCP as a minimum

|

| Set ISCDTY = "A" \* FN800

|

| (calculate ISC duty cycle)

| Clip ISCDTY at 1.0 as a

| maximum

|

| GO TO KAM\_UPDATE

| (update keep alive cells)

RUNNING = 0 ----------------| "A" = FN820B "D" = PSIBRM

(normal strategy) | "B" = KPSIND "E" = PSIBRN

| "C" = KPSINU "F" = FN824(N\_BYTE)

|

| --- ELSE ---

|

RUNNING = 1 ----------------| "A" = V820A "D" = VSIBRM

(in self test) | "B" = VPSIND "E" = VSIBRN

| "C" = VPSINU "F" = 1.0

| (VIP GAIN MULTIPLIER)

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IDLE SPEED CONTROL - KAM UPDATE

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ISC\_KAM\_UPDATE

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 and IPSIBR has a non-zero

value, then adaptive ISC strategy will roll this correction value into KAM

and drive the IPSIBR term back to zero. Control of the rate at which the

IPSIBR value is driven to zero is calibration dependent.

There are four ISCKAM cells designated for idle corrections. The appropriate

cell is pointed to by the flag ISFLAG which tracks the load state at idle. A

checksum has also been added, ISKSUM, (see KAM Chapter), the total of the

four ISCKAM cells minus the value in ISKSUM must be less than or equal to one

during Power Up Sequencing; otherwise, a reinitializing occurs. 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).

\* IBGPSI >OR= UPDATM.

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.

CALIBRATION CONSTANTS

The following calibration constants are used to control the ISCKAM update

routine:

- UPDISC = Time that engine speed must be within the specified deadband

(RPMDED) prior to KAM update. ..Typical value - 3 seconds.

- UPDATM = Pacing at which the IPSIBR correction factor is rolled into KAM.

Value is in terms of background loop counts. ..Typical value - 5

background passes.

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IDLE SPEED CONTROL - KAM UPDATE

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KAM\_UPDATE

ISCFLG NOT= 1 --------------| | Exit KAM\_UPDATE

(not in RPM control mode) | | (do not update KAM)

| |

ISCTMR < UPDISC ------------|OR --------| END OF ISC LOGIC

(not at DSDRPM long enough)| |

| |

HCAMFG = 1 -----------------| |

(on hi-cam) | |

| |

IPSIBR = 0 -----------------| |

(closed loop ISC | |

correction is 0) | |

| |

IBGPSI < UPDATM ------------| |

(not time to update KAM) | --- ELSE ---

|

IPSIBR > 0 -----------------| | Increment ISCKAM(N)

(positive C/L correction) |AND -------| (roll correction into

| | KAM)

ISCKAM(N) < PSIBRM ---------| | Increment ISKSUM

(< max allowed value) | Decrement IPSIBR

| (balance DESMAF equation)

|

| Set IBGPSI = 0

| (reset closed loop

| correction to 0)

|

| END OF ISC LOGIC

IPSIBR <OR= 0 --------------| |

(negative C/L correction) | | --- ELSE ---

|AND -------|

ISCKAM(N) > PSIBRN ---------| | Decrement ISCKAM(N)

(> min allowed value) | (roll correction into

| KAM)

| Decrement ISKSUM

| Increment IPSIBR

| (balance DESMAF equation)

|

| Set IBGPSI = 0

| (reset closed loop

| correction to 0)

|

| END OF ISC LOGIC

|

| --- ELSE ---

|

| IBGPSI = 0

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IDLE SPEED CONTROL - FAM - GUAA

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FILTERED AIR MASS (FAM) LOGIC/AIR MASS DETERMINATION

This section describes logic associated with filtering of the calculated air

mass at idle. Specifically it details:

- Entry/Exit conditions for FAM region. Air mass filtering is required to

provide acceptable engine performance at stabilized idle operation. When

conditions (throttle position, desired engine speed, actual idle speed)

indicate filtering is desired, a control flag (REFFLG) is set and an

adaptation of the common rolling average filter routine is entered. This

action, in effect, drives the filtered air mass (FAM) into a calibrated

deadband approximately centered about the instantaneous air mass

(N\*ENGCYL\*ARCHG). This procedure should provide a near fixed AM signal

at idle.

- Determination of the idle air mass: Either the instantaneous

(N\*ENGCYL\*ARCHG) or the filtered (FAM) air mass can feed the AM register

at idle for use in the fuel pulsewidth calculation. In general if the

control flag (REFFLG) is set, the filtered air mass value will feed the

AM register -- unless the instantaneous air mass exceeds FAM by a

calibrated percent difference (DELTAM). When FAM is referenced, it is

clipped at a calibrated percent (MAXFAM) above (N\*ENGCYL\*ARCHG) as a

maximum allowed value. The AM register is always clipped at a minimum

value (MINAM) regardless of whether the filtered or instantaneous AM is

used.

CALIBRATION CONSTANTS:

The following calibration constants are used to specify entry conditions into

the FAM region, control of the filter routine and selection of the

appropriate AM value.

- AMDESN = Defines the desired engine speed below which air mass filtering

can be enabled. Should be kept at a minumum to avoid unnecessary

activation of the FAM filter routine. ..Typical value - 900 RPM.

- AMRPM = Incremental adder to DSDRPM; total defines an engine speed limit

below which air mass filtering can occur. Should be kept to a minimum to

avoid unnecessary activation of the FAM filter routine. ..Typical value

- 75 to 125 RPM.

- AMRPMH = Hysteresis term for AMRPM; after entry into the FAM region the

total of DSDRPM + AMRPM + AMRPMH defines the engine speed exit condition.

Should be large enough so that it not triggered by normal fluctuations in

engine speed at idle due to load transitions (eg. A/C or power steering

cycling). ..Typical value - 350 RPM.

- DELRAT = Throttle position adder to RATCH. Used to describe a throttle

position below which air mass filtering is enabled. Should be set equal

to DELTA + HYSTS (see throttle mode select logic). ..Typical value - 15

counts.

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IDLE SPEED CONTROL - FAM - GUAA

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- DLHYST = TP hysteresis on exit from FAM.

- EFAMPH = Upper (AMPEM-EM) clip on entry to FAM.

- EFAMPL = Lower (AMPEM-EM) clip on entry to FAM.

- FAMINC = FAM increment/decrement when entering FAM region, lb/min.

- FAMLIM = Establishes a deadband centered around FAM. The filter is run

only if the instananeous AM is outside this deadband; (FAM plus or minus

FAMLIM \* N \* ENGCYL \* ARCHG). FAMLIM may be thought of as the deadband

size. Eg., if FAMLIM was 0.05, then the deadband would be FAM plus or

minus 5 percent of the instantaneous AM. If FAMLIM is too large, the

filter will not respond to changes in instantaneous Idle AM. If FAMLIM

is too small, the filter will vary with the oscillations in instantaneous

AM. Typical value - 0.035.

- IFAM = Initial FAM - Upper FAM clip on exit from FAM.

- SAMRAT = SAMRAT is used to pace the filter in terms of background loop

counts. ..Typical value - 5.

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IDLE SPEED CONTROL - FAM - GUAA

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- DELTAM = Multiplier of the filtered air mass. Establishes a threshold

which if exceeded by the instantaneous AM, forces the AM register to

reference the instantaneous AM value. This provides a breakout capacity

of the filtered routine which may be necessary due to unanticipated loads

at idle. ..Typical value - 1.15.

- MAXFAM = Multiplier of the instantaneous AM value. When referencing the

FAM register at idle, MAXFAM \* (N\*ENGCYL\*ARCHG) establishes an upper clip

on the AM value. ..Typical value - 1.25.

- MINAM = A minimum clip on the AM register. TCFAM = Time constant for

FAM, sec.

DEDICATED REGISTERS/FLAGS:

The following registers/flags are used by this routine.

- FAM\_FLG = Flag indicating in FAM region and AM = FAM.

- FFMTMR = FAM filter Timer, sec.

- RATCH = Lowest filtered throttle position (see System Equations in this

book for a better description).

- REFFLG = Flag indicating (when set) that conditions to enter the filtered

region have been satisfied. Flag is also referenced by adaptive fuel

control to indicate when to use/update specific idle cells.

- BGCNT = Background counter used to pace the filtered AM algorithm.

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IDLE SPEED CONTROL - FAM - GUAA

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FILTERED AIR MASS LOGIC (FAM)

ALWAYS ------------------------| AM = N \* ENGCYL \* ARCHG

---->(Tip-in into normal AM)

TP > RATCH + DELRAT + DLHYST ----------------|OR ---| Set REFFLG = 0

(not closed throttle) | | (use AM)

| |

DSDRPM > AMDESN -----------------------------| | Clip FAM to IFAM

(desired RPM too high for FAM) | |

| |

N\_BYTE > DSDRPM + AMRPM + AMRPMH ------------| |

(RPM higher than desired idle RPM) |

| --- ELSE ---

|

| Enter FAM region

|

| Set BGCNT = 0

---->(Tip-out into closed throttle and FAM) | (reset FAM

| update counter)

TP <OR= RATCH + DELRAT ----------------------|AND --|

(near closed throttle) | | Set REFFLG = 1

| | Clip AM to

DSDRPM <OR= AMDESN --------------------------| | EFAMPH\*FAM as max.

| | EFAMPL\*FAM as min.

(desired RPM within FAM region) | | Set FAM =

| | AM + FAMINC

N\_BYTE <OR= DSDRPM + AMRPM ------------------| |

(RPM closed to desired idle RPM) | |

| | Set FFMTMR = 0

REFFLG = 0 ----------------------------------| |

(last state was normal AM) | (initialize FAM

| filter timer

| during entry)

|

| --- ELSE ---

---->(FAM update delay) |

|

REFFLG = 1 ----------------------------------| |

(in FAM region) | |

| |

BGCNT + 1 < SAMRAT --------------------------|AND --| Increment BGCNT

(sampling counter too low) | |

| |

|(N\*ENGCYL\*ARCHG) - FAM | > | |

(N\*ENGCYL\*ARCHG) \* FAMLIM -----------------| |

(AM within reasonable limits) |

|

|

|

| --- ELSE ---

|

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IDLE SPEED CONTROL - FAM - GUAA

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---->(FAM update) |

|

REFFLG = 1 ----------------------------------| | Set FAM = UROLAV

(in FAM region) | | (AM,TCFAM)

| | FFMTMR is the

BGCNT + 1 >OR= SAMRAT -----------------------|AND --| sample period

(sampling counter OK) | | Set FFMTMR = 0

| | (reset FAM timer

|(N\*ENGCYL\*ARCHG) - FAM| > (N\*ENGCYL\*ARCHG) | | for next update)

\* FAMLIM ----------------------------------| | Set BGCNT = 0

(AM within reasonable limits) |

| --- ELSE ---

|

| Set BGCNT = 0

| do not update

| FAM

Determine state of FAM\_FLG:

REFFLG = 1 --------------------------------|

|AND ---| FAM\_FLG = 1

(N \* ENGCYL \* ARCHG) <OR= (FAM \* DELTAM) --| |

| --- ELSE ---

|

| FAM\_FLG = 0

Determine state of FAMREG:

REFFLG = 0 ---------------------------| FAMREG = 0

|

| --- ELSE ---

|

FAM\_FLG = 1 --------------------------| FAMREG = 255

|

| --- ELSE ---

|

| FAMREG = 128

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CHAPTER 10

A/C CLUTCH STRATEGY

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A/C CLUTCH STRATEGY - GUE0

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A/C CLUTCH STRATEGY

NOTES:

1. This strategy is based on the "CH" version (6E-031). Additions or

revisions include:

a) Minimum A/C enabled time feature.

ACCTMR replaces ACDTMR.

c) A variable time period for WOT A/C

Cut-out, varies as a function of

relative throttle position.

2. This strategy includes provisions for a brake input. On applications

without the brake input, set BRKCOT = 0 which will disable this feature.

Also, software should include the BIFLG Flag with an initial value of ZERO

(clear). This also disables the brake input feature as long as the BIFLG is

kept clear.

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A/C CLUTCH STRATEGY - GUE0

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AIR CONDITIONER CLUTCH CONTROL

BRIEF DESCRIPTION:

This routine controls the state of the A/C clutch. The strategy can disable

the A/C clutch by energizing a normally closed relay. The A/C clutch is

disabled when the A/C clutch has been enabled for a minimum time period and

when any of the following conditions are met:

1. Time since start is less than a calibration value.

2. ECT is greater than an "over-heat" calibration value.

3. Engine RPM is less than a "near stall" calibration

value.

4. Brake is applied. (Duration of A/C

disable period is a calibration value.

5. TP is greater than a "WOT" calibration value.

(Duration of A/C disable period is a

calibration value.)

After the clutch is disabled, the routine prevents it from being re-enabled

until all of the following conditions are met:

1. The A/C cycling control switch is closed.

2. The clutch has been off longer than a minimum

off-time.

3. If, at closed throttle, the idle speed

control system has been given time to

prepare for the impending increase in load.

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A/C CLUTCH STRATEGY - GUE0

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DEFINITIONS

INPUTS

Registers:

- ACBTMR = Time since brake went on.

- ACCTMR = Time since A/C clutch transition.

- ACITMR = Time since Idle Speed Control system was

warned of impending increase in load.

- A3CTMR = Free running timer that is reset to 0 on

every A3C state change. Described in the

TIMER Chapter.

- APT = If equal to -1, Closed throttle.

- ATMR1 = Time since start.

- ECT = Engine Coolant Temperature, Deg F.

- HWFLAG = Flag that is set to 1 if the Heated

Windshield is on.

- HWFLGL = Latched Heated Windshield Flag.

0 -> H/W never actuated,

1 -> H/W on for the first time.

- HWTMR = Free running timer that is reset to 0 on if A3CTMR > H/W

switching frequency. Described in the timer chapter.

- LSTA3C = State of A3C the last pass. DAC same bit number as A3C

to see state changes.

- N = Engine speed, RPM.

- WCOTMR = WOT A/C cut-out timer.

Bit Flags:

- A3C = If equal to 1, A/C cycling control switch is closed.

- ACCFLG = If set to 0, A/C clutch is disabled; if

set to 1, A/C clutch is enabled.

- BIFLG = If equal to 1, Brake is on.

Calibration Constants:

- ACRT = Air conditioning recognition time threshold, msec.

- ACSTRD = Maximum time to keep A/C disabled after start, sec.

- ACMNDT = Minimum disable time for A/C clutch, 1/8 sec.

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A/C CLUTCH STRATEGY - GUE0

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- ACMNET = Minimum enable time for A/C clutch.

- ACOFFH = Hysteresis for ACOFFN, RPM.

- ACOFFN = Minimum RPM for enabling A/C clutch, RPM.

- ACWDLY = Delay time to enable A/C after WOT, 1/8 sec.

- A3CTT = Heated windshield transition time threshold.

This is longest time for a H/W frequency half

period and is calibrated to 250 msec. This

Vector calibratable value should not be changed.

- BRKCOT = Maximum time to disable A/C due to brake, 1/8 sec.

- CTAC = Maximum value of ECT to enable A/C Clutch,

Deg F.

- CTACH = Hysteresis for CTAC, Deg F.

- HWRT = Heated Windshield recognition time threshold.

This is time required to set the HWFLAG and is

calibrated to 300 msec. This Vector calibratable

value should not be changed.

- HWPPM = Airflow increment required when heated windshield load

is sensed, ppm.

- HWRPM = RPM required for Heated Windshield operation.

Should be calibrated to 1400 RPM.

- IDLCOT = Maximum time to delay A/C when at idle, msec.

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A/C CLUTCH STRATEGY - GUE0

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OUTPUTS

Registers:

- A3CTMR = Free running timer that is reset to 0 on

every A3C state change. Described in the

TIMER Chapter.

- HWFLAG = Flag that is set to 1 if the Heated

Windshield is on.

- HWFLGL = Latched Heated Windshield Flag.

0 -> H/W never actuated,

1 -> H/W on for the first time.

- HWTMR = Free running timer that is reset to 0 on if A3CTMR > H/W

switching frequency. Described in the timer chapter.

- LSTA3C = State of A3C the last pass. DAC same bit number as A3C

to see state changes.

Bit Flags:

- ACCFLG = See Inputs above.

- ACIFLG = If equal to 1, Flag to indicate that Idle Speed

control system should prepare for load increase.

10-6

A/C CLUTCH STRATEGY - GUE0

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A/C CLUTCH CONTROL LOGIC

ECT > CTAC ------------|S Q---|

| |

ECT < CTAC - CTACH ----|C |

|

N < ACOFFN ------------|S Q---|

| |

N > ACOFFN + ACOFFH ---|C |

|

A3C = 0 -----------------------|

|

ATMR1 < ACSTRD ----------------|

|OR -|

BIFLG = 1 -------------| | |

|AND ---| |

ACBTMR < BRKCOT -------| | |

| |

WCOTMR < ACWDLY ---------------| |

| |AND-|OR-| DISABLE A/C

ACCTMR >OR= ACMNET ----| | | | CLUTCH (A/C Off)

(Min ON time) |OR ---------| | | (turn OUTPUT on)

| | | SET ACCFLG = 0

ACCFLG = 0 ------------| | | CLEAR ACIFLG = 0

(Clutch disabled) | |

| |

A3C = 0 ---------------------------------| |

(A/C Pressure Switch off) | --- ELSE ---

|

AC3TMR > ACRT --------------------| |

(H/W is off) | |

| |

ACCTMR >OR= ACMNDT ---------------| | ENABLE A/C

(Min OFF time) |AND ------| CLUTCH (A/C on)

| | (Turn OUTPUT off)

APT NOT= -1 --------------| | | SET ACCFLG = 1

|OR ----| | CLEAR ACIFLG = 0

ACITMR >OR= IDLCOT -------| |

| --- ELSE ---

ACCFLG = 0 ---------------| |

(A/C Off) | |

| |

ACCTMR >OR= ACMNDT -------|AND --------------| SET ACIFLG = 1

(Min OFF time) | | (ISC warning flag)

|

A3CTMR > ACRT ------------|

(H/W is off)

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HEATED WINDSHIELD RECOGNITION - GUE0

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HEATED WINDSHIELD RECOGNITION STRATEGY

Both the heated windshield and the A/C clutch share a common input

(ACCS) to the EEC module. When the A/C is on, the ACCS input is high and the

CPU flag A3C is 1. The heated windshield signal is a 5 Hz (3-8 Hz) square

wave frequency input. Recognition of the frequency input is accomplished

using two free running millisecond timers. A3CTMR resets on any A3C

transition while HWTMR is used to set the heated windshield flag HWFLAG.

Many closely spaced A3C transitions will keep the value of A3CTMR low and

this indicates that heated windshield is in use.

EEC has no control over the heated windshield. External hardware

performs all control, switching and timing functions. The EEC does, however

increase idle RPM in neutral or park to increase alternator power output.

The heated windshield strategy is as follows:

- H/W will operate in all driving modes with A/C either on or off.

- H/W idle RPM will be a minimum of 1400 RPM in park or neutral and normal

RPM in drive.

- RPM will be increased for the first H/W actuation only.

- RPM will be increased when the H/W is first sensed and will remain high

(even if masked by the A/C on signal) until A/C is off and the H/W signal

is no longer present.

HEATED WINDSHIELD VS. A/C RECOGNITION

LSTA3C - A3C NOT= 0 -----------| Set LSTA3C = A3C

(A3C state change) | Set A3CTMR = 0

A3CTMR > A3CTT (250 msec) -----| Set HWTMR = 0

HWTMR > HWRT (300 msec) -|AND -| Set HWFLAG = 1

| | Set HWFLGL = 1

HWFLAG = 0 --------------| | (latch current state of H/W on)

| |

HWFLGL = 0 --------------| |--- ELSE ---

(first time H/W on) |

|

A3CTMR > ACRT -----|AND -------| Set HWFLAG = 0

| | (explicitly turn off H/W)

A3C = 0 -----------|

(A/C off)

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CHAPTER 11

CANISTER PURGE

11-1

CANISTER PURGE - GXW0

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CANISTER PURGE STRATEGY

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.

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CANISTER PURGE - GXW0

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DEFINITIONS

INPUTS

Registers:

- AM = Air Mass flow (lb/min).

- ATMR1 = Time since initial engine startup, secs.

- ATMR2 = Time since Engine Coolant Temp (ECT) reached

TEMPFB, (sec).

- CPRGTMR = Current Purge on time.

- ECT = Engine Coolant Temperature, deg F.

- N = Engine RPM.

- NACTMR = Not at Closed Throttle Timer, sec.

- PRGTMR = Total Purge on time.

- TCSTRT = Temperature of Engine Coolant at Cold Startup,

deg F.

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.

- CTPRGH = Hysteresis term for CTPRG, deg F.

- EVRPM = Minimum Engine Speed to Purge, RPM.

- EVRPMH = Hysteresis term for EVRPM.

- EVTDOT = Purge time delay at Part throttle or WOT.

- FN600 = Canister Purge Duty Cycle Multiplier

X-input = PRGTMR

Y-output = Duty Cycle Multiplier.

- FN602 = Canister Purge Duty Cycle Multiplier

X-input = CPRGTMR

Y-output = Duty Cycle Multiplier.

- FN605A = Canister Purge Duty Cycle vs. AM

X-input = AM

Y-output = Purge Duty Cycle.

- PRGTD1 = Canister purge cold startup delay time.

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CANISTER PURGE - GXW0

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- 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.

- TEMPFB = Minimum ECT required to start ATMR2 timer,

deg F.

OUTPUTS

Registers:

- CPRGTMR = Current Purge on time.

- PRGTMR = Total Purge on time.

- PURGDC = Canister Purge Duty Cycle.

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CANISTER PURGE - GXW0

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CANISTER PURGE LOGIC

TCSTRT >OR= CTHIGH -----------|

|AND -|

ATMR1 >OR= PRGTD3 ------------| |

|

|

CTLOW < TCSTRT < CTHIGH ------| |

|AND -|OR -|

ATMR1 >OR= PRGTD2 ------| | | |

|AND -| | |

ATMR2 >OR= PRGTD5 ------| | |

| |

| |

TCSTRT <OR= CTLOW ------------| | |

|AND -| |

ATMR1 >OR= PRGTD1 ----| | |

|AND ---| |

ATMR2 >OR= PRGTD4 ----| |

|

ECT < CTPRG - CTPRGH ---|S Q-------------|AND -| ENABLE PURGE

| | |

ECT > CTPRG ------------|C | | SET PURGDC =

(Over temp. disable) | | FN600(PRGTMR) \*

| | FN602(CPRGTMR) \*

NACTMR >OR= EVTDOT ----------------------| | FN605A(AM)

| |

| | --- ELSE ---

CLOSED LOOP FUEL CONTROL ------| | |

|OR ------| | DISABLE PURGE

PURGSW = 1 --------------------| |

(to allow Open Loop Purge) | SET PURGDC = 0

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

PURGE ENABLED -------| | COUNT UP PRGTMR

|AND --------| COUNT UP CPRGTMR

FN605A(AM) NOT= 0 ---| |

| --- ELSE ---

|

| FREEZE PRGTMR

| SET CPRGTMR = 0

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CANISTER PURGE - GXW0

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CHAPTER 12

THERMACTOR AIR STRATEGY

12-1

THERMACTOR AIR AND AUXILLARY STRATEGIES - GUE0

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This section contains three related strategies which are discussed in the

order shown below.

- Thermactor Air

- Inlet Air Control

- Supercharger Strategy

The THRMHP assists in determining which of the strategies is activated. This

is a calibratible switch and has four settings.

- THRMHP = 0 - Disables Inlet Air Control (IACFLG = 0)

- THRMHP = 3 - Enables Inlet Air Control (IACFLG = 1)

- THRMHP = 2 - Enables Supercharger Strategy

- THRMHP = 1 - Enables Thermactor Air

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THERMACTOR AIR AND AUXILLARY STRATEGIES - GUE0

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THERMACTOR AIR STRATEGY

Thermactor air refers to air added to the exhaust gas mixture from the

belt driven thermactor air pump.

The computer controls two solenoids to create three mutually exclusive

air states:

Thermactor Air State TAB Solenoid TAD Solenoid

Upstream on on

Downstream on off

Bypass off off

Bypass off on

TAB - Thermactor Air Bypass (AM1)

TAD - Thermactor Air Divert (AM2)

Upstream refers to air added at or near the exhaust ports. This is done

to provide better oxidation of the exhaust gas mixture when a richer

exhaust gas mixture is anticipated. It is not possible to operate in

closed loop fuel control while air is introduced upstream (the EGO sensor

may always indicate a lean condition).

Downstream refers to air added to the catalyst mid-bed. Downstream air

is compatible with closed loop fuel control and is the normal thermactor

air state.

Bypass refers to the condition in which no thermactor air is added to the

exhaust gas mixture. This feature is used primarily to protect the

catalyst from over-temperature conditions.

The THERMACTOR AIR CONTROL LOGIC is executed if the Off-chip port

selection switch (THRMHP) is set = 1. In order to disable thermactor

logic, (without enabling Inlet Air Control [3.0L SHO] or Supercharger

(3.8L SC) Strategy), set THRMHP = 0. The thermactor air control logic is

shown on the next page.

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THERMACTOR AIR AND AUXILLARY STRATEGIES - GUE0

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DEFINITIONS

INPUTS

Registers:

- ACT = Air Charge Temperature, deg F.

- APT = Part throttle flag.

- ATMR1 = Time since Engine Startup, sec.

- ATMR2 = Time since ECT greater than TEMPFB, sec.

- AWOTMR = Time at WOT, sec.

- CTATMR = Closed throttle Upstream Air Timer, sec. (See Timer Chapter).

- ECT = Engine Coolant Temperature, deg F.

- HMTMR = High Power Demand Timer, sec. (See Timer Chapter).

- LOAD = Universal Load parameters, unitless. It also equal Aircharge

normalized to sea.

- MFATMR = Managed Fuel Air Timer, sec. (See Timer Chapter)

- N = Engine speed, RPM.

- NACTMR = Not at Closed throttle Timer, sec.

- RATCH = Filtered throttle position.

- TCSTRT = Temperature of ECT at startup, deg F.

- TP = Throttle Position.

Bit Flags:

- AFMFLG = Flag indicating that ACT sensor has failed.

- CFMFLG = Flag indicating that ECT sensor is in/out of range, 0 = in

range.

- CHKAIR = Thermactor Air Status Flag. (1 = Air diverted upstream or

dumped)

- CRKFLG = Flag indicating status of Crank.

- CTAFLG = Flag indicating state of CTATMR (Closed Throttle Upstream Air

timer).

- HSPFLG = High Speed Mode flag; 1 = High speed alternate fuel/spark.

- LEGOFG1 = Flag indicating lack of EGO-1 switching, if set.

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THERMACTOR AIR AND AUXILLARY STRATEGIES - GUE0

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- LEGOFG2 = Flag indicating lack of EGO-2 switching, if set.

- MFMFLG = Flag indicating that MAF sensor has failed.

- TFMFLG = Flag indicating that TP sensor has failed.

- UNDSP = Flag if set to 1 indicates Underspeed Mode, or Crank.

Calibration Constants:

- ATBYS = Minimum ACT to Bypass thermactor Air, deg F.

- BYHTMR = Bankline timer time delay for Thermactor Bypass.

- BYPWOT = Wide Open Throttle Bypass Time delay.

- BYSTM1 = ATMR1 Thermactor Bypass Time Delay for TCSTRT <or= CTLOW.

- BYSTM2 = ATMR1 Thermactor Bypass Time Delay for CTLOW < TCSTRT < CTHIGH.

- BYSTM3 = ATMR1 Thermactor Bypass time Delay for TCSTRT >or= CTHIGH.

- BYSTM4 = ATMR2 Thermactor Bypass Time delay for TCSTRT <or=CTLOW.

- BYSTM5 = ATMR2 thermactor Bypass Time Delay for CTLOW < TCSTRT < CTHIGH.

- CTARTM = Upstream air time delay during Decel, sec.

- CTBYS = Minimum ECT to Bypass thermactor Air, deg F.

- CTBYSH = Hysteresis for ATBYS and CTBYS.

- CTHIGH = Hot start minimum engine coolant temperature, Deg F.

- CTLOW = Cold Start Maximum ECT, deg F.

- DMPDLY = Managed Fuel Air State Time Delay to Bypass Thermactor Air, sec.

- DNLOD = Maximum load for downstream air.

- DNLODH = Hysteresis for DNLOD.

- DNSTMI = Time delay for Downstream air when not at Closed Throttle, sec.

- HMCTM = Upstream Air Time Delay, sec.

- HMSTM = Maximum time that Upstream Air occurs during crowds (after

startup).

- MFATM1 = ATMR1 MFA enable time delay for TCSTRT <or= CTLOW.

- MFATM2 = ATMR1 MFA enable time delay for CTLOW < TCSTRT < CTHIGH.

- MFATM3 = ATMR1 MFA enable time delay for TCSTRT >or= CTHIGH.

- MFATM4 = ATMR2 MFA enable time delay for TCSTRT <or= CTLOW> CTHIGH.

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THERMACTOR AIR AND AUXILLARY STRATEGIES - GUE0

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- MFATM5 = ATMR2 MFA enable time delay for CTLOW < TCSTRT < CTHIGH.

- NIAC = Maximum RPM for single inlet airflow path, RPM.

- NIACH = Hysteresis term for turning OFF IAC, RPM.

- NUMEGO = Calibration switch which indicates number of EGO sensors

present, mono or stereo.

- THRMHP = Off chip port selection switch.

= 0 - Disables Inlet Air Control (IACFLG = 0)

= 3 - Enables Inlet Air Control (IACFLG = 1)

= 2 - Enables Supercharger Strategy

= 1 - Enables Thermactor Air

-

TEMPFB = Minimum ECT required to start ATMR2 timer, deg. F.

- THBPSC = Throttle breakpoint for Supercharger Bypass, A/D counts.

- THBPSH = Hysteresis for THBPSC, A/D counts.

- UPLOD = Minimum Percent LOAD for upstream air.

- UPLODH = Hysteresis for UPLODH.

- UPRPM2 = Maximum RPM for Decel Upstream Air.

- UPRPMH = Hysteresis term for UPRPM.

- UPSTM1 = ATMR1 Thermactor Upstream Time Delay for TCSTRT <OR= CTLOW.

- UPSTM2 = ATMR1 Thermactor Upstream time delay CTLOW < TCSTRT < CTHIGH.

- UPSTM3 = ATMR1 Thermactor Upstream time delay for TCSTRT >OR= CTHIGH.

- UPSTM4 = ATMR2 Thermactor Upstream Time Delay for TCSTRT <OR= CTLOW.

- UPSTM5 = ATMR2 Thermactor Upstream Time Delay for CTLOW < TCSTRT <

CTHIGH.

- UPSWOT = WOT Upstream Air Time Delay.

OUTPUTS

Bit Flags:

- CHKAIR = Thermactor Air Status Flag. (1 = Air diverted upstream or

dumped)

- IACFLG = Flag which indicates setting of (IAC). If set to 1, IAC valve

is open and IAC is enabled; cleared (0), then IAC is disabled.

- USAFLG = Upstream Air Flag; 0 = Not in Upstream Air, 1 = In Upstream Air.

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THERMACTOR AIR AND AUXILLARY STRATEGIES - GUE0

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UNIVERSAL CHKAIR LOGIC

Under certain circumstances, it is necessary to force Open Loop fuel control

independently of the presence of Thermactor hardware. The following logic is

used with and without thermactor air. If the engine system does NOT have

thermactor air, (THRMHP NOT=1), this CHKAIR logic will only be used to force

Open Loop fuel. On systems WITH thermactor air, this universal logic can

force air bypass in addition to Open Loop fuel.

ECT > CTBYS ------------| |

|AND ---|S Q----|

ACT > ATBYS ------------| | |

| |

ECT < CTBYS - CTBYSH ---| | |

|OR ----|C |

ACT < ATBYS - CTBYSH ---| |

|

NUMEGO = 1 (MONO EGO) ----------| |

|AND ---|

LEGOFG1 = 1 --------------------| |OR --| CHKAIR = 0

| | (Force Open Loop

NUMEGO = 2 (STEREO EGO) --------| | | Fuel)

| | | (Systems which

LEGOFG1 = 1 --------------------|AND ---| | have Thermactor

| | | Air will Bypass

LEGOFG2 = 1 --------------------| | | according to the

| | Thermactor Logic)

APT = 1 (WIDE OPEN THROTTLE) ---| | |

|AND ---| | --- ELSE ---

AWOTMR >OR= BYPWOT -------------| |

| CHKAIR = 1

| (Do NOT force

| Open Loop Fuel)

| NOTE: Thermactor

| may still set

| CHKAIR = 0

| if hardware is

| present and

| Upstream Air is

| requested)

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THERMACTOR AIR AND AUXILLARY STRATEGIES - GUE0

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THERMACTOR AIR CONTROL LOGIC

THRMHP NOT= 1 ---------------------------------| Exit Thermactor

| strategy

| (Fuel strategy

| will use

| Universal

AFMFLG = 1 --------------------| | CHKAIR logic)

| |

CFMFLG = 1 --------------------| | --- ELSE ---

| |

TFMFLG = 1 --------------------|OR ------------| BYPASS AIR

| | (No change to

MFMFLG = 1 --------------------| | CHKAIR)

| SET USAFLG = 0

|

| --- ELSE ---

"A" ------------------------------------| |

|OR ---| BYPASS AIR

CHKAIR = 0 -----------------------------| | SET CHKAIR = 0

(Universal CHKAIR flag) | | (forced open

| | loop fuel)

HSPFLG = 1 -----------------------------| |

| SET USAFLG = 0

"B" ------------------------------------| |

| | --- ELSE ---

ATRMR1 <OR= HMSTM --------------| | |

| | |

APT = 1 (WIDE OPEN THROTTLE) ---| | |

|AND ---| |

AWOTMR < UPSWOT ----------------| | |

| | UPSTREAM AIR

CTATMR >OR= CTARTM -------------| | | SET CHKAIR = 0

|AND ---|OR ---| (forced open

CTAFLG = 1 ---------------------| | | loop fuel)

| | SET USAFLG = 1

ATMR1 <OR= HMSTM ---------------| | |

| | |

HMTMR <OR= HMCTM ---------------| | |

|AND ---| |

PERLOAD > UPLOD + UPLODH -|S Q -| |

| |

PERLOAD < UPLOD ----------|C | --- ELSE ---

|

MFATMR <OR= DMPDLY ---------------------| | DOWNSTREAM AIR

|AND --| SET CHKAIR = 1

NACTMR <OR= DNSTMI -------------| | | (not forced

|OR ----| | open loop fuel)

LOAD < DNLOD - DNLODH --|S Q----| | SET USAFLG = 0

| |

LOAD > DNLOD -----------|C | --- ELSE ---

|

| BYPASS AIR

| SET CHKAIR = 1

| (not forced

| open loop fuel)

| SET USAFLG = 0

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THERMACTOR AIR AND AUXILLARY STRATEGIES - GUE0

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NOTE: CTAFLG = 1 requirement allows Upstream air immediately

during Decel if CTARTM = 0.

"A" LOGIC

Normal startup Bypass logic: Air is bypassed as long as time is less than

the relevant time delay.

TCSTRT >OR= CTHIGH -------------|

|AND ---|

ATMR1 < BYSTM3 -----------------| |

|

CTLOW < TCSTRT < CTHIGH --------| |

|AND ---|OR -- "A"

ATMR1 < BYSTM2 ---------| | |

|OR ----| |

ATMR2 < BYSTM5 ---------| |

|

TCSTRT <OR= CTLOW --------------| |

|AND ---|

ATMR1 < BYSTM1 ---------| |

|OR ----|

ATMR2 < BYSTM4 ---------|

"B" LOGIC

Normal Start Upstream Logic: Air is diverted upstream as long as it is not

bypassed and as long as the time since start is less that the relevant time

delay.

TCSTRT >OR= CTHIGH -------------|

|AND ---|

ATMR1 < UPSTM3 -----------------| |

|

|

CTLOW < TCSTRT < CTHIGH --------| |

|AND ---|OR ----| "B"

ATMR1 < UPSTM2 ---------| | |

|OR ----| |

ATMR2 < UPSTM5 ---------| |

|

|

TCSTRT <OR= CTLOW --------------| |

|AND ---|

ATMR1 < UPSTM1 ---------| |

|OR ----|

ATMR2 < UPSTM4 ---------|

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THERMACTOR AIR AND AUXILLARY STRATEGIES - GUE0

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INLET AIR CONTROL (THRMHP = 3)

When enabled by the THRMHP, the inlet air control (IAC) strategy opens a

normally-closed valve to increase the airflow to the engine and improve

top-end performance. The valve is located on one side of the split plenum

intake manifold. The strategy controls the valve through a normally closed

vacuum solenoid.

THRMHP NOT= 2 ----------------| IACFLG = 0

| Exit IAC logic

|

| --- ELSE ---

|

N > NIAC -----------|S Q------| Open IAC Valve

| | IACFLG = 1

N < NIAC - NIACH ---|C |

| --- ELSE ---

|

| Close IAC Valve

| IACFLG = 0

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THERMACTOR AIR AND AUXILLARY STRATEGIES - GUE0

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SUPERCHARGER BYPASS SOLENOID (THRMHP = 2)

This Section describes the Supercharger Bypass Solenoid Strategy which has

been designed to support the 3.8L Mass Air Sequential Fuel Injection program.

THRMHP NOT= 2 ----------------------| No change, exit this

| Logic.

TFMFLG = 0 ----------------| |

| | --- ELSE ---

CRKFLG = 0 ----------------| |

|AND ----| Enable Supercharger

UNDSP = 0 -----------------| | Bypass Output

(Run Mode) | |

| | --- ELSE ---

TP > RATCH + THBPSC -|S Q--| |

| | Disable Supercharger

TP < RATCH + | | Bypass Output

THBPSC - THBPSH ---|C

NOTE: The initial Supercharger hardware is a three-way vacuum solenoid which

is normally OPEN. When the Supercharger Bypass Output is OFF, vacuum is

applied to the Actuator. When the output is ON, the actuator is vented to

the atmosphere. WHEN THRMHP NOT= 1, CHKAIR must be set = 1 or cleared

(thermactor logic) to insure Open Loop/Closed loop fuel control.

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THERMACTOR AIR AND AUXILLARY STRATEGIES - GUE0

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CHAPTER 13

ELECTRO-DRIVE FAN STRATEGY

13-1

ELECTRO-DRIVE FAN STRATEGY - GXW0

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TWO-SPEED ELECTRO DRIVE FAN CONTROL

(EDFHP = 1)

The electric fan provides additional air circulation for engine cooling

purposes under circumstances where an engine-driven fan is inadequate, i.e.,

low vehicle speed or unusually high engine temperatures. To minimize

accessory load on the engine, the fan is always turned off during CRANK Mode.

The EEC controls the state of the cooling fan. The fan may be operated at

either high or low speed. The strategy controls the state of the fan via two

outputs as shown in the truth table below.

The cooling fan is turned on at low speed if:

1) The engine temperature is higher than normal (approximately 216 deg

F);

2) The A/C is ON and the vehicle speed does not provide enough natural

airflow (approximately 43 MPH).

The cooling fan will turn on at high speed if:

1) The engine temperature is higher than desirable (approximately 230 deg

F) and the fan has been operating at low speed.

2) ECT sensor is out of specification.

The cooling fan will turn off if:

1) The driver demand is high (WOT type Mode as defined

by A/C Cutout Strategy);

or

2) The A/C clutch is not cycling rapidly;

OR

3) Vehicle speed is high enough to provide enough

airflow for engine cooling.

provided the engine coolant temperature is not too high.

CPU OUTPUT EEC OUTPUT

(Software) (Hardware)

FAN STATE EDF HEDF EDF HEDF

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

Off 1 0 On Off

Low speed 0 0 Off Off

High speed 0 1 Off On

Not Used 1 1 On On --> NOT USED

Note: OFF = 12V (Referenced to ground)

ON = <1V (Referenced to ground)

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ELECTRO-DRIVE FAN STRATEGY - GXW0

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DEFINITIONS

INPUTS

Registers:

- ACCTMR = Time since A/C State transition (off to On, or On to Off), sec.

(See TIMER chapter).

- ECT = Engine Coolant Temperature, deg F.

- EDFTMR = Set to 0 when the EDF (low speed fan) is de-energized or CRKFLG

= 1. Otherwise, it is free-running.

- HSFFLG = High Speed Fan Flag.

- RATCH = Warm curb Idle throttle position, counts.

- TP = Throttle Position, counts.

- VSBAR = Vehicle Speed, MPH.

- WCOTMR = Time since near WOT A/C Cutout. This timer will re-enable the

A/C and Fan regardless of the throttle mode after the engine responds to

the driver (ACWDLY sec).

Bit Flags:

- ACCFLG = Flag that is set to 1 when A/C clutch is enabled.

- CFMFLG = Flag indication that ECT sensor is in/out of range; 0 = in

range.

- CRKFLG = Flag that is set when in CRANK mode.

Calibration Constants:

- ACMNFT = Minimum amount of time that the A/C Clutch must be disengaged

before turning off the fan, secs. This prevents rapid Fan cycling.

(This value must be > 2 seconds.)

- ACWDLY = Time delay before turning the A/C on and allowing the fan to

turn on, ie, at low vehicle speeds. Units are seconds. (This value must

be less than 25 seconds.)

- EDFHP = Electro drive fan hardware present switch.

- EDFTM = Minimum low speed fan time to turn on high speed fan, secs.

- HEDFHP = Two speed fan output present switch.

- HSFEC1 = ECT for Grade Load High Speed Fan turn on, lower than HSFEC2.

- HSFEC2 = ECT for normal High Speed Fan turn on, higher than HSFEC1.

- HSFHYS = Hysteresis for HSFECT, deg F. (Should be 6 deg F, per Car

Engineering Direction)

13-3

ELECTRO-DRIVE FAN STRATEGY - GXW0

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- HSFLOD = Minimum LOAD for Grade Load High Speed Fan.

- HSFRPM = Minimum RPM for Grade Load High Speed Fan.

- HSFVS = Maximum VSBAR for Grade Load High Speed Fan.

- LSFECT = Minimum ECT for Low Speed Fan, deg F. (Should be 216 deg F, per

Car Engineering Direction)

- LSFHYS = Hysteresis for LSFECT, deg F. (Should be 4 deg F, per Car

Engineering Direction)

- LSFVS = Minimum vehicle speed at which electric fan cooling is not

required, MPH. (Should be 48 MPH, per Car Engineering Direction)

- LSFVSH = Hysteresis term to prevent cycling of FAN output, MPH. (Should

be 5 MPH, per Car Engineering Direction)

OUTPUTS

Registers:

- EDF = Low Speed Electro-drive Fan Output (See truth table).

- EDFTMR = Set to 0 when the EDF (low speed fan) is de-energized or CRKFLG

= 1. Otherwise, it is free-running.

- HEDF = High Speed Electro-drive Fan Output (See truth table).

- HSFFLG = High Speed Fan Flag.

13-4

ELECTRO-DRIVE FAN STRATEGY - GXW0

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The electric fan is controlled according to the logic shown below.

EDFHP = 0 -----------------------------------| No Fan Control

| Exit logic

|

| --- ELSE ---

|

CRKFLG = 1 ----------------------------------| TURN FAN OFF

(crank mode) | SET EDFTMR = 0

| EDF = 1

| HEDF = 0

|

| --- ELSE ---

HEDFHP = 1 ------------------------| |

|AND -----| TURN ON HIGH

HSFFLG = 1 ---------|AND ---|S Q --| | SPEED FAN

(overheated) | | | EDF = 0

| | | HEDF = 1

EDFTMR >OR= EDFTM --| | |

(low speed fan on) | |

| |

ECT < HSFEC1 - HSFHYS ------|C |

|

| --- ELSE ---

CFMFLG = 1 ---------------------------| |

| |

ECT > LSFECT -----------|S Q ---------| |

(hot engine) | | |

| | |

ECT < LSFECT - LSFHYS --|C | |

|OR ---| TURN ON LOW

| | SPEED FAN

VSBAR < LSFVS - LSFVSH -------| | | EDF = 0

(vehicle speed low) | | | HEDF = 0

|AND ---| |

ACCFLG = 1 -------------------| | --- ELSE ---

(A/C on) |

|

ACCTMR >OR= ACMNFT ---------| |

(fan turn off delay) |AND -----| |

| | |

ACCFLG = 0 -----------------| | |

| |

WCOTMR < ACWDLY ----------------------|OR ---| TURN FAN OFF

(WOT fan re-enable) | | EDF = 1

| | HEDF = 0

VSBAR > LSFVS ------------------------| |

(vehicle speed high) | --- ELSE ---

|

| NO CHANGE

| TO FAN STATE

Where HSFFLG logic is described on the following page:

13-5

ELECTRO-DRIVE FAN STRATEGY - GXW0

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N\_BYTE >OR= HSFRPM -------|

(high rpm) |

|

LOAD >OR= HSFLOD ---------| |

(high load) |AND -------| Set HSFFLG = 1

| |

VSBAR <OR= HSFVS ---------| | (high speed fan flag,

(low speed) | | grade load condition)

| |

ECT >OR= HSFEC1 ----------| | --- ELSE ---

(lower temp. turn on) |

|

ECT >OR= HSFEC2 ----------------------| Set HSFFLG = 1

(higher temp. turn on) |

| (high speed fan flag,

| boilover, no load)

|

| --- ELSE ---

|

| Set HSFFLG = 0

13-6

CHAPTER 14

DATA OUTPUT LINK

14-1

DATA OUTPUT LINK - GXK0

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DATA OUTPUT LINK - TRIPMINDER

The Data Output Link (DOL) provides a communication line between the EEC and

the vehicle dashboard computer, Tripminder, for the transfer of fuel

consumption information. The fuel flow information sent by the EEC is used

for computation of instantaneous and average fuel economy, which is then

displayed to the driver.

The Tripminder requires an appropriate integer number of pulses within 100

msec period. Therefore, within each background loop or each 100 msec period,

whichever is shorter, the EEC sums the fuel flow and through the injectors

output since the summing period started, converts this sum into DOL pulses,

and outputs these pulses at a maximum frequency of 500 Hz during the

following summation period.

The fuel flow is converted into DOL pulses according to the following

equation:

DOL\_COUNT = INTEGER (FUEL\_SUM \* 7804.19 \* INJOUT) + DOL\_COUNT

The FUEL\_SUM is then reduced by the amount converted into DOL\_COUNTS (One

DOL\_COUNT = 1.282E-4 lbm).

where,

DOL\_COUNT = Number of pulses to be output beginning

in the next summation period. One

DOL\_COUNT = 1.282E-4 lbm.

FUEL\_SUM = Sum of fuel flow per injector, which was

initiated since last summation period. It is

updated during the Fuel PW output routine.

7804.19 = (48000 pulses/gal)/6.15 lbm/gal, pulses/lmb.

INJOUT = Number of injectors per output port.

(See Fuel Strategy)

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DATA OUTPUT LINK - GXK0

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FUEL\_SUM = FUEL\_SUM + LBMF\_INJn

LBMF\_INJn = Fuel Flow per injector, calculated from

FUELFLOWn (n= 1, 2). (See Fuel Strategy).

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

| | | | | | | | | | | |

| | | | | | | | | | | |

FUELPW ----- ----- ----- ----- ----- ------

|<-- 1 BACKGROUND LOOP -->|----

|| |

|| |

DOL | |

OUTPUT --------------------------- ------------------------

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DATA OUTPUT LINK - GXK0

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14-4

CHAPTER 15

VEHICLE SPEED CONTROL STRATEGY

15-1

VEHICLE SPEED CONTROL - GUE0

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VEHICLE SPEED CONTROL STRATEGY

(VSTYPE = 2)

The strategy now utilizies a Vehicle Speed Sensor. The logic for this sensor

appears in both Systems Equations and EEC Overview of this Text.

The integrated Vehicle Speed Control (VSC) models the mechanical Cruise

Control of previous model years. When activated, the system is designed to

maintain the vehicle speed within prescribed limits, at any driver-selected

speed above 25 MPH. The value added by the integrated VSC includes accurate

digital control and the Favorite Speed Set feature as well as Component

complexity reduction. While the hardware is no longer provided for Favorite

Speed Set, the software still exists. As this strategy book is meant to

represent the total system, the logic for Favorite Speed is included.

Brake ON/OFF Switch (BOO)

Neutral/Drive Switch (NDS)

Throttle Position Sensor (TPS)

Vehicle Speed Sensor (VSS)

Speed Control Command Switch (VSCCS)

The VSC strategy controls the vehicle speed by means of a pulsetrain sent to

a Vent solenoid (to decrease speed) or to a Vacuum Solenoid (to increase

speed).

Speed Control Command Switch Input

The driver operates the VSC system by pressing buttons on the steering wheel

as is done with the mechanical system. The five traditional buttons (ON,

OFF, ACCEL, RESUME and COAST) are incorporated into the integrated VSC as

switches. ON-OFF is one switch; SET ACCEL-COAST another; and RESUME is on a

switch by itself. Depression of any of these switches causes a unique

voltage level at the VSCCS input.

The strategy reads the VSCCS input and sets a flag corresponding to the

button pressed. If no buttons are currently depressed, the strategy

interprets the voltage level as a HOLD state (if the VSC is operating) which

means that the state selected by the most recent button depression is

maintained.

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VEHICLE SPEED CONTROL - GUE0

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VEHICLE SPEED CONTROL SOFTWARE MODULE OVERVIEW

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

( ENTER VSC LOGIC )

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

|

----------- NO ------

< VSTYPE = 2 >-----------( EXIT )

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

| YES

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

| VEHICLE SPEED CONTROL |

| COMMAND SWITCH LOGIC |

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

|

\_\_\_\_\_\_\_\_\_ Y \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

< STATE 1 >----------| STATE 1 LOGIC |---

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

N | |

\_\_\_\_\_\_\_\_\_ Y \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

< STATE 2 >----------| STATE 2 LOGIC |---|

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

N | |

\_\_\_\_\_\_\_\_\_ Y \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

< STATE 3 >----------| STATE 3 LOGIC |---|

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

N | |

\_\_\_\_\_\_\_\_\_ Y \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

< STATE 4 >----------| STATE 4 LOGIC-----|

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

N | |

\_\_\_\_\_\_\_\_\_ Y \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

< STATE 5 >----------| STATE 5 LOGIC |---|

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

N | |

\_\_\_\_\_\_\_\_\_ Y \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

< STATE 6 >----------| STATE 6 LOGIC |---|

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

N | |

\_\_\_\_\_\_\_\_\_ Y \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

< STATE 7 >----------| STATE 7 LOGIC |---|

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

N | |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

| STATE 8 LOGIC |------------------------|

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

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VEHICLE SPEED CONTROL - GUE0

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( cont. )

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|

|

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

| SET SPEED RAMP LOGIC |

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

|

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

| VSC\_ERROR LOGIC |

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

|

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

| VSC\_DC CALCULATION |

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

|

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

| DUTY CYCLE OUTPUT ALGORITHM |

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

|

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

( RETURN )

--------

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VEHICLE SPEED CONTROL - GUE0

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DEFINITIONS

INPUTS

Registers:

- DEBTMR = IVSCCS debounce timer.

- IVSCCS = Input vehicle speed control command switch.

- IVSCCS\_LST = Last input vehicle speed control command switch.

- MPH = Current (or actual) Vehicle speed, MPH.

- N = Engine Speed, RPM.

- RATCH = Closed Throttle Position, counts.

- RES\_SPEED = Vehicle Control Speed set by Driver, mph.

- SET\_SPEED = Current Desired Vehicle Control Speed.

- TP = Throttle Position, counts.

- VBAT = Filtered Inferred Battery Voltage, volts;

it is initialized to 12.5 Volts.

- VSC\_BUTTONS = Flag register containing VSC button status.

- VSC\_DC = Vehicle Speed Control output duty cycle.

- VSC\_STATES = Flag register containing VSC state status,

unitless.

- VSCCS = Vehicle Speed Control Command Switch.

Bit Flags:

- ACCEL\_BUT = Flag that indicates that the ACCEL button is

depressed (1 = ACCEL button depressed).

- ACCEL\_STATE = Flag that indicates that the VSC is in ACCEL Mode

(1 = ACCEL Mode).

- BIFLG = Flag that indicates that the brake has been

depressed (1 = Brake depressed).

- BRAKE\_STATE = Flag that indicates that the Brake has been

depressed (1 = Brake depressed).

- COAST\_BUT = Flag that indicates that the driver depressed

the COAST Button (1 = Button depressed).

- COAST\_STATE = Flag that indicates that the driver depressed

the COAST Button recently.

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VEHICLE SPEED CONTROL - GUE0

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- HOLD\_STATE = Flag that indicates normal VSC (1 = Stable Speed).

- NDSFLG = Flag that indicates that the transmission is in

drive (1 = Drive).

- OFF\_BUT = Flag that indicates that the driver depressed

OFF button (1 = Button depressed).

- ON\_STATE = Flag that is set equal to zero when VSC is OFF.

(1 = Enabled).

- RESUM\_BUT = Flag that indicates that RESUME button was

depressed (1 = Button Depressed).

- RESUM\_STATE = Flag that indicates that the VSC is in RESUME

Mode (1 = RESUME Mode).

- VSCCS\_ERROR = VSC\_Buttons error range identifier.

- VSC\_PULSE = Background flag indicating to EOS that a dither

pulse is in progress.

Calibration Constants:

- DEBAMP = Minimum IVSCCS amplitude change, counts.

- DEBTIM = Debounce time delay, seconds.

- ACLDED = Maximum increment above MPH to which SET\_SPEED can

increase, mph.

- ACLINC = Acceleration ramp rate, MPH/sec.

- DCBIAS = DC correction factor.

- HACCEL = Input VSCCS input range, counts.

- HCOAST = Input VSCCS input range, counts.

- HIHOLD = Input VSCCS input range, counts.

- HI\_OFF = Input VSC command Switch input range, counts.

- HLDREF = Offset for the Duty Cycle.

- HLDRNG = Error deadband for no pulses required.

- HRESUM = Upper limit for recognition of RESUME request,

counts.

- LACCEL = Input VSCCS input range, counts.

- LCOAST = Input VSCCS input range, counts.

- LOWBAT = Minimum Reliable Battery Voltage, volts.

- LOHOLD = Input VSCCS input range, counts.

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VEHICLE SPEED CONTROL - GUE0

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- LOW\_ON = Input VSCCS input range, counts.

- LRESUM = Inputs VSCCS input range, counts.

- MAXVSP = Maximum Vehicle Speed to Enable Vehicle

Speed Control, MPH.

- MINVSP = Minimum Vehicle Speed to enable Vehicle

Speed Control, MPH.

- MPHDED = Deadband for Vehicle Speed Control, mph. If the

actual speed is less than the SET\_SPEED - MPHDED,

then the VSC should be disabled.

- MPHH = Hysteresis term to promote VSC stability.

- NCGSHP = Neutral gear/Clutch switch

0 = No switches present;

1 = Either/both switches present.

- SETGN = SET\_SPEED proportional gain.

- TAPGN = Throttle position proportional gain.

- TRLOAD = Transmission Load.

0 = Manual Transmission, no clutch or gerar 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.

- VEHGN = Vehicle Speed proportional gain.

- VSCFRQ = Desired VSC Frequency, Hz.

- VSNMAX = Maximum RPM for vehicle Speed Control function,

Rev/Min.

- VSTYPE = Vehicle speed sensor cruise control hardware present switch;

0 = No vehicle speed and no cruise control,

1 = Vehicle speed sensor, no cruise control (VSS),

2 = Both vehicle speed sensor and cruise control (VSS+VSC).

OUTPUTS

Registers:

- DEBTMR = IVSCCS debounce timer.

- IVSCCS\_LST = Last input vehicle speed control command switch.

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VEHICLE SPEED CONTROL - GUE0

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- RES\_SPEED = Vehicle Control Speed set by Driver, mph.

- SCVAC = Vacuum solenoid used to increase speed.

- SCVNT = Vent solenoid used to decrease speed.

- VSCCS = Vehicle Speed Control Command Switch; input, debounced counts.

- VSC\_ERROR = Vehicle Speed Control Error.

- VSC\_OFF\_COUNT = Number of scheduler passes with output off.

- VSC\_ON\_COUNT = Number of scheduler passes with output on.

Bit Flags:

- ACC\_REQ = Flag set when ACCEL\_BUT is depressed.

- ACCEL\_BUT = Flag that indicates that the ACCEL button is

depressed (1 = ACCEL button depressed).

- ACCEL\_STATE = Flag that indicates that the VSC is in ACCEL Mode

(1 = ACCEL Mode).

- BRAKE\_STATE = Flag that indicates that the Brake has been

depressed (1 = Brake depressed).

- COAST\_BUT = Flag that indicates that the driver depressed

the COAST Button (1 = Button depressed).

- COAST\_STATE = Flag that indicates that the driver depressed

the COAST Button recently.

- HOLD\_STATE = Flag that indicates normal VSC (1 = Stable Speed).

- OFF\_BUT = Flag that indicates that the driver depressed

OFF button (1 = Button depressed).

- ON\_STATE = Flag that is set equal to zero when VSC is OFF.

(1 = Enabled).

- RESUM\_BUT = Flag that indicates that RESUME button was

depressed (1 = Button Depressed).

- RESUM\_STATE = Flag that indicates that the VSC is in RESUME

Mode (1 = RESUME Mode).

- VSCCS\_ERROR = VSC\_Buttons error range identifier.

- VSC\_PULSE = Background flag indicating to EOS that a dither

pulse is in progress.

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VEHICLE SPEED CONTROL - GUE0

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The VSCCS debounce logic attempts to reject spurious noise on the vehicle

speed control input signal. The timer, DEBTMR, is loaded with DEBTIM seconds

whenever the last raw input, IVSCCS\_LST, differs from the current raw input,

IVSCCS, by more than DEBAMP counts. If the current raw input does not change

by more than DEBAMP counts over a period of DEBTIM seconds, DEBTMR is allowed

to count down to zero. Upon reaching zero, the actual vehicle speed control

register, VSCCS, is loaded with the current raw input, IVSCCS.

VSCCS DEBOUNCE LOGIC

|IVSCCS\_LST - IVSCCS| > DEBAMP ----------| Set DEBTMR = DEBTIM

| (load debounce timer)

|

| Set IVSCCS\_LST = IVSCCS

| (update last register)

DEBTMR = 0 ------------------------------| Set VSCCS = IVSCCS

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VEHICLE SPEED CONTROL - GUE0

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Vehicle Speed Control Command Switch Logic

The following logic interprets the speed control switch inputs.

VBAT > LOWBAT -------------|

(Check Voltage Range) |

|AND -----| SET OFF\_BUT = 1

VSCCS < HI\_OFF ------------| | (No change to ON\_STATE

(Off Button Depressed) | or VSCCS\_ERROR)

|

| --- ELSE ---

VBAT > LOWBAT -------------| |

|AND -----| SET COAST\_BUT = 1

LCOAST < VSCCS < HCOAST ---| | (No Change to ON\_STATE

(COAST button Depressed) | or VSCCS\_ERROR)

|

| --- ELSE ---

VBAT > LOWBAT -------------| |

|AND -----| SET ACCEL\_BUT = 1

LACCEL < VSCCS < HACCEL ---| | (No Change to ON\_STATE

(ACCEL button depressed) | or VSCCS\_ERROR)

|

| --- ELSE ---

VBAT > LOWBAT -------------| |

|AND -----| SET RESUM\_BUT = 1

LRESUM < VSCCS < HRESUM ---| | (No Change to ON\_STATE

(RESUME button depressed) | or VSCCS\_ERROR)

|

| --- ELSE ---

VBAT > LOWBAT -------------| |

|AND -----| SET VSCCS\_ERROR = 0

LOHOLD < VSCCS < HIHOLD ---| | (No Change to ON\_STATE)

(No Buttons depressed) |

| --- ELSE ---

|

VBAT > LOWBAT -------------| |

|AND -----| SET ON\_STATE = 1

VSCCS > LOW\_ON ------------| | (No Change to

(ON button depressed) | VSCCS\_ERROR)

|

| --- ELSE ---

|

| SET ON\_STATE = 0

| SET VSCCS\_ERROR = 1

| (Battery Voltage

| outside permissible

| range.)

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VEHICLE SPEED CONTROL - GUE0

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If VBAT < LOWBAT, then Battery Voltage is too low; Vehicle Speed Control must

be disabled (but NOTE that VBAT is initialized to 12.5 Volts).

NOTE: The VSCCS ranges (HI\_OFF, LCOAST, HCOAST, etc.) are defined by EED

Vehicle Controls and Convenience Product Systems and Applications Department

and should not be changed from the base release values unless they have given

specific permission.

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VEHICLE SPEED CONTROL - GUE0

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VSC SPEED CONTROL LOGIC

The Integrated Vehicle Speed Control was designed to operate in the similar

manner as the standalone version (Cruise Control). The driver enables the

Speed Control by pressing the ON button. The speed is selected by pressing

SET ACCEL or COAST (sets current speed). Continuous depressing of SET ACCEL

will increase the speed until released and Coast, of course, will slow it

down. Hitting the brake will deactivate it as will shifting the transmission

into neutral or turning the Vehicle Speed Control OFF. The speed of the

vehicle MUST be above 25 MPH to use Vehicle Speed Control.

The VSC strategy uses a hierarchical State Diagram Logic. In other words,

the strategy will enter a particular State if its entry conditions are met

and if the entry conditions of a higher priority state are not met. The

various states are mutually exclusive (except for ON\_STATE). In general,

conditions to disable (turn it Off) or otherwise de-activate (put on standby)

the VSC are checked first. Redundant Brake condition is the one exception to

this rule.

When all other states are equal to zero, the VSC strategy is either in

Standby Mode (ON\_STATE = 1) or OFF Mode (ON\_STATE = 0).

The Vehicle speed Control strategy has three parts:

A. VSC State Determination

B. VSC Duty Cycle

C. VSC Duty Cycle Output Routine

(Pulsewidth calculation)

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VEHICLE SPEED CONTROL - GUE0

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A. VSC STATE DETERMINATION

STATE 1 - DRIVER DEPRESSED OFF-BUTTON OR HAS NOT DEPRESSED ON-BUTTON

ON\_STATE = 0 -------|

(VSC is OFF) |OR ---| CLEAR all VSC STATE Flags

| |

OFF\_BUT = 1 --------| | SET RES\_\_SPEED = 0

(Off But depressed) | Set ACC\_REQ = 0

| Set VSC\_PULSE = 0

| (This forces a 100% duty

| cycle to the Vent Solenoid)

|

| --- ELSE ---

|

| Check STATE 2

STATE 2 - VEHICLE SPEED OUTSIDE ACCEPTABLE RANGE

If VSC has a fault in the button logic, the Vehicle Speed is outside the

normal range of operation; or, the VSC buttons have a fault. In either

instance, Standby Mode is entered and all VSC States, except ON\_STATE, are

cleared and Vehicle Speed Control is exited. However, if none of the "OR

GATE" conditions described below is met, the logic runs through a comparison

of factors which should indicate that vehicle speed is within normal range

and continues on to check STATE 3.

N > VSNMAX -------------------|

|

MPH < MINVSP ---------|S Q----|

| | | Clear All VSC States

MPH > MINVSP + MPHH --|C | | except ON\_STATE and

|OR ---| BRAKE\_STATE

MPH > MAXVSP ---------|S Q----| | ACC\_REQ = 0

| | | VSC\_PULSE = 0

MPH < MAXVSP - MPHH --|C | | (This will force 100%

| | vent pulse)

VSCCS\_ERROR = 1 --------------| |

| --- ELSE ---

|

| Check STATE 3

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VEHICLE SPEED CONTROL - GUE0

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STATE 3 - BRAKE APPLIED OR TRANSMISSION IN NEUTRAL

When the driver depresses the brake pedal, a flag is set which this logic

seeks. If BIFLG is set equal to one (brake depressed), VSC is disengaged,

but not turned OFF. The driver may press RESUME to attain the speed set

before braking (or disengagement) took place.

BIFLG = 0 -------------------| | Check STATE 4

(Brake Not Depressed) |AND -----|

| |

NDSFLG = 1 ----------| | |

|OR ----| |

TRLOAD = 0 ----------| | --- ELSE ---

|

ACCEL\_BUT = 1 ----------| | Button is stuck;disable VSC

(ACCEL\_BUT depressed) | |

| | VSCCS\_ERROR = 1

RESUM\_BUT = 1 ----------|OR -----------| Set BRAKE\_STATE = 1

(RESUM\_BUT depressed) | | Clear all other states

| | except ON\_STATE

COAST\_BUT = 1 ----------| | ACC\_REQ = 0

| VSC\_PULSE = 0

| (100% Vent pulse)

|

| --- ELSE ---

|

| (Brake depressed or

| Transmission in Neutral)

| Set BRAKE\_STATE = 1

| Clear all other States

| except ON\_STATE.

| ACC\_REQ = 0

| VSC\_PULSE = 0

| (100% Vent Pulse)

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VEHICLE SPEED CONTROL - GUE0

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STATE 4 - VEHICLE SPEED IS COASTING DOWN

If the driver needs to slow down, the driver may press COAST until the new,

slower speed is reached.

COAST\_BUT = 1 -----------| SET COAST\_STATE = 1

(COAST But depressed) | CLEAR all other States

| except ON\_STATE.

| SET\_SPEED = MPH

| RES\_SPEED = MPH

| VSC\_PULSE = 0

| ACC\_REQ = 0

| (100% Vent pulse)

|

| --- ELSE ---

|

COAST\_STATE = 1 ---------| Do normal Duty Cycle

(Driver released button)| calculation)

| SET VSC\_PULSE = 1

| SET HOLD\_STATE = 1

| CLEAR all other States

| except ON\_STATE

| SET SPEED = MPH

| RES\_SPEED = MPH

|

| --- ELSE ---

|

| Check STATE 5

NOTE: If the COAST\_BUT = 0 and COAST\_STATE = 1, the driver wants to stop

coasting.

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VEHICLE SPEED CONTROL - GUE0

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STATE 5 - VEHICLE IS ACCELERATING

This button actually provides two functions. It sets the initial speed the

driver chooses to drive; or it can increase the speed if the driver

continuously holds it down.

ACCEL\_BUT = 1 -------------|

(ACCEL Button depressed) |

|AND ---| SET ACCEL\_STATE = 1

ACCEL\_STATE = 0 -----------| | CLEAR all other STATES

(Entered ACCEL State) | except ON\_STATE

| SET VSC\_PULSE = 1

| (Do Normal Duty Cycle

| calculation)

| SET\_SPEED = MPH

| RES\_SPEED = MPH

|

| --- ELSE ---

|

ACCEL\_BUT = 1 -------------| | Set ACCEL\_STATE = 1

(ACCEL Button depressed) | | Clear all other States

|AND ---| except ON\_STATE

| | SET VSC\_PULSE = 1

ACCEL\_STATE = 1 -----------| | (Do normal duty cycle

| calculation)

| (The SET\_SPEED will ramp

| and cause the vehicle

| to accelerate)

| RES\_SPEED = MPH

|

| --- ELSE ---

ACCEL\_BUT = 0 -------------| |

|AND ---| SET HOLD\_STATE = 1

ACCEL\_STATE = 1 -----------| | CLEAR all other States

(ACCEL But no | (except ON\_STATE)

longer depressed) | SET\_SPEED = MPH

| RES\_SPEED = MPH

| SET VSC\_PULSE = 1

|

| --- ELSE ---

|

| Check STATE 6

NOTE: If ACCEL\_BUT = 0 and ACCEL\_STATE = 1, then exit ACCEL Mode.

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VEHICLE SPEED CONTROL - GUE0

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STATE 6 - RESUME VEHICLE SPEED TO RES\_SPEED VALUE

This button allows the driver to resume the vehicle speed that was set before

braking or manually accelerating. It does not store this "former" speed if

the VSC is turned OFF (that is the function of Favorite Speed setting when

the hardware is installed).

RESUM\_BUT = 1 ------------|

(Driver depressed |

resume button) |

|

RESUM\_STATE = 0 ----------|

|

BRAKE\_STATE = 1 ----------|AND ----| SET RESUM\_STATE = 1

(Brake was applied) | | CLEAR all other states

| | Except ON\_STATE

| | SET\_SPEED = MPH

RES\_SPEED > MINVSP -------| | SET VSC\_PULSE = 1

(RESUM speed OK) |

| --- ELSE ---

|

| Check State 7

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VEHICLE SPEED CONTROL - GUE0

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STATE 7 - ACCEL/DECEL DECISION TO RESUME SPEED

This logic compares the existing speed against the speed the vehicle traveled

previous to braking, accelerating or coasting down. It determines whether it

needs to increase or decrease speed to meet the former setting.

RESUM\_STATE = 1 -------| | Set RESUM\_STATE = 1

|AND ----| Clear all other States except

MPH < RES\_SPEED -------| | ON\_STATE

| Set VSC\_PULSE = 1

| Set ACC\_REQ = 1

| (Ramp speed up)

|

| --- ELSE ---

|

RESUM\_STATE = 1 ----------------| SET HOLD\_STATE = 1

| CLEAR all other States

| except ON\_STATE.

| ACC\_REQ = 0

| VSC\_PULSE = 1

| (Do normal D.C. Calculations)

| SET\_SPEED = RES\_SPEED

|

| --- ELSE ---

|

| Check STATE 8 logic

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VEHICLE SPEED CONTROL - GUE0

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STATE 8 - MAINTAIN VEHICLE SPEED

HOLD State keeps the VSC at the most recent setting. It allows a very narrow

band of fluctuation and functions until the driver depresses a button.

HOLD\_STATE = 1 -------------| | Set HOLD\_STATE = 1

|AND --| Clear all other States

SET\_SPEED <OR= MPH+MPHDED --| | except ON\_STATE

| Set VSC\_PULSE = 1

|

| --- ELSE ---

|

HOLD\_STATE = 1 --------------------| SET BRAKE\_STATE = 1

| CLEAR all other States

| except ON\_STATE.

| SET VSC\_PULSE = 0

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VEHICLE SPEED CONTROL - GUE0

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SET\_SPEED RAMP FOR RESUME STATE AND ACCEL STATE

This logic ramps the SET\_SPEED up to RES\_SPEED at a rate of ACLINC MPH/sec,

to provide smooth acceleration. The rate of acceleration is clipped to MPH

as a minimum to prevent the SET\_SPEED from lagging.

ACCEL\_REQ = 1 -----|

|OR ----|

ACCEL\_BUT = 1 -----| |

|AND ---| SET\_SPEED = SET\_SPEED

SET\_SPEED >OR= | | + ACLINC\* (Time since

MPH - ACLDED -------------| | last update)

|

| --- ELSE ---

ACCEL\_REQ = 1 -------------| |

|OR ----| SET\_SPEED = MPH

ACCEL\_BUT = 1 -------------|

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VEHICLE SPEED CONTROL - GUE0

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B. VSC\_DC OUTPUT ROUTINE

For purposes of Strategy Description, the VSC\_DC OUTPUT Routine is divided

into two subroutines: VSC\_DC Calculation and DUTY CYCLE OUTPUT.

VSC\_DC CALCULATION

The VSC\_DC is based on the difference between the set speed and the actual

vehicle speed with some adjustments for relative throttle position. The

calculation is done in two steps to more closely model the analog system.

VSC\_PULSE = 1 ---------| VSC\_ERROR = DCBIAS + [SETGN \* SET\_SPEED]

| - [VEHGN \* MPH] - TAPGN \* (TP - RATCH)

|

| --- ELSE ---

|

| VSC\_ERROR = 0 (This will force VENT action)

VSC\_DC = VSC\_ERROR - HLDREF

NOTE: DCBIAS, SETGN, VEHGN, TAPGN, HLDRNG and HLDREF are hardware constants.

Any changes to the base values should be co-ordinated through the Vehicle

Controls and Convenience Products Systems and Applications Engineering Dept,

EED.

|VSC\_DC| < HLDRNG ---------------| Hold position

| VSC\_DC = 0

| (Turn OFF SCVAC)

| (Turn ON SCVNT)

|

| --- ELSE ---

|

VSC\_DC < 0 ----------------------| Slow Down

| VSC\_DC = |VSC\_DC|

| (Turn OFF SCVAC)

| (Duty cycle to SCVNT = VSC\_DC)

|

| --- ELSE ---

|

| Speed Up

| (Turn ON SCVNT)

| (Duty cycle to SCVAC = VSC\_DC)

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VEHICLE SPEED CONTROL - GUE0

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C. DUTY CYCLE OUTPUT ALGORITHM

VSC\_ON\_COUNT = VSC\_DC/(VSCFRQ \* 1 \* 10E-3)

VSC\_OFF\_COUNT = (1-VSC\_DC) / (VSCFRQ \* 1\*10E-3)

OUTPUT to appropriate solenoid.

Fixed Frequency/Variable Pulsewidth

The Fixed Frequency/Variable Pulsewidth method "best fits" the duty cycle

(ON\_TIME) to 10 msec. (If VSCFRQ = 100) period which is divided into 10

"slices". Each of these 10 slices is equal to 1 msecs (10E-6 seconds).

ON\_TIME is "rounded" up or down to the nearest integer.

Example of Fixed Frequency/Variable Pulsewidth Method

ON\_TIME +-+-+-+-+-+-+-+ +-+-+-+-+-+-+-+

| | |

| | |

OFF\_TIME -+ +-+-+-+-+-+-+

|<--5.0 ms -->|<-5.0 ms ->|

50% Duty Cycle

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CHAPTER 16

RIDE CONTROL STRATEGY

16-1

RIDE CONTROL STRATEGY - GXY0

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ADJUSTABLE SHOCK ABSORBER OUTPUT

OVERVIEW

The adjustable shock absorber module is a stand alone module, separate

from the EEC IV, which controls shock absorber firmness. The EEC IV output

ACL provides an indication of vehicle acceleration to the shock control

module. Other inputs to the shock module come directly from the appropriate

sensor (VSS brake input, etc.). The ACL output will be energized under

engine running conditions by the logic shown below to indicate hard

acceleration. The ACL output may also be energized during key on, engine off

conditions by a high TP value in order to verify wiring harness integrity

during VIP.

HPACL = 0 ---------------------------------| No change

| Exit Logic

CRKFLG = 0 ----------| |

(Underspeed/Run | | --- ELSE ---

Mode) |AND ----| |

| | | Set ACL = 1

ARCHG >OR= SHKCHG ---| |OR ---------| (energize ACL output-

(high engine load) | | hard acceleration)

| |

TP >OR= RATCH+SHKTP ----------| | --- ELSE ---

(large throttle opening) |

| Set ACL = 0

| (deenergize ACL output)

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RIDE CONTROL STRATEGY - GXY0

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DEFINITIONS

INPUTS

Registers:

- ARCHG = Air Charge Mass inducted per Intake Stroke, lbm/Intake.

- TP = Instantaneous Throttle Position, counts.

- RATCH = Lowest filtered Throttle Position, counts.

Bit Flag:

- CRKFLG = Indicates status of engine, if = 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.

- SHKCHG = Minimum ARCHG value to indicate if hard acceleration.

Typical value: .00015

- SHKTP = Minimum number of throttle counts above the closed

throttle position (RATCH) to indicate hard acceleration.

Typical value: 650 counts.

OUTPUT

Bit Flag:

- ACL = Provides an indication of vehicle acceleration

to the shock control module.

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RIDE CONTROL STRATEGY - GXY0

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CHAPTER 17

ELECTRONICALLY CONTROLLED ACCESSORY DRIVE

17-1

ELECTRONICALLY CONTROLLED ACCESSORY DRIVE - GXY0

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ELECTRONICALLY CONTROLLED ACCESSORY DRIVE (ECAD)

OVERVIEW

The Electronically Controlled Accessory Drive (ECAD) module is a stand

alone unit. It determines alternator demand, and if alternator demand will

allow half speed accessory drive operation, the module inputs a signal to the

EEC-IV processor. This signal is essentially asking EEC to check certain

additional conditions, necessary before half speed mode can be allowed. If

these conditions (outlined below) do exist, EEC outputs a signal to the ECAD

module telling it to operate at half speed. The ECAD module then actuates half

speed operation.

The following conditions are checked in every case:

- ECAD unit is asking for half speed mode

- ECT is below a maximum temperature

- Engine speed is above a minimum RPM, and

- Vehicle speed is above a minimum value.

Additionally, if the system has Thermactor Air (THRMHP = 1), the progam checks

that an upstream air condition does not exist. On non-thermactor systems, the

program checks that a minimum temperature and time since start-up has been

reached.

DEFINITIONS

INPUTS

Registers:

- ECT = Engine Coolant Temperature.

- N\_BYTE = Engine speed, RPM.

- VSBAR = Filtered Vehicle Speed.

Bit Flags:

- ECADI = Input from stand alone ECAD module to EEC: 0 -> full speed

mode only; 1 -> half speed mode allowed.

- USAFLG = Upstream air flag: 0 -> not in upstream air; 1 -> in upstream

air.

Calibration Constants:

- ECADECT = ECT threshold for ECAD. If the ECT is greater than ECADECT,

then the ECAD unit must be in full speed mode.

- ECADHP = Hardware present switch for ECAD: 1 -> ECAD hardware present.

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ELECTRONICALLY CONTROLLED ACCESSORY DRIVE - GXY0

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- ECADN = RPM threshold for ECAD. If N\_BYTE is greater than ECADN, then

the ECAD unit may go into half speed mode.

- ECADVS = Vehicle speed threshold for ECAD. If VS is greater than

ECADVS, then the ECAD unit may go into half speed mode.

- EDETHYS = ECAD ECT hysteresis term = ECADECT - bandwidth.

- EDNHYS = ECAD RPM hysteresis term = ECADN - bandwidth.

- EDTM1 = ATMR1 ECAD time delay for TCSTRT <OR= CTLOW.

- EDTM2 = ATMR1 ECAD time delay for CTLOW < TCSTRT < CTHIGH.

- EDTM3 = ATMR1 ECAD time delay for TCSTRT >OR= CTHIGH.

- EDTM4 = ATMR2 ECAD time delay for TCSTRT <OR= CTLOW.

- EDTM5 = ATMR2 ECAD time delay for CTLOW < TCSTRT < CTHIGH.

- EDVSHYS = ECAD VS hysteresis term = ECADVS - bandwidth.

OUTPUTS

Bit Flags:

- ECADOT = Output from EEC to ECAD stand alone unit: 0 -> half speed

mode; 1 -> full speed mode.

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ELECTRONICALLY CONTROLLED ACCESSORY DRIVE - GXY0

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PROCESS

ECADHP = 0 --------------------------| NO CHANGE

(no ECAD hardware) | EXIT LOGIC

|

AFMFLG = 0 ---| | --- ELSE ---

| |

CFMFLG = 0 ---| |

|AND ------------| |

TFMFLG = 0 ---| | |

| | |

MFMFLG = 0 ---| | |

(not in failure mode) | |

| |

THRMHP = 1 ------| | |

(thermactor air |AND -| | |

system) | | | |

| |OR ----| |

USAFLG = 0 ------| | | |

| | |

"A" --------| | | |

|AND ------| | |

THRMHP = 0 -| | |

| |

ECADI = 1 ---------------------|AND -| HALF SPEED MODE

| | Clear ECADOT

ECT < ECADECT ----------|S Q -| |

(over temp protection) | | | --- ELSE ---

| | |

ECT > EDETHYS ----------|C | | FULL SPEED MODE

| | Set ECADOT

N\_BYTE > ECADN --|S Q --------|

(RPM > min RPM) | |

| |

N\_BYTE < EDNHYS -|C |

|

VSBAR > ECADVS ----|S Q ------|

(VS > minimum VS) |

|

VSBAR < EDVSHYS ---|C

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ELECTRONICALLY CONTROLLED ACCESSORY DRIVE - GXY0

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ECAD TIME/TEMP DELAY

When there is no Thermactor air system, the ECAD operates at full speed before a

minimum temperature and time start-up is reached.

TCSTRT >OR= CTHIGH -|

|AND ------|

ATMR1 < EDTM3 ------| |

|

CTLOW < TCSTRT < CTHIGH -| |

|AND -|OR -----| "A"

ATMR1 < EDTM2 -| | |

|OR ------| |

ATMR2 < EDTM5 -| |

|

TCSTRT <OR= CTLOW --| |

|AND ------|

ATMR1 < EDTM1 -| |

|OR -|

ATMR2 < EDTM4 -|

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ELECTRONICALLY CONTROLLED ACCESSORY DRIVE - GXY0

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CHAPTER 18

SHIFT INDICATOR LIGHT

18-1

SHIFT INDICATOR LIGHT - GUA0

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DEFINITIONS

INPUTS

Registers:

- N = Engine RPM.

- SLTMR = Shift Light Timer.

Bit Flags:

- CRKFLG = Flag indicating state of engine mode.

Calibration Constants:

- FN651 = Incremental Indicated RPM shift point as a function

of ECT.

- FN652A = Indicated RPM shift point as a function of LOAD.

- SHIRPM = Overspeed RPM.

- SLTIM1 = Time delay to validate the Shift Indicator Light,

sec.

- SLTIM2 = Maximum time that SIL (shift indicator light)

is on, sec.

- SPTRPM = Minimum RPM at which SIL timer enables.

- 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 convertor

clutch control,

= 3 -> AXOD,

= 4 -> C6E4 (E4OD),

= 5 -> A4LD-E

= 6 -> FAX-4,

= 7 -> AOD-E (AOD-I),

= 8 -> 4EAT,

= 9 -> CD4E.

OUTPUTS

Registers:

- SLTMR = See Inputs above.

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SHIFT INDICATOR LIGHT - GUA0

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SHIFT INDICATOR LIGHT LOGIC (TSTRAT = 1)

Shift Indicator Light refers to the light located in the instrument cluster.

The light is used to signal the driver when to up-shift on a manual

transmission for best fuel economy.

The strategy turns the shift light on when either of the following conditions

are met:

1) Engine RPM is greater than an "over speed" calibration value; or

2) The shift light timer SLTMR is between a lower calibration value and

an upper calibration value.

Control of SLTMR (and the shift light) is based on engine RPM and load. The

SLTMR counts up when engine RPM goes above a trigger value. The trigger

value varies as a function of LOAD and ECT (engine coolant temperature). The

time delay before the shift light turns on eliminates light flicker due to

RPM jitter about the trigger value. The upper time limit prevents driver

annoyance.

LIGHT ON/OFF LOGIC

N > SHIRPM --------------------|

|OR -|

SLTIM1 < SLTMR <OR= SLTIM2 ----| |

|AND -| TURN ON SHIFT LIGHT

TSTRAT = 1 -------------------------| |

| | --- ELSE ---

CRKFLG = 0 -------------------------| |

| TURN OFF SHIFT LIGHT

NOTE: The calibration parameter, TSTRAT, selects the appropriate

transmission strategy. The Shift Indicator Light strategy will execute only

if TSTRAT = 1.

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SHIFT INDICATOR LIGHT - GUA0

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SLTMR LOGIC

N > SPTRPM -------------|

|OR ----|

N > FN651 + FN652A -----| |AND ---| COUNT UP SLTMR

| |

PART THROTTLE Mode -------------| | --- ELSE ---

|

| Set SLTMR = 0

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CHAPTER 19

INPUT CONVERSIONS AND FILTERS

19-1

INPUT CONVERSIONS AND FILTERS - GUF1

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INPUT CONVERSIONS AND FILTERS

DEFINITIONS

INPUTS

Registers:

- ACT = Air charge temperature.

- AELOAD = Filtered LOAD for manifold filling effect.

- AIR37 = The maximum air charge for a particular engine speed(N) as

described by FN037.

- AM = Air Mass Flow, lbm/min.

- AMINT = Integrated Air Mass flow (lbm).

- APT = Throttle Mode Flag.

- ARCHCOR = Backflow correction for Mass Air Meter.

- ARCHG = Air Charge Mass inducted per Intake Stroke,

lbm/Intake.

- ARCHLI = Air charge leakage (lbm/intake).

- BAPBAR = Rolling average of barometric pressure sensor

values.

- BAPCNT = BAP transition counter.

- BAPTMR = Barometric pressure update, msecs.

- BPKFLG = Update enable flag for key on updates, unitless.

- DEBTMR = VSCCS Debounce timer, sec.

- DATA\_TIME = 3 byte time of transition.

- DSDRPM = Desired RPM (from ISC logic).

- ECT = Coolant temperature, deg F.

- EGO = Exhaust Gas Oxygen Sensor.

- EM = EGR mass flow, lbm/min.

- EPTBAR = Rolling average EPT Transducer.

- EPTZER = EPT sensor value at idle.

- EVP = EGR valve position, counts.

- FAM = Filtered air mass.

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INPUT CONVERSIONS AND FILTERS - GUF1

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- HEGO = Heated Exhaust Gas Oxygen Sensor. (EGO and HEGO

provide the same function, See HEGO Section in

this Chapter)

- IACC\_NDS = AC Clutch/Neutral-Drive input.

- IACT = Voltage output by the ACT sensor converted

to counts, A/D.

- IBAP = Instantaneous BP sensor reading (FN000)

- IECT = Voltage output by the ECT sensor converted

to counts, A/D.

- IEGO = Voltage output by the EGO (or HEGO Sensor)

converted to counts, A/D.

- IEPT = EPT sensor data for PFE EGR.

- IIVPWR = Ignition key-on power (A/D counts).

- IMAF = Input Air Meter Reading, A/D counts.

- INTM = Delta time between Air Meter Samples, sec.

= current Sample time - Last Sample time.

- ITAR = Voltage output by TAR converted to A/D counts.

- IVCAL = Calibration input voltage used to correct

MAF and VBAT (A/D counts).

- IVSCCS = Input VSC command switch.

- KNK\_HIGH = Knock level input flag.

- LOAD = Normalized ARCHG/SARCHG.

- MAF = Instantaneous Mass Air flow (lbm/min).

(MAF = FN036 (VMAF))

- MAFCON = MAF voltage correction gain calibrated for

the particular EEC processor in use.

(MAFCON = VCAL / MAFK1 )

- MAF\_TIME = OUTINT 1 time for MAF fuel.

- MPH = Rolling average Vehicle Speed.

- MINTIM1 = Last SCAP edge prior to the background

calculation of BAP.

- MINTIM2 = Last SCAP edge prior to the previous SCAP

edge prior to the background loop calculation

of BAP.

- MPHCNT = MPH sensor transition count.

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INPUT CONVERSIONS AND FILTERS - GUF1

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- MPHTIM1 = Last MPH transition time.

- MPHTIM2 = First MPH transition time.

- N = RPM - engine speed in revolutions per minute.

- NBAR = Rolling average RPM.

- NDBAR = Filtered Engine Speed.

- NDDTIM = Timer which tracks time since Neutral/Drive

(Drive/Neutral) Switch State change, sec.

- N\_BYTE = Single precision (BYTE) engine speed, Rev/Min.

It is used whenever possible to save memory.

- OLDTP = The last value of TP.

- PINPT = Pressure input switch, 0 = 1st, 2nd, 3rd gear; 1 = 4th gear.

- PINPT2 = Pressure input switch, 0 = 1st, 2nd gear; 1 = 3rd, 4th gear.

- PIPCNT = Number of PIPs which have occurred.

- PIP Period = Amount of time between consecutive PIP

signals.

- PSPS = Power Steering Pressure Switch.

- PUTMR = Counts up after hardware reset.

- RATCH = Kicker off lowest filtered TP.

- RAWAIRCHG = Raw Air charge from the air mass

integration.

- TP = Throttle position.

- TBART = Rolling average of TP for Knock Strategy.

- TPBAR = Rolling average Throttle Angl.

- VBAT = Battery Voltage.

- VMAF = Corrected Air Meter Voltage (volts).

VMAF = (IMAF/IVCAL + MAFK2) \* MAFCON

- VSBAR = Filtered Vehicle Speed.

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INPUT CONVERSIONS AND FILTERS - GUF1

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Bit Flags:

- BPUFLG = Keyon update flag in RAM, unitless.

- CRKFLG = Crank Flag.

- DNDSUP = Drive/Neutral Select.

- FAM\_FLG = Flag indicating in FAM region and AM = FAM.

- INDFLG = AXOD Instantaneous N/D Flag.

- KAM\_ERROR = Indicates Keep Alive RAM invalid.

- KNOCK\_DETECTED = Flag set to 1, if knock occurred in

current PIP half-period.

- KNOCK\_OCCURRED = Flag set to 1 (in the Knock Interrupt

routine), if knock occurred in current or last PIP

period.

- NDSFLG = Neutral/Drive Flag 1 = Drive.

- PTPFLG = PIP occurred after 50 msec.

- REFFLG = 1 when in idle air flow region.

- UNDSP = Underspeed Flag.

Calibration Constants:

- AMDESN = Desired RPM threshold to enter Idle AM logic, RPM.

- AMRPM = Actual RPM (byte) threshold to enter Idle AM logic.

- AMRPMH = RPM (byte) threshold hysteresis.

- ARCHLK = Air flow leakage (lbm/min).

- BIHP = Brake Input Hardware Switch.

- BPSSW = Calibration switch:

1 = Barometric pressure sensor

0 = No sensor (use constant BP value)

- CTEHI = Calibration constant for minimum ECT (engine coolant

temperature) to enable EPTZER at idle, degrees F.

- DEBTIM = Debounce time delay, secs.

- DELRAT = Change in RATCH.

- DELTAM = Air Mass Delta to enter/exit filtered AM

at Idle.

- ENGCYL = Number of PIPs per Engine Revolution; or

Number of Intake Strokes Per Engine

Revolution. (Number of cylinders/2)

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INPUT CONVERSIONS AND FILTERS - GUF1

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- EPTSW = Calibration switch to enable or disable

rolling average EPTZER at idle.

- FAMLIM = Multiplier for FAM deadband.

- FN000 = Frequency versus pressure data; used in

conversion of frequency to pressure.

X-input = frequency

Y-output = Pressure, "Hg.

- FN036 = Mass Air Transfer function as a function of

corrected Air Mass Sampling voltage (VMAF).

Input = Calculated MAF sensor voltage;

Output = Mass Air Flow (Lb/min).

- FN037 = A function that relates engine speed to maximum

air charge.

- FN394F = Time delay before recognition of N/D Transition

- forward gear Input = ECT; OUTPUT = Seconds.

- FN394R = Time delay before recognition of N/D Transition

- reverse gear Input = ECT; OUTPUT = Seconds.

- FN703A = ECT/ACT Transfer function. Input = A/D converter

counts and Output = temperature, deg F.

- FN1035(N,LOAD) = Air Meter Backflow Correction Table.

X-input = FN070 - Normalized engine speed, RPM

Y-input = FN021 - Normalized LOAD

Output = LOAD.

- IDLDEL = A/D count equivalent to Idle back pressure,

"H2O \* IXFRPR, counts.

- IERPMH = Idle RPM hysteresis term for EPTZER update.

- KONBP = BP constant used in absence of sensor. Range of

0 to 31.875.

- KSF = Keypower Scaling Factor; a calibration constant

which has historically been 3.731; this value can

be changed on VECTOR to satisfy the requirements

of different processors; a newer value for KSF

is 5.5991; the user should check with the EEC Design

Group to determine which value for KSF is applicable

to a specific processor level.

- MAFK1 = Universal Mass Air Flow Voltage Correction Gain,

unitless. (0 <OR= MAFK1 <OR= 1.99)

- MAFK2 = Universal Mass Air Flow Voltage Correction Offset,

unitless. (1.0 <OR= MAFK2 <OR = 1.99)

- MAXFAM = Difference between FAM & AMPEM at idle.

- MINAM = Minimum Air Mass Clip, lb air/min.

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INPUT CONVERSIONS AND FILTERS - GUF1

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- MNPIP4 = Minimum PIP period for 4-cylinder engine, clock ticks.

- MNPIP6 = Minimum PIP period for 6-cylinder engine, clock ticks.

- MNPIP8 = Minimum PIP period for 8-cylinder engine, clock ticks.

- NDDELT = Time before N/D, D/N switch registers, Range of

0 to 31.875.

- NRUN = Minimum engine speed to exit Crank mode.

- PFEHP = Switch to select EGR strategy: 1 = PFE; 0 = Sonic.

- SAMRAT = Sample rate for AM filter.

- SARCHG = Standard Air Charge, lb.

= 4.4256 \* 10E-5 \* (Engine Size in Cubic

Inches/number of cylinders).

- TCAELD = Time constant for AELOAD, sec.

- TCBBAR = Time constant for BAPBAR, sec.

- TCDASD = Time constant for DSTPBR, sec.

- TCDASU = Time constant for DSTPBR, sec.

- TCDESN = Time constant for DESNLO, sec.

- TCDLOP = Time constant for DELOPT, sec.

- TCDP = Time constant for DESDP, sec.

- TCEACT = Time constant for EGR ACT, sec.

- TCECT = Time constant for ECT, sec.

- TCEGR = Time constant for EGRBAR, sec.

- TCEPT = Time constant for EPT, sec.

- TCFAM = Time constant for FAM, sec.

- TCINJD = Time constant for INJDLY, sec.

- TCMPH = Time constant for MPH, sec.

- TCN = Time constant for N, sec.

- TCNDBR = Time constant for NDBAR, sec.

- TCTP = Time constant for TPBAR, sec.

- TCTPT = Time constant for TBART, sec.

- TCVBAT = Time constant for VBAT, sec.

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INPUT CONVERSIONS AND FILTERS - GUF1

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- TCVS = Time constant for VSBAR, sec.

- TKYON1 = Minimum time delay before PIPs are recognized, sec.

- TKYON2 = Time delay before Keyon Updates are permitted, sec.

- TKYON3 = Maximum time keyon updates are allowed, sec.

- TKYON4 = Time delay before resetting BPKFLG, sec.

- TPDLTA = Minimum TP change for Tip-Out. Range 0 to 1023.

- TSTALL = Elapsed time necessary to indicate a stall,

msec.

- VBPMAX = Maximum time since last BP update, secs.

- VCAL = Calibration constant; the value is normally

2.5 volts; this value can be changed on VECTOR

to satisfy the requirements of certain processors.

OUTPUTS

Registers:

- ACT = Air charge temperature.

- AELOAD = Filtered LOAD for manifold filling effect.

- AM = Air Mass Flow, lbm/min.

- AMINT = Integrated Air Mass flow (lbm).

- ARCHG = Air Charge Mass inducted per Intake Stroke,

lbm/Intake.

- ARCHCOR = Backflow correction for Mass Air Meter.

- ARCHI = Air Charge (lbm/intake), foreground corrected integrated value.

- BAPBAR = Rolling average of barometric pressure sensor

values.

- BAPCNT = BAP transition counter.

- BP = Barometric pressure value stored in volatile RAM.

- BPKFLG = Update enable flag for key on updates, unitless.

- ECT = Coolant temperature, deg F.

- EPTBAR = Rolling average EPT Transducer.

- EPTZER = EPT sensor value at idle.

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INPUT CONVERSIONS AND FILTERS - GUF1

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- EVP = EGR valve position, counts.

- FAM = Filtered air mass.

- FAMREG = 0; not in FAM region.

128; in FAM region, AM = N \* ENGCYL \* ARCHG

255; in FAM region, AM = FAM

- IBAP = Instantaneous BP sensor reading (FN000)

- IEPT = EPT sensor data for PFE EGR.

- INTM = Delta time between Air Meter Samples, sec.

= current Sample time - Last Sample time.

- LST\_IACC = Last ACC/NDS input.

- MAF\_TIME = OUTINT 1 time for MAF fuel.

- MINTIM1 = Last SCAP edge prior to the background

calculation of BAP.

- MINTIM2 = Last SCAP edge prior to the previous SCAP

edge prior to the background loop calculation

of BAP.

- MPH = Rolling average Vehicle Speed.

- MPHCNT = MPH sensor transition count.

- MPHTIM1 = Last MPH transition time.

- MPHTIM2 = First MPH transition time.

- NBAR = Rolling average RPM.

- NDBAR = Filtered Engine Speed.

- RATCH = Kicker off lowest filtered TP.

- RAWAIRCHG = Raw Air charge from the air mass

integration.

- TAR = Throttle Angle Rate of change.

- TPBAR = Rolling average Throttle Angl.

- VBAT = Battery Voltage.

- VMAF = Corrected Air Meter Voltage (volts).

VMAF = (IMAF/IVCAL + MAFK2) \* MAFCON

- VSBAR = Filtered Vehicle Speed.

- VSCCS = Debounced IVSCCS.

Bit Flags:

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INPUT CONVERSIONS AND FILTERS - GUF1

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- A3C = A/C Flag, 1 = ACC on.

- BIFLG = Brake on.

- BPUFLG = Keyon update flag in RAM, unitless.

- DNDSUP = Drive/Neutral Select.

- EGOFL1 = Rich EGO-1 Flag.

- EGOFL2 = Rich EGO-2 Flag.

- INDFLG = AXOD Instantaneous N/D Flag.

- KNOCK\_OCCURRED = Flag set to 1 (in the Knock Interrupt

routine), if knock occurred in current or last PIP

period.

- NDSFLG = Neutral/Drive Flag 1 = Drive.

- POWSFG = Power Steering Flag.

- PTPFLG = PIP occurred after 50 msec.

- REFFLG = 1 when in idle air flow region.

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INPUT CONVERSIONS AND FILTERS - GUF1

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MULTIPLEXED ACC\_NDS INPUT - (Analog Input)

The ACC input reflects the state of the A/C Cycling Switch. As a multiplexed

input, however, the logic also includes setting of the Neutral Drive Switch.

This switch reflects the change in transmission states (i.e., neutral/park,

drive/in gear). Automatic transmissions use a Neutral/Drive switch from the

transmission; Manuals use a clutch switch, gear switch or no switch. A

clutch or gear switch is recommended for manuals. Among its many uses

(primarily fuel control), it is most heavily used in controlling Idle Speed.

The output sets a flag (NDSFLG) equal to one if the transmission is in gear

(or drive) and equal to zero if the transmission is in neutral.

A diagram follows the logic set forth below which explains the "steps" or

settings.

|IACC\_NDS - LST\_IACC| > 10 ----------| Could be NOISE

| DO NOT UPDATE A3C

| or NDS

| LST\_IACC = IACC\_NDS

|

| --- ELSE ---

|

IACC\_NDS >OR= 952 -------------------| Neutral/Drive input is high

| A/C OFF

| INDFLG = 1

| A3C = 0

| LST\_IACC = IACC\_NDS

|

| --- ELSE ---

|

IACC\_NDS >OR= 556 -------------------| Neutral/Drive input is low

| A/C OFF

| INDFLG = 0

| A3C = 0

| LAST\_IACC = IACC\_NDS

|

| --- ELSE ---

|

IACC\_NDS >OR= 412 -------------------| Neutral/Drive input is high

| A/C ON

| INDFLG = 1

| A3C = 1

| LST\_IACC = IACC\_NDS

|

| --- ELSE ---

|

| Neutral/Drive input is low

| A/C ON

| INDFLG = 0

| A3C = 1

| LST\_IACC = IACC\_NDS

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INPUT CONVERSIONS AND FILTERS - GUF1

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IACC\_NDS FLAG STATE

(counts)

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

1023 | |

| INDFLG = 1 |

| A3C = 0 |

| |

952 -----------------

| |

| INDFLG = 0 |

| A3C = 0 |

| |

556 -----------------

| |

| INDFLG = 1 |

| A3C = 1 |

| |

412 -----------------

| |

| INDFLG = 0 |

| A3C = 1 |

| |

0 -----------------

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INPUT CONVERSIONS AND FILTERS - LOAD CALCULATIONS - GUAB

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LOAD CALCULATION (LOAD)

OVERVIEW

Air charge is normalized by dividing by Standard Air Charge. Standard Air

Charge is a constant equal to 4.4256 \* 10E-5 \* (Engine Size in Cubic

Inches/number of cylinders).

DEFINITIONS

INPUTS

Registers:

- ARCHG = Air Charge Mass inducted per Intake Stroke, lbm/Intake.

- SARCHG = Standard Air Charge, lbm/Intake.

OUTPUTS

Registers:

- LOAD = Normalized load parameter, unitless.

PROCESS

LOAD = ARCHG/SARCHG

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INPUT CONVERSIONS AND FILTERS - LOAD CALCULATIONS - GUAB

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PERCENT LOAD CALCULATION (PERLOAD)

OVERVIEW

PERLOAD is percent of peak load at any altitude.

DEFINITIONS

INPUTS

Registers:

- LOAD = Normalized load parameter, unitless.

- N = Revolutions per minute.

- BP = Barometric Pressure, in Hg.

Calibration Constants:

- FN035(N) = Peak load at sea level as a function of RPM.

OUTPUTS

Registers:

- peak\_load\_sl = Output of FN035(N), temporary register.

- PERLOAD = Percent of peak load at any altitude.

- PEAK\_LOAD =Peak load at any altitude and RPM.

PROCESS

always: PEAK\_LOAD = BP/29.9 \* peak\_load\_sl

PRLDSW = 0 --------| PERLOAD = LOAD/PEAK\_LOAD

|

| --- ELSE ---

|

| PERLOAD = LOAD

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INPUT CONVERSIONS AND FILTERS - GUAB

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ACCEL ENRICHMENT LOAD FILTER (AELOAD)

The AELOAD calculation is a time-dependent rolling average filter of LOAD.

It is used to sense the manifold filling effect during an acceleration,

especially from Idle. The AELOAD time constant TCAELD is a calibration

constant which should be small enough to prevent a false inference of

manifold filling after the LOAD has reached a stable value and AE fuel is no

longer required.

AELOAD = UROLAV (LOAD,TCAELD)

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INPUT CONVERSIONS AND FILTERS, AIR CHARGE CALCULATIONS - GUF1

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AIR CHARGE CALCULATIONS

DEFINITIONS

INPUTS

Registers:

- RAWAIRCHG = Integrated MAFS output over a PIP period.

- N = RPM.

Bit Flags:

- IMFMFLG = Instantaneous mass air flow sensor FMEM flag.

Calibration Constants:

- ARCHSW = Air charge select switch, 0 = no filtering, 1 = use filling

model.

- FN037 = Backflow clip.

- FKARCH = Manifold filling model slow filter constant.

- FILFRC = Fraction to select slow transient vs fast. transient filter.

- FKARC1 = Fast filter constant for manifold filling.

OUTPUTS

Registers:

- ARCHG = Actual air charge.

- ARCHFG = Filtered air charge according to filling model.

- ARCHI = Instantaneous air charge.

- FILRC1 = Ratio ARCHI/ARCHFG, background calculation for calibration

purposes.

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INPUT CONVERSIONS AND FILTERS, AIR CHARGE CALCULATIONS - GUF1

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AIR CHARGE CALCULATION (ARCHG)

The strategy integrates the instantaneous airflow, MAF, over each PIP period.

To calculate the average air charge, ARCHG, this integration is accomplished

by summing the average MAF over a finite period of time.

The air meter sample period starts at each rising PIP edge. Successive

samples are then obtained at fixed intervals of approximately one msec. This

sampling continues until the next rising PIP edge occurs (at which time the

final sample is taken). The MAF sensor is described in the EEC Overview

Chapter.

n = n

-----

\

AMINT = / 1/2\*[MAF(n) + MAF(n-1) ] (Tn - T(n-1))

-----

n=1

ARCHG = Final AMINT when integration is complete.

AIRFLOW INTEGRATION SCHEME

|<------------------ PIP PERIOD --------------------->|

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

PIP UP | PIP UP

EDGE | EDGE

| | |

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

CORRECTED AIR METER SAMPLES

MAF;(LBM/MIN)

| | \* \* \* \* | | | \* |

| \* \* |\* \* \* \* | \* \* | \*\*\*\*\*\*\*\*\*\*\*\* \* |

\*\* \* 1| 2| 3\* \* \* \* \* \* \* 4|/////////| |

| | | | |/////////| |

| | | | |//AREA\*//| |

| | | | |/////////| |

| | | | |/////////| |

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

T0 T1 T2 T3 ..... T(n-1) Tn T(n+1)

MAF(n) = Instantaneous MAF at time, Tn.

AREA\* = Instantaneous integrated Air Charge.

(AREA = 1/2[MAF(n) + MAF(n-1)]\*(Tn - T(n-1) )

At time T(n+1), the sum of the AREA\*s, AMINT, is stored as RAWAIRCHG and then

set to 0. Approximately every millisecond, the software will do an A/D

conversion of the MAF sensor input, calculate the instantaneous airlow, MAF

and update AMINT (the instantaneous integrated aircharge).

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INPUT CONVERSIONS AND FILTERS, AIR CHARGE CALCULATIONS - GUF1

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Once every millisecond:

VMAF = IMAF \* 2.5/IVCAL \_\_ volts

INTM = DATA\_TIME - MAF\_TIME \_\_ clock ticks

AMINT = prev. AMINT + 1/2 \* [MAF + FN036] \* INTM \_\_ lbm

MAF = FN036(VMAF) \_\_ lbm/clock ticks

MAF\_TIME = DATA\_TIME \_\_ clock ticks

At each rising-edge of PIP, the software will do an A/D conversion of the MAF

sensor, calculate the instantaneous airflow, MAF, and store the final

integrated AMINT as RAWAIRCHG.

At each rising edge of PIP, 1) Complete the integration, 2) Start the next

integration, 3) Correct airflow for pulsations, 4) Filter the aircharge for

manifold filling effects.

1) VMAF = IMAF \* 2.5/IVCAL \_\_ volts

INTM = DATA\_TIME - MAF\_TIME \_\_ clock ticks

AMINT = prev. AMINT + 1/2 \* [MAF + FN036] \* INTM \_\_ lbm

MAF = FN036(VMAF) \_\_ lbm/clock ticks

MAF\_TIME = DATA\_TIME \_\_ clock ticks

RAWAIRCHG = AMINT \_\_ lbm/intake

2) AMINT = 0 \_\_ lbm

3) During low engine speed operation, intake pressure pulsing may produce

backflow through the air meter. Backflow is misinterpreted as positive air

flow by the MAF sensor, which inflates the air mass values. To prevent

erroneous ARCHI calculations due to backflow, the strategy clips ARCHI to

AIR37 as a maximum value.

In the foreground at the PIP interrupt at the completion of the airmeter

integration, and perform the following:

RAWAIRCHG \* ARCHCOR

+ ARCHLI <OR= AIR37 -----------------------| ARCHI = RAWAIRCHG \* ARCHCOR

| + ARCHLI

|

| ---- ELSE ----

|

| ARCHI = AIR37

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INPUT CONVERSIONS AND FILTERS, AIR CHARGE CALCULATIONS - GUF1

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In background, evaluate FN037, where the input is N (engine speed) and

the output is AIR37.

AIR37 = FN037(N)

In background, look up the airflow correction for pulsation:

ARCHCOR = FN1035(N,LOAD)

In background, calculate the aircharge offset for leakage, ARCHLI

(lbm/intake). The calibration constant, ARCHLK (lbm/min), includes all

leakage terms not measured by the air flow meter (such as PCV, CANP, EVR

solenoid, etc.) Typical calibration value is 0.15 lbm/min for 5.0L.

ARCHLI (lbm/intake) = ARCHLK (lbm/min) / N \* ENGCYL

19-19

INPUT CONVERSIONS AND FILTERS, MANIFOLD FILLING MODEL - GUF1

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MANIFOLD FILLING MODEL

OVERVIEW

Because of the delays associated with manifold filling, the airflow

through a meter mounted up- stream of the throttle body is not equal to the

port airflow on an instantaneous basis. This leads to fueling errors during

transients. To compensate for these errors, a filtering algorithm was

developed.

When the throttle body airflow changes slowly, the filling filter constant is

proportional to engine displacement/manifold volume and volumetric

efficiency. A close approximation is an air charge filter constant, FKARCH,

that is proportional to (VEFF) \* (engine displacement/manifold volume)/ (2 \*

ENGCYL).

During a fast tip-in the air charge can be approximated by a different filter

constant. The constant, FKARC1 is proportional to 1/2 \* (VEFF) \* (engine

displacement/manifold volume)/ENGCYL, however the volumetric efficiency at

wide open throttle is used.

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INPUT CONVERSIONS AND FILTERS, MANIFOLD FILLING MODEL - GUF1

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4) In the foreground at the PIP interrupt at the completion of the ARCHI clip

(item 3 above), filter the instantaneous aircharge using the Manifold Filling

Model:

FOREGROUND FILTERED AIR CHARGE

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

ARCHSW = 0 ------------------------| ARCHFG = ARCHI

(no filter on archg) |

| ---- ELSE ----

|

ARCHI/ARCHFG <OR= FILFRC -----------| ARCHFG = (1-FKARCH) \* ARCHFG +

(fast vs. slow transient) | FKARCH \* ARCHI

| (slow transient archg filter)

|

|

| --- ELSE ---

|

| ARCHFG = (1-FKARC1) \* ARCHFG +

| FKARC1 \* ARCHI

Air charge is the air mass inducted per intake stroke. Once per background

loop, the strategy updates ARCHG to the most recent integration, ARCHFG.

In the background calculations:

IMFMFLG = 0 -----------| ARCHG = ARCHFG

| FILRC1 = ARCHI/ARCHFG

|

| --- ELSE ---

|

| ARCHG update is calculated during

| MAF sensor FMEM. See FMEM logic.

| ARCHFG = ARCHG

Note: ARCHG update can be inhibited during MAF sensor FMEM. See FMEM logic.

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INPUT CONVERSIONS AND FILTERS, MANIFOLD FILLING MODEL - GUF1

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CALIBRATION EXAMPLES:

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

Slow filter:

FKARCH ~ (VEFF) \* (engine displacement/manifold volume)/(2 \* ENGCYL)

Assume:

ENGCYL = 3

VEFF ~ 0.60

eng.disp. = 231 in.3 (3.8L super charge)

man.vol. = 1200 in.3 ( " )

FKARCH = (0.6)\*(231/1200) / 2\*3

= 0.019

Note:

As the manifold volume gets smaller the ratio,

engine displacement/manifold volume gets larger

and the 'slow' filter becomes very fast.

Fast filter:

FKARC1 ~ (VEFF) \* (engine displacement/manifold volume)/(2 \* ENGCYL)

Assume:

VEFF = 0.80 (wide open throttle)

FKARC1 = (0.80)\*(231/1200)/2\*3

FKARC1 = 0.026

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INPUT CONVERSIONS AND FILTERS - GUF1

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AIR CHARGE TEMPERATURE SENSOR (ACT)

FN703A (IACT) is the transfer function for the air charge temperature sensor.

It converts from raw A/D counts to degrees F. IACT is the raw A/D counts

from the ACT sensor.

Air Mass (AM)

Determine Air Mass (AM) value:

REFFLG = 0 ---------------| AM = (N \* ENGCYL \* ARCHG)

|

| --- ELSE ---

|

FAM\_FLG = 1 --------------| AM = FAM

| where:

| MINAM <OR= AM <OR=

| (N \* ENGCYL \* ARCHG \* MAXFAM)

|

| --- ELSE ---

|

| AM = (N \* ENGCYL \* ARCHG)

| where:

| MINAM <OR= AM

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INPUT CONVERSIONS AND FILTERS - GUF1

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BAROMETRIC PRESSURE

The barometric pressure will be read with a sensor, or alternatively, a

constant value will be used (KONBP). A calibration switch is used to

indicate that a sensor is to be read.

BPSSW = 1 ---------------------------| BP = BAPBAR

|

| --- ELSE ---

|

| BP = KONBP

BAROMETRIC PRESSURE FILTER (BAPBAR)

The BAPBAR calculation is a time-dependent rolling average filter of

Barometric pressure BAP. The BAPBAR time constant TCBBAR is a calibration

constant.

BAPBAR = UROLAV (IBAP,TCBBAR)

See BP FMEM logic in the FMEM chapter.

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INPUT CONVERSIONS AND FILTERS - GUF1

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INSTANTANEOUS BAROMETRIC PRESSURE (IBAP) (BPSSW = 1)

The BAP calculation is a conversion of the SCAP (Digital BAP) sensor period

into the corresponding barometric pressure. BAP is updated each background

loop, using the largest even number of SCAP transitions which have occurred

since the last update. The following parameters have been redefined but have

an equivalent in MX strategy.

GX MX

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

IBAP MAP

BAPCNT MAPCNT

BAPCNTFLG MAPCNTFLG

BAPTMR MAPTMR

VBPMAX VMPMAX

BAPBAR MAPBAR

Upon each SCAP transition:

SCAP TRANSITION -----------------| Set BAPCNT = BAPCNT + 1

| Set MINTIM1 = Time of Scap

| Transition

| Set MDELTA = Time since last

| transition

If the BP sensor was detected faulty, reset the counters:

BAPTMR > VBPMAX -----| | Set BAPCNT = 0

|OR --------| Set MINTIM2 = Clock

MDELTA < VBPDL1 -----|

When BAP update is required:

BAPCNT is odd ------------------| Set BAPCNT = BAPCNT - 1

| Set MINTIM1 = MINTIM1 - MDELTA

| Set BAPCNTFLG = 1

BAPCNT NOT= 0 -------------------| Set IBAP = FN000 (BAPCNT/2\*

| (MINTIM1 - MINTIM2))

| Set MINTIM2 = MINTIM1

| Set BAPCNT = 0

BAPCNTFLG = 1 -------------------| Set BAPCNT = 1

| Set BAPCNTFLG = 0

BAPTMR is a free-running timer which is set to zero after a SCAP

transition, during the background routines. See timer chapter.

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INPUT CONVERSIONS AND FILTERS - GUF1

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BATTERY VOLTAGE FILTER (VBAT)

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.

VBAT = UROLAV (VBAT',TCVBAT)

Instantaneous Battery Voltage is calculated from:

VBAT' = IIVPWR \* VCAL \* KSF/IVCAL

BOO - BRAKE ON/OFF (Digital input)

This input is the voltage of the vehicle brake and stop lamp circuitry. If

the Brake input hardware is present, a flag named BIHP is set to 1. If the

switch is not present in the system, then BIHP ijs set to 0.

BIHP = 1 ---------------------|

|AND -----| Brake Applied

BOO HIGH ---------------------| | BIFLG = 1

|

| --- ELSE ---

|

| Brake Not Applied

| BIFLG = 0

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INPUT CONVERSIONS AND FILTERS - GUF1

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ENGINE COOLANT TEMPERATURE SENSOR (ECT)

FN703A (IECT) is the transfer function for the ECT sensor. It converts from

raw A/D counts to degrees F. IECT is the raw A/D counts from the ECT sensor.

ENGINE COOLANT TEMPERATURE FILTER (ECT)

The ECT calculation is a time-dependent rolling average of instantaneous

engine coolant temperature. The ECT time constant TCECT is calibratable.

ECT = ROLAV (FN703A(IECT),TCECT)

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INPUT CONVERSIONS AND FILTERS - GUF1

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EGR POSITION FILTER (EGRBAR) (PFEHP = 0)

The EGRBAR calculation is a time dependent rolling average filter of

instantaneous EGR valve position EVP. It is updated each background pass

while in RUN or UNDERSPEED mode. The EGRBAR time constant TCEGR is a

calibration parameter.

EGRBAR = UROLAV (EVP,TCEGR)

EGR POSITION RATCHET (E0FF) (PFEHP = 0)

The lowest filtered EGR position EOFF is controlled by the following logic:

EGRBAR < EOFF -------------|

|

CRKFLG = 0 ----------------|AND ---| SET EOFF = EGRBAR

(RUN or UNDERSPEED mode) |

|

APT = -1 ------------------|

(closed throttle mode)

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INPUT CONVERSIONS AND FILTERS - GUF1

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IDLE DOWNSTREAM PRESSURE (EPTZER) LOGIC

CRKFLG = 1 --------------------| EPTBAR = EPTZER

|

| --- ELSE ---

|

APT = -1 ---------------| | Idle EPTZER Update

| |

N <OR= DSDRPM + IERPMH -| | EPTZER =

|AND --| ROLAV (IEPT,TCEPT)

EPTSW = 1 --------------| |

| |

ECT >OR= CTEHI ---------| | --- ELSE ---

|

| EPTBAR =

| ROLAV (IEPT,TCEPT)

|

| No Update to EPTZER

KEY ON EPTZER UPDATE (PFEHP = 1)

EPTZER is a KAM register. Conditions for EPTZER update are similar to those

for Inferred BP. The same enabling logic may be used. BPUFLG is the BP

update enable flag.

BPUFLG = 0 -------------|

(Power reset may |

have occurred) |

|

PTPFLG = 1 -------------|OR ------| Do NOT Update

(PIP Occurred) | | EPTZER

| |

PUTMR < TKYON2 ---------| |

(Too soon to update) | | --- ELSE ---

| |

PUTMR > TKYON3 ---------| |

(Too late to update) | Conditions are

| appropriate for update

|

IEPT > VEPTLL -----------| | EPTZER =

|AND ----| ROLAV (IEPT+IDLDEL,TCEPT)

IEPT < VEPTHL -----------| |

| --- ELSE ---

|

| Sensor out of range

| Initialize EPTZER

| EPTZER = 650

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INPUT CONVERSIONS AND FILTERS - GUF1

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GX does not have Inferred BP, therefore, the following logic needs to be

defined for GX.

PUTMR < TKYON1 --------------| Ignore any PIPs; probably

| due to noise transients

| PTPFLG = 0

PUTMR < TKYON1 --------------|

|AND ---| Allow Key On updates

KAM\_ERROR = 1 ----| | | BPUFLG = 1

|OR -------|

BPKFLG = 0 -------|

(Not a reset)

PUTMR > TKYON2 --------------|

|AND ---| Begin ECTCNT for TCSTRT

ECTCNT = 0 ------------------| | Calculation

| TCSTRT = Arithmetic average

| of the first 8 consecutive

| ECT readings (ECTCNT is the counter)

UNDSP = 0 -------------------|

(RUN Mode) |AND ---| Enable Key On updates

| | for next startup

ATMR1 > TKYON4 --------------| |

| BPKFLG = 0

EVP - EGR VALVE POSITION SENSOR (PFEHP = 1)

(Analog Sensor)

The EVP sensor provides a signal proportional to the valve position. As a

rule of thumb, pintle position (percent of Full Travel) is equal to (IEVP -

EOFF)\*0.14.

The strategy converts pintle position (counts) into EGR mass flow (EM), in

the EGR strategy.

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INPUT CONVERSIONS AND FILTERS - GUF1

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HEGO - HEATED EXHAUST GAS OXYGEN SENSOR (Analog Input)

The HEGO sensor is a modified (it is connected to a power and a ground wire)

EGO sensor and provides the same functions as the EGO. The modification

allows it to heat up more quickly than the unmodified EGO sensor

(approximately 18 seconds versus 80 seconds), thus providing an earlier

Closed Loop operation on a cold start. This modification also allows it to

operate at cooler locations in the exhaust system providing greater

flexibility in sensor packaging. Associated with this property is more

accurate sampling of the exhaust when the HEGO may be placed closer to the

catalytic converter.

There is a slightly longer transport delay between EGO switch and fuel

injection changes which may cause a longer "tracking" effect, but the bottom

line is the ability to elicit a more even and accurate sampling.

Additionally, the more stable sensor temperature of the HEGO is known to keep

contaminants away from the sensor, reducing degradation of the sensor over

50K miles. It also avoids the EGO cool-down during Idle which occurs with

the normal EGO.

IEGOn > 855 ------------------| HEGO is Lean

| EGOFLn = 0

|

| --- ELSE ---

|

| HEGO is Rich

| EGOFLn = 1

NOTE: The A/D conversion of the "HEGO" is inverse to the analog signal (low

signal translates to high counts). Low Oxygen level = Rich gas = High

voltage (approximately 1.0 volt); High Oxygen level = Lean gas = Low voltage

(approximately 0.0 volt).

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INPUT CONVERSIONS AND FILTERS - GUF1

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KS - KNOCK SENSOR

(Digital Input)

KS is an accelerometer tuned to measure engine vibration over a range within

which knock typically occurs. KS is mounted on a strategic location of the

engine structure. The following logic is checked every PIP up-edge BEFORE

calculating the SPOUT.

KNOCK DETECTION LOGIC

KNOCK\_DETECTED = 1 ---------|

|AND ---| Set KNOCK\_OCCURRED = 1

KNK\_HIGH = 1 ---------------| |

(KI currently indicating | --- ELSE ---

knock) |

|

KNOCK\_DETECTED = 1 ---------| | KNOCK\_OCCURRED = 1

|AND ---| KNOCK\_DETECTED = 0

KNK\_HIGH = 0 ---------------| |

(KI currently indicating | --- ELSE ---

NO knock) |

| KNOCK\_OCCURRED = 0

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 = 60/(ENGCYL\*"MAXRPM") \* "Clock Freq"/36

n = 4 for a 4-cylinder engine MNPIP4 = 1923 at 15 MHz

n = 6 for a 6-cylinder engine MNPIP6 = 1282 at 15 MHz

n = 8 for a 8-cylinder engine MNPIP8 = 961 at 15 MHz

NOTE: MNPIP should correspond to an RPM which is greater than the speed at

which the strategy turns off the Fuel (Speed Limiter). The base values are

equivalent to 6500 RPM.

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INPUT CONVERSIONS AND FILTERS - GUF1

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ENGINE SPEED CALCULATION (N and N\_BYTE)

The engine speed calculation converts the PIP period (time between

consecutive PIP signals) into the equivalent engine speed (N) in revolutions

per minute (RPM). The calculation is done each background loop.

N\_BYTE = N = 30/PIP PERIOD (4-cylinder, ENGCYL = 2)

N\_BYTE = N = 20/PIP PERIOD (6-cylinder, ENGCYL = 3)

N\_BYTE = N = 15/PIP PERIOD (8-cylinder, ENGCYL = 4)

NOTE:

1) If the PIP period becomes >OR= TSTALL, N and N\_BYTE are set to zero. This

insures that if the PIP signal goes away because of a stall, N and N\_BYTE

will become zero to trigger CRANK mode.

2) A comparison of N and N\_BYTE is shown below:

N N\_BYTE

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

Precision: double (word) single (byte)

Range: 0 to 7000+ 0 to 4080

Resolution: .25 16

Units: RPM RPM

Initial Value: 0 0

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INPUT CONVERSIONS AND FILTERS - GUF1

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ENGINE SPEED FILTER (NBAR)

The NBAR calculation is a time-dependent rolling average filter of

instantaneous engine speed N. It is updated each background pass while in

RUN or UNDERSPEED mode. The NBAR time constant TCN is calibratable.

NBAR = UROLAV (N,TCN)

ENGINE SPEED FILTER (NDBAR)

The NDBAR calculation is a time dependent rolling average filter of

instantaneous engine speed N. It is updated each background pass while in

RUN or UNDERSPEED mode. The NDBAR time constant TCNDBR is a calibration

parameter.

NDBAR = UROLAV (N,TCNDBR)

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INPUTS CONVERSIONS AND FILTERS, NEUTRAL/DRIVE TRANSITION LOGIC - GUA0

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INDS INPUT - NEUTRAL/DRIVE SWITCH INPUT

OVERVIEW

This input reflects the applied transmission load to the engine, ie.

neutral/park, drive/in gear.

- Manual transmissons can be configurated 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 5 volt module pull up provides an

"in gear" indication which can be overridden by proper selection of

the TRLOAD software switch. (Set TRLOAD = 0).

- Non-electronic automatic transmissions typically have a two state

switch which indicates neutral or drive. All transmissions except

the AXOD use a mechanical switch connected to the gearshift lever.

Drive is indicated by a 5 volt signal, neutral is indicated by a 0

volt signal. AXOD are unique in that instead of using a

Neutral/Drive switch, the AXOD uses a Neutral Pressure switch. This

is a hydraulic switch which senses hydraulic pressure in the forward

clutch. The voltage indicated by the NPS is opposite to that

indicated by the NDS. Drive is indicated by 0 volts and neutral is

indicated by 5 volts (except in overdrive). The NPS must be used in

conjunction with the two other transmission hydraulic switches (THS

2/3 and THS 3/4) to properly decode neutral, forward, and reverse

states.

- Electronic automatic transmissions typically use a 6 position PRNDL

sensor to determine the operator selected gear. The PRNDL sensor is

a ratiometric sensor with six discrete resistors in series. The

sensor is decoded by looking at the differing voltages produced by

each of the PRNDL positions.

The engine control strategy typically requires information on the current

state of engine loading. This is priovided by NDSFLG. If NDSFLG = 1,

the engine is loaded (trans. in gear or in drive). If NDSFLG = 0, the

engine is unloaded (trans. in neutral or clutch depressed). DNDSUP, the

delayed neutral/drive flag contains exactly the same information as

NDSFLG except that it is delayed (see FN394 F/R, NDDTIM, etc.) in an

attempt to match PRNDL movement with actual application of transmission

load. (Manual transmission automatically get a 0 delay time).

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 VIP).

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INPUTS CONVERSIONS AND FILTERS, NEUTRAL/DRIVE TRANSITION LOGIC - GUA0

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DEFINITIONS

INPUTS

Registers:

- INDS = IACC\_NDS = Raw input from A/D in counts. Indicated

transmission state.

- NDDTIM = Timer which tracks time since Neutral/Drive switch state

change, sec.

Bit Flags:

- INDFLG = Instantaneous Neutral/Drive flag.

- NDSFLG = For automatic transmissions: 1 = PRNDL indicates in gear, 0

= PRNDL indicates neutral. For manual transmissions: 1 = clutch out

and/or transmission in gear, 0 = clutch in and/or transmission in

neutral.

Calibration Constants:

- FN394F(ECT) = Time delay before transmission engages - forward gear.

- NDDELT = Time delay before N/D to D/N switch registers in DNDSUP.

-

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.

OUTPUTS

Bit Flags:

-

DNDSUP = Delayed neutral drive indication. For automatic

transmissions: 1 = transmission is in gear, 0 = transmission is in

neutral. For manual transmissions: DNDSUP = 0.

- NDSFLG = For automatic transmissions: 1 = PRNDL indicates in gear, 0

= PRNDL indicates neutral. For manual transmissions: 1 = clutch out

and/or transmission in gear, 0 = clutch in and/or transmission in

neutral.

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INPUTS CONVERSIONS AND FILTERS, NEUTRAL/DRIVE TRANSITION LOGIC - GUA0

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PROCESS

NDSFLG - INSTANTANEOUS (NON-DELAYED) TRANSMISSION STATE

INDFLG = 0 ------------|

|OR ---| Set NDSFLG = 0

TRLOAD = 0 ------------| | (neutral state)

(forced neutral) |

| (Zero NDDTIM timer on

| the transition)

|

| --- ELSE ---

|

| Set NDSFLG = 1

| (drive/loaded state)

|

| (Zero NDDTIM timer on

| the transition)

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INPUTS CONVERSIONS AND FILTERS, NEUTRAL/DRIVE TRANSITION LOGIC - GUA0

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DNDSUP FLAG LOGIC

The DNDSUP flag is used to delay the strategy response to a "PRNDL"

change until the transmission actually shifts. The transmission shift

response is inferred using a time delay since the PRNDL change.

NDDTIM >OR= NDDELT ----------| DNDSUP = NDSFLG

|

| --- ELSE ---

|

| No Change to

| DNDSUP

DNDSUP - DELAYED TRANSMISSION STATE

Neutral Indication --------------|

(NDSFLG = 0) |AND ---|

| |

Transmission Disengaged --| | |

(NDDTIM >OR= NDDELT) |OR ---| |

| |OR --| Set DNDSUP = NDSFLG

TRLOAD <OR= 3 ------------| | | (Update delayed

(Manual Transmission) | | Neutral/Drive flag)

|

Drive Indication ----------------| |

(NDSFLG = 1) |AND ---|

|

Transmission Engaged -----| |

(NDDTIM >OR= FN394F) | |

|OR ---|

TRLOAD <OR= 3 ------------|

(Manual Transmission)

Automatic Transmission:

DNDSUP delays strategy recognition of a transmission shift until the

transmission actually engages or disengages (regardless of the state of

the gear switch (or pressure switch) inputs). The time delay, FN394F is

dependant upon the type of transmission used. Therefore, calibration of

these functions should be coordinated with the appropriate transmission

development activity.

Manual Transmission

If TRLOAD = 0, NDSFLG is forced to 0, therefore DNDSUP is always 0.

If TRLOAD is 1,2 or 3, DNDSUP will follow the state of NDSFLG with no

time delay.

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INPUTS CONVERSIONS AND FILTERS - GUA0

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PIP - PROFILE IGNITION PICKUP (Digital Input)

The PIP Sensor is the 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. The timer which keeps track of the time since last PIP

(TSLPIP) functions with 0.001 second resolution. An example of PIP's use in

Knock control is shown below.

N(RPM) = 60/(ENGCYL \* "PIP PERIOD")

"PIP PERIOD" has units of secs.

If the PIP period (time elapsed since the last PIP signal) becomes greater

than or equal to TSTALL (800 msec), the engine speed RPM is set to zero.

This insures that if the PIP signal goes away because of a stall, RPM

will become zero to trigger CRANK mode.

PIP COUNTER CONTROL LOGIC

CRKFLG = 1-----|

(CRANK mode) |AND ----| Count PIP signals as they occur.

| | (PIPCNT is the counter)

N > NRUN ------| |

|

| --- ELSE ---

|

| Stop counting PIP signals

| PIPCNT = 0

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INPUTS CONVERSIONS AND FILTERS - GUA0

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PIP NOISE FILTER

\*\*\*\*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\*\*

\* \* \* \*

\* \* \* \*

\* \* \* \*

\* \* \* \*

\* \*\*\*\*\*\*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\*

| <-------------------> |

PIP up edge to PIP up edge

filter

| <-----> |

PIP up edge to PIP down edge

filter

In the EEC-IV system, there is a method of noise blanking to eliminate

some of the noise that occurs on the PIP input. There is a PIP up edge to

PIP up edge filter. 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.

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). In GU,

the calibration values are MNPIPn. They are defined in this chapter where

MNPIPn is described.

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INPUTS CONVERSIONS AND FILTERS - GUA0

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PSPS - POWER STEERING SWITCH (Available but NOT currently used) (Digital Input)

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.

PSPS LOW ------------------------| No Power Steering Load

| POWSFG = 1

|

| --- ELSE ---

|

| Power Steering Load

| POWSFG = 0

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INPUTS CONVERSIONS AND FILTERS - GUA0

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TAR - THROTTLE ANGLE RATE

(Analog Input)

TAR input comes from an analog differentiator circuit which is fed by the TP

Sensor (Described below). Units of TAR are degrees per second. TAR is an

important factor in controlling the amount of fuel injection as well as a

vital part of Idle Speed control. Both NQ and MX provide this function

through a hardware/software combination, while 9X uses a software TAR.

OLDTP - TP > TPDLTA ----------| TAR = 0

|

| --- ELSE ---

|

| TAR = (655 - ITAR)/5.42

TP - THROTTLE POSITION SENSOR

(Analog Input)

TP sensor is a rotary ratiometric device responding to the throttle shaft

position outputting a voltage which is high if the TP angle is great and

small when the TP angle is small. TP sensor measures a range of 0-50 degrees

of throttle movement. One degree of throttle travel is equal to

approximately 9.6 counts.

THROTTLE POSITION FILTER (TPBAR)

The TPBAR calculation is a time-dependent rolling average filter of

instantaneous throttle position (TP). It is updated each background pass

while in RUN or UNDERSPEED mode. The TPBAR time constant, TCTP, is

calibratable parameter.

TPBAR = UROLAV (TP,TCTP)

THROTTLE POSITION FILTER (TBART)

The TBART calculation, used in the Knock Strategy, is a time-dependent

rolling average filter of instantaneous throttle position (TP). It is

updated each background pass while in RUN or UNDERSPEED mode. The TBART time

constant, TCTPT, is calibratable parameter.

TBART = UROLAV (TP,TCTPT)

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INPUTS CONVERSIONS AND FILTERS - GUA0

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THROTTLE POSITION RATCHET (RATCH)

The throttle position ratchet (RATCH) continuously seeks a lower value for

both throttle angle breakpoints, CLOSED THROTTLE/PART THROTTLE and PART

THROTTLE/WOT, by seeking the lowest filtered throttle angle (TPBAR). The

algorithm is not used during CRANK mode.

CRKFLG = 0 -----------------|

| | RATCH = TPBAR

TPBAR <OR= RATCH -----------|AND -----|

| | --- ELSE ---

N > 450 RPM ----------------| |

| NO CHANGE TO RATCH

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INPUTS CONVERSIONS AND FILTERS - GUA0

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VSS - VEHICLE SPEED SENSOR

(Digital Input)

VSS is part of the EEC system and is used also by the dashboard computer.

VSS is a digital input whose frequency is proportional to vehicle speed

(similar to relationship of PIP signal to RPM).

VS CALCULATION

The vehicle speed sensor signal frequency is proportional to the vehicle

speed. The sensor frequency varies from 0 to 280 Hz.

VEHICLE SPEED = 0.45 / (VSS Period)

The strategy updates VS once per background loop if the sensor voltage

crossed zero volts (MPHCNT > 0) during the previous background loop.

DURING VEHICLE SPEED SENSOR INTERRUPT:

(Rising Edge Only)

MPHCNT = MPHCNT + 1

MPHTIM1 = Clock Time

IF FIRST\_MPH = 0 ---| MPHTIM1 = Clock Time, FIRST\_MPH = 1

|

| --- ELSE ---

|

| MPHCNT = MPHCNT + 1

| MPHTIM1 = Clock Time

Once per background, the following logic is executed.

TSLMPH >OR= 255 msec -------| Set FIRST\_MPH = 0

| VS = 0

| MPHTIM2 = MPHTIM1

|

| --- ELSE ---

|

MPHCNT > 0 -----------------| VS = 0.45 \* MPHCNT/

| (MPHTIM1 - MPHTIM2)

| MPHCNT = 0

| MPHTIM2 = MPHTIM1

|

| --- ELSE ---

|

| Do NOT Update VS

| MPHTIM2 = MPHTIM1

NOTE: The software will handle the unit conversion from clock ticks to

seconds (1 tick = 3.0\*10E-6 sec, 12 MHz EEC; 1 tick = 2.4\*10E-6 sec, 15 MHz

EEC)

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INPUTS CONVERSIONS AND FILTERS - GUA0

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VSCCS - VEHICLE SPEED CONTROL COMMAND SWITCH

(Analog Input)

The VSCCS is the output of a voltage divider network. The range of the VSCCS

output is selected by the vehicle's driver by means of steering wheel-mounted

switches. The software uses a timer to debounce the switch input. If the

instantaneous input IVSCCS is stable, the VSCCS register is updated.

DEBTMR >OR= DEBTIM ------|

|AND ---| VSCCS = IVSCCS

VSCHP = 1 ---------------|

VEHICLE SPEED (MPH)

The MPH calculation is a time-dependent rolling average filter of

instantaneous vehicle speed, VS. The MPH time constant, TCMPH, is a

calibratible parameter.

MPH = UROLAV (VS,TCMPH)

VEHICLE SPEED (VSBAR)

VSBAR calculation is a time-dependent rolling average filter of instantaneous

vehicle speed, VS. The time constant, TCVS, is a calibratible parameter.

VSBAR = UROLAV (VS,TCVS)

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INPUTS CONVERSIONS AND FILTERS, ROLLING AVERAGE ROUTINE - GUF0

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ROLLING AVERAGE ROUTINE (ROLAV/UROLAV)

OVERVIEW

The EEC-IV filters inputs using a rolling average routine. This routine

requires a time constant, a sampling rate, an old average, and a new value to

compute the new average. The equation is:

NEW AVERAGE = FILTER CONSTANT \* NEW VALUE + (1 - FILTER CONSTANT) \*

OLD AVERAGE

where FILTER CONSTANT = 1/(1 + TIME CONSTANT / SAMPLE PERIOD); the sampling

period is the time elapsed between new calculations. For most filters, the

sampling period will equal the background loop time. The time constant is a

function of the input being filtered. When the (NEW VALUE - OLD AVERAGE) \*

FILTER CONSTANT is less than the bit resolution of new average, the old

average is incremented or decremented by 1 bit per calculation until the new

average equals the old average. The strategy will specify rolling average

filters using the following structure:

Set new\_avg = (U)ROLAV(new\_value,time\_const)

where new\_avg = output of rolling average filter

ROLAV = signed rolling average routine

UROLAV = unsigned rolling average routine

new\_value = input value to filter

time\_const = time constant

DEFINITIONS

INPUTS

Registers:

- TCxxxx = Time constant (seconds).

- FK\_TMR = sampling period (seconds).

- old average = Last output from filter routine.

- new value = Most recent value of input to be filtered.

OUTPUTS

Registers:

- new average = Latest filtered value.

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INPUTS CONVERSIONS AND FILTERS, ROLLING AVERAGE ROUTINE - GUF0

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PROCESS

FKxxxx = 1/[1 + (TCxxx/FK\_TMR)]

-1 Bit < FKxxxx \* (new value - old average) < 0 -| new average =

| old average - 1 bit

|

| --- ELSE ---

|

0 < FKxxxx \* (new value - old average) < 1 Bit ---| new average =

| old average + 1 bit

|

| --- ELSE ---

|

| new average =

| old average +

| FKxxxx \* (new value -

| old average)

Note: If (new value - old average) equals zero,

then new average = old average.

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INPUTS CONVERSIONS AND FILTERS, ROLLING AVERAGE ROUTINE - GUF0

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INPUT LIST FOR ROLLING AVERAGE FILTER ROUTINE

new value old average FK\_TMR TCxxxx

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

LOAD AELOAD BG\_TIMER TCAELD

BAP BAPBAR BG\_TIMER TCBBAR

FN703A(IECT) ECT BG\_TIMER TCECT

IEPT+IDLDEL EPTZER BG\_TIMER TCEPT

IEPT EPTZER BG\_TIMER TCEPT

IEPT EPTBAR BG\_TIMER TCEPT

N NDBAR BG\_TIMER TCNDBR

N NBAR BG\_TIMER TCN

TP TPBAR BG\_TIMER TCTP

VS VSBAR BG\_TIMER TCVS

FN1341 INJDLY BG\_TIMER TCINJD

CINTV INJDLY BG\_TIMER TCINJD

INJDLY' INJDLY BG\_TIMER TCINJD

FN221+EOFF DELOPT BG\_TIMER TCDLOP

DP' DESDP BG\_TIMER TCDP

DSDRPM DESNLO BG\_TIMER TCDESN

AM FAM FFMTMR TCFAM

ACT ECT BG\_TIMER TCECT

IEGO EGOBAR BG\_TIMER TCVEGO (VIP)

IEPT CFIEPT BG\_TIMER VTCEPT (VIP)

EVP EGRBAR BG\_TIMER TCEGR

TP TBART BG\_TIMER TCTPT

VBAT' VBAT BG\_TIMER TCVBAT

VS MPH BG\_TIMER TCMPH

EGRACT' EGRACT BG\_TIMER TCEACT

TP DSTPBR BG\_TIMER TCDASD

TP DSTPBR BG\_TIMER TCDASU

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INPUTS CONVERSIONS AND FILTERS, ROLLING AVERAGE ROUTINE - GUF0

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CALIBRATION PHILOSOPHY

1) The values for the time constants in the base calibration were calculated

using the filter constants in the base calibration an assumed background

loop time of 25 msec, and the following equation:

time constant = [(1/filter constant) - 1] \* sampling period.

(Sample period approximately equals background loop time for most

filters. FAM is the exception.)

2) Several filter constants are currently non-calibratable. With this EMR

(8-092), the time constants for these become calibratable. The effective

time constants for these have been increasing as the background loops

have increased. This could develop into some problems in the calibration

if the time constants were to suddenly change, so the values in the base

calibration are equal to the current effective time constant (assume 25

msec loop time).

3) In previous releases the filter constant was the calibration parameter.

This gave an increasing time constant as rpm (loop time) increased. Now

the time constant is fixed. All filters will act differently with the

implementation of EMR 8-092.

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INPUTS CONVERSIONS AND FILTERS, ROLLING AVERAGE ROUTINE - GUF0

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CHAPTER 20

TIMERS

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TIMERS - GUF1

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TIMER SUMMARY

TIMER DESCRIPTION

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

ACBTMR A/C Clutch Brake Timer (sec)

ACCTMR Time since A/C Clutch Cycled (sec)

ACITMR A/C Clutch Idle Turn-on

Delay Msec Timer (msec)

ACWTMR Time since A/C WOT Mode (sec)

ADPTMR Adaptive fuel timer (sec)

ATMR1 Time since start (time since exiting crank

mode) (sec)

ATMR2 Time since engine coolant temperature became

greater than TEMPFB (sec)

ATMR3 Time since Entering RUN Mode (sec)

A3CTMR Time between A3C state changes.

BAPTMR Time since last BP sensor interrupt (msec)

CRKTMR Time in CRANK Mode (sec)

CTATMR Closed Throttle Upstream Air Timer (sec)

CTNTMR Closed Throttle mode neutral timer (sec)

CTTMR Time at closed throttle timer (sec)

DEBTMR Vehicle Speed Command Switch Debounce Timer (sec)

DLTMR Decel fuel low load timer, sec.

EDFTMR Electro-Drive Fan Timer (sec)

FFMTMR FAM filter timer (sec)

HLTMR High LOAD timer (sec)

HMTMR Timer limiting Upstream Air (sec)

HWTMR Time at which A3CTMR remains below threshold.

LESTMR1 EGO-1 lack of switching timer (sec)

LESTMR2 EGO-2 lack of switching timer (sec)

LUGTMR LOM load transition timer (sec)

MFATMR Managed Fuel/Air timer (sec)

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TIMERS - GUF1

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MULTMR Time since incrementing LAMMUL (msec)

NACTMR Time not at closed throttle (sec)

NDDTIM Time since neutral/drive switch state change

(sec)

NWOTMR Not at Wide Open Throttle Timer. (sec)

PRGTMR Canister purge accumulation timer (sec)

PUTMR Time since CPU power-up (msec)

TSEGRE Accumulated time EGR is enabled (sec)

TSLPIP Time since last PIP (msec)

WCOTMR A/C Clutch WOT Cutout Timer (sec)

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TIMERS - GUF1

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DEFINITIONS

INPUTS

Registers:

- APT = Throttle mode flag (-1 = closed throttle; 0 = part throttle;

1 = wide open throttle)

- BP = Barometric absolute pressure.

- ECT = Engine coolant temperature, deg. F.

- EDF = Electro drive fan flag, if set to 0, energized.

- IVSCCS = A/D Conversion of the speed control command switch,

counts.

- IVSCCS\_LST = Previous valid SCCS input.

- LOAD = Universal normalized load parameter.

- N = Engine speed, RPM.

- NDBAR = Filtered engine speed.

- RATCH = Lowest filtered throttle position, counts.

- TCSTRT = Temperature of ECT at cold start-up, deg.F.

- TP = Instantaneous throttle position, counts.

- VSCCS = Previous valid SCCS input.

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TIMERS - GUF1

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Bit Flags:

- ACCFLG = A/C status flag (0 = A/C disabled; 1 = A/C

enabled).

- ACIFLG = Flag to indicate that idle speed control

system should prepare for load increase.

- AFMFLG = Flag indicating that ACT sensor has failed.

- BIFLG = Brake is on.

- CFMFLG = Flag indicating that ECT sensor is in/out of range.

- CRKFLG = Crank flag (1 = engine in Crank mode).

- CTNFLG = 1 = closed throttle neutral idle.

- DNDSUP = Drive/Neutral select.

- IDLFLG = Flag indicating transmission in drive and at idle.

- MFAFLG = Managed Fuel Air State flag, set to 1 if MFA

is being used.

- MFMFLG = Flag indicating that MAF sensor has failed.

- NDSFLG = Neutral/Drive flag, 1 = Drive.

- SWTFLG = Managed Fuel Air State Flag.

- UNDSP = Underspeed flag, if set to 1 indicates Underspeed

mode or Crank.

- WMEGOL = Flag indicating Wrmego was 1 at least once.

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TIMERS - GUF1

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Calibration Constants:

- AFECT1 = Minimum ECT for starting the Adaptive Fuel timer,

deg F.

- AFECT2 = Overtemp ECT to zero the adaptive fuel timer.

- BYHTMR = Bankline timer time delay for Thermactor bypass.

- BYPLES = Time delay before bypass after last Ego switch.

- CTHIGH = Hot start minimum engine coolant temperature,

Deg F.

- CTLOW = Cold start maximum ECT, deg F.

- DEBAMP = Minimum change in IVSCCS to reset the debounce

timer.

- DEBTIM = Debounce time delay.

- DFLDH = Decel Fuel low load hysteresis.

- DFLDL = Decel Fuel low load shut off.

- FN087 = Time delay to enable A/C Clutch; maximum allowable

time A/C disabled at WOT. Input = TP-RATCH (A/D

Counts)

- FN125 = LOM Load function to activate LOM spark strategy.

Input: RPM and Output: load.

- FN306 = Cranking fuel pulsewidth multiplier versus

time in crank, sec. X-input = CRKTMR.

- FN880(CTNTMR) = DSDRPM adder vs. time at Idle, sec.

- EGRMPT = Egrate ramp time for TCSTRT <or= CTLOW, sec.

- HLODH = Upper LOAD Limit for Closed Loop Fuel Control,

unitless.

- 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.

- INLRPM = Maximum RPM to increment CTHTMR.

- INLRPH = Hysteresis for INLRPM.

- LOESSW = Logic switch to reenter closed loop due to lack of

Ego switching open loop.

- LUGSW = LUGTMR logic switch.

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TIMERS - GUF1

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- LUGTIM = Engine load transition time, sec.

- MFALH = Managed fuel air state maximum Load condition.

- MFALHH = Hysteresis for MFALH.

- MFALL = Managed Fuel Air State Minimum load value.

- MFANLO = Managed Fuel Air State minimum RPM.

- MFANHH = Hysteresis for MFANHI.

- MFANHI = Managed Fuel Air State Maximum RPM.

- MFANLH = Hysteresis for MFANLO.

- MFASN = Managed fuel air state constant RPM entry

condition.

- MFATM1 = ATMR1 MFA enable time delay for TCSTRT <or=

CTLOW.

- MFATM2 = ATMR1 MFA enable time delay for CTLOW <

TCSTRT < CTHIGH.

- MFATM3 = ATMR1 MFA enable time delay for TCSTRT

>or= CTHIGH.

- MFATM4 = ATMR2 MFA enable time delay for TCSTRT

<or= CTLOW.

- MFATM5 = ATMR2 MFA enable time delay for CTLOW <

TCSTRT < CTHIGH.

- MPMNBP = Minimum BP for fuel economy mode; used in

MFATMR logic.

- MPNBPH = BP Hysteresis for MPMNBP in SWTFLG logic.

- 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.

- SWTCNT = Managed fuel air state EGO switch requirement.

- TEMPFB = Minimum ECT required to start ATMR2 timer,

deg F.

- THBP4 = Minimum throttle position above RATCH for WOT

A/C cut-out, counts.

- THBP4H = Hysteresis term for throttle position, counts.

- UPLOD = Minimum PERLOAD to disable Upstream Air.

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TIMERS - GUF1

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- UPLODH = Hysteresis term added to UPLOD to define Minimum

LOAD to enable Upstream Air.

- UPRPM2 = Maximum RPM for decel upstream air.

- UPRPMH = Hysteresis for INLRPM.

- VSMPG = Minimum Vehicle Speed to remain in MFA Mode

(if speed sensor is present), mph.

- VSMPGH = Hysteresis term for entering MFA mode.

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

0 = No vehicle speed and no cruise control,

1 = Vehicle speed sensor, no cruise control (VSS),

2 = Both vehicle speed sensor and cruise control (VSS+VSC).

OUTPUTS

Bit Flags:

- ADPTMR\_FLG = Adaptive Fuel Time Flag.

- CTAFLG = Closed throttle decel upstream air flag.

- CTNFLG = 1 = closed throttle neutral idle.

- DMFLG = Decel fuel low load timer enabled flag, 1 = Count up timer.

- IDLFLG = Flag indicating transmission in drive and at idle.

- LEGOFG1 = Lack of EGO-1 switching.

- LEGOFG2 = Lack of EGO-2 switching.

- MFAFLG = Managed Fuel Air State flag, set to 1 if MFA

is being used.

- SWTFLG = Managed Fuel Air State Flag.

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TIMERS - GUF1

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TIMER CONTROL LOGIC

ACBTMR - A/C CLUTCH BRAKE TIMER

(0.125 SEC RESOLUTION)

BRIEF DESCRIPTION:

The purpose of this timer is to provide a means of controlling the maximum

amount of time that the A/C clutch is disabled after the brake is applied.

NOTE: If BRKCOT is calibrated to zero, (See A/C clutch control routine),

this time routine has no control of the A/C clutch.

BIFLG = 1 -----------------------| COUNT UP ACBTMR

|

| --- ELSE ---

|

| SET ACBTMR = 0

20-9

TIMERS - GUF1

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ACCTMR - A/C CLUTCH TRANSITION TIMER

(0.125 SEC RESOLUTION)

BRIEF DESCRIPTION:

The purpose of this timer is to prevent rapid cycling of the A/C output.

ACCTMR forces the A/C state to remain static (ON or OFF) for a minimum amount

of time, ACMNET.

PRESENT ACCFLG = 1 -----|

(clutch engaged) |AND ---|

| |

PREVIOUS ACCFLG = 0 ----| |

|OR ----| SET ACCTMR = 0

PRESENT ACCFLG = 0 -----| | | (any transition)

|AND ---| |

PREVIOUS ACCFLG = 1 ----| | --- ELSE ---

|

| COUNT UP ACCTMR

NOTE: ACCTMR is initialized to maximum value.

ACITMR - A/C CLUTCH TURN-ON DELAY TIMER

(MSEC RESOLUTION)

BRIEF DESCRIPTION:

The purpose of this timer is to provide a means of delaying the turn-on of

the A/C clutch while at idle in order to give the idle speed control system

time to prepare for the impending increase in load.

ACIFLG = 1 ---------------------| COUNT UP ACITMR

|

| --- ELSE ---

|

| SET ACITMR = 0

20-10

TIMERS - GUF1

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ACWTMR - A/C CLUTCH WIDE OPEN THROTTLE TIMER (SECONDS)

(SEC RESOLUTION)

BRIEF DESCRIPTION:

The purpose of this timer is to provide a means of controlling the maximum

amount of time that the A/C clutch is disabled while at WOT. This timer is

used as an input to the WCOTMR logic. NOTE: If FN087 is calibrated to zero

(See WCOTMR routine below), this timer routine has no control of the A/C

clutch.

TP > RATCH + THBP4 --------------|S Q-----| COUNT UP ACWTMR

| | (Clip at 254 sec max)

TP < RATCH + THBP4 - THBP4H -----|C |

| --- ELSE ---

|

| SET ACWTMR = 0

ADPTMR - ADAPTIVE FUEL ENABLE TIMER

BRIEF DESCRIPTION:

This timer allows Adaptive Fuel to be enabled if the Engine is in Run Mode

and the Engine Coolant Temperature is within a certain band. Adaptive Fuel

is disabled if either of these conditions is not met.

RUN mode ------------------------|

|AND-----| COUNT UP ADPTMR

AFECT1 <OR= ECT <OR= AFECT2 -----| | Set ADPTMR\_FLG

|

| --- ELSE ---

|

| SET ADPTMR = 0

| Clear ADPTMR\_FLG

20-11

TIMERS - GUF1

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ATMR1 - TIME SINCE ENGINE START-UP

CRKFLG = 0 ---------------------------| COUNT UP ATMR1

(RUN or UNDERSPEED mode) |

| --- ELSE ---

|

| SET ATMR1 = 0

ATMR2 - TIME SINCE ENGINE COOLANT TEMPERATURE BECAME GREATER THAN TEMPFB

ECT > TEMPFB --------|S Q------------| COUNT UP ATMR2

| |

NEVER----------------|C | --- ELSE ---

|

| SET ATMR2 = 0

(EXCEPT AT POWER-UP

INITIALIZATION)

ATMR3 - TIME SINCE ENTERING RUN MODE

UNDSP = 0 -------------------------| Increment ATMR3

(Run Mode)

20-12

TIMERS - GUF1

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A3CTMR - A3C TRANSITION TIMER (.001 sec)

The A3CTMR measures the time between A3C state changes. If the time is small

(<250 msec), then the Heated Windshield is probably on.

ALWAYS ----------| Increment A3CTMR

A3CTMR is reset to 0 on any A3C transition - (LSTA3C - A3C NOT= 0 in

successive background passes). See A/C Clutch Section.

BAPTMR - TIME SINCE LAST BP SENSOR INTERRUPT (msec)

BP sensor transition -----------------| Reset BAPTMR = 0

(reset occurs in background |

routine. Flag is NEW\_BAP) | --- ELSE ---

|

| Count up

CRKTMR - TIME IN CRANK MODE

This timer indicates time since RPM not equal to zero, and provides a means

for decreasing cranking fuel pulsewidth as a function of time (using FN306).

N = 0 ---------------------------------| Set CRKTMR = 0

(Engine not running |

or stalled) | --- ELSE ---

|

| Increment CRKTMR

20-13

TIMERS - GUF1

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CTATMR - CLOSED THROTTLE UPSTREAM AIR TIMER

(0.125 sec Resolution)

BRIEF DESCRIPTION:

This Timer is used to delay Upstream Air after Closed Throttle Mode is

entered during a Decel.

APT = -1 -----------------------| | Count Up CTATMR

|AND ------| CTAFLG = 1

N > UPRPM2 + UPRPMH ------|S Q--| |

| | --- ELSE ---

N < UPRPM2 ---------------|C |

| CTATMR = 0

| CTAFLG = 0

CTNTMR - CLOSED THROTTLE NEUTRAL TIMER

ECT > CTHIGH --------------------|

|

APT = -1 (CLOSED THROTTLE) ------| | Count up CTNTMR

| | Clip to NIOLD + NIHYS

NDSFLG = 0 (NEUTRAL) ------------|AND ---| Set CTNFLG = 1

| |

N < INLRPM + FN880 --------|S Q--| | --- ELSE ---

| |

N > INLRPM+FN880+INLRPH ---|C | Count down CTNTMR

| Set CTNFLG = 0

| Clip CTNTMR to 0

CTTMR - TIME AT CLOSED THROTTLE

APT = -1 (CLOSED THROTTLE mode) --------| COUNT UP CTTMR

|

| --- ELSE ---

|

| SET CTTMR = 0

20-14

TIMERS - GUF1

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DEBTMR - VEHICLE SPEED COMMAND SWITCH DEBOUNCE TIMER

(msec resolution)

BRIEF DESCRIPTION:

The debounce timer, DEBTMR, prevents the strategy from treating noise or

intermittents as valid switch command inputs.

Registers:

IVSCCS = A/D conversion of the Speed Control Command switch, counts.

IVSCCS\_LST = Previous valid SCCS input.

DEBTMR = SCCS debounce timer, secs.

Calibration Constant:

DEBAMP = Minimum change in IVSCCS to reset the debounce timer.

DEBTIM = Debounce time delay.

|IVSCCS\_LST - IVSCCS| > DEBAMP ------| SET DEBTMR = DEBTIM

ALWAYS ------------------------------| Count down DEBTMR to zero

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TIMERS - GUF1

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DLTMR LOGIC

APT = -1 ---------------------|

(Closed Throttle) |AND ----| DMFLG = 1

| | COUNT UP DLTMR

PERLOAD < FN320A -|S Q ------| |

(Decel) | | --- ELSE ---

| |

PERLOAD > FN320A | | DLTMR = 0

+ HLODH -| | DMFLG = 0

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TIMERS - GUF1

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EDFTMR - ELECTRO-DRIVE FAN TIMER (SEC)

(One Sec Resolution)

This timer routine provides a means of delaying the turn-on of the high speed

fan until after the low speed fan has been on for a minimum amount of time.

EDF DE-ENERGIZED ------------|

(EDF = 1) |OR ---| EDFTMR = 0

| |

CRKFLG = 1 ------------------| | --- ELSE ---

|

| Count Up EDFTMR

FFMTMR - FAM FILTER TIMER (SEC)

The FAM filter timer is a free running timer used as the sample period for

the FAM filter. FFMTMR is reset when entering FAM region, and after each FAM

filter update, as shown in the FAM logic at the end of the Idle Speed Control

chapter.

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TIMERS - GUF1

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HLTMR - HIGH LOAD TIMER

(0.125 sec Resolution)

The HLTMR delays Open Loop fuel control during crowds. Running Closed Loop

fuel during crowds elimiates the need for Upstream Air during those

conditions.

PERLOAD < FN320A -------------|S Q---| HLTMR = 0

| |

PERLOAD > FN320A + HLODH -----|C | --- ELSE ---

|

| Count Up

| HLTMR

HMTMR - TIMER LIMITING UPSTREAM AIR

(1 sec Resolution)

BRIEF DESCRIPTION:

The HMTMR limits the length of time that the air is directed Upstream during

heavy crowds. See Thermactor Chapter.

PERLOAD > UPLOD + UPLODH -|S Q----| Count Up HMTMR

| | Clip to 255

PERLOAD < UPLOD ----------| |

| --- ELSE ---

|

| HMTMR = 0

HWTMR - HEATED WINDSHIELD TIMER (.001 sec)

The HWTMR measures the time at which A3CTMR remains below a threshold value

(<OR= 300 msec). It is used to set the heated windshield flag HWFLG.

ALWAYS ----------| Increment HWTMR

HWTMR is reset to 0 if A3CTMR > 250 msec. See A/C Clutch Section.

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TIMERS - GUF1

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IDLFLG - IDLE WITH TRANSMISSION IN DRIVE

DNDSUP = 1 (DRIVE) ---------------|

|

APT = -1 (CLOSED THROTTLE mode) --|

|AND ---| SET IDLFLG = 1

N < IDLRPM ---------------|S Q----| |

| | --- ELSE ---

N > IDLRPM + IDRPMH ------|C |

| SET IDLFLG = 0

LESTMR1 - LACK OF EGO SWITCHING TIMER (TIME SINCE LAST EGO SWITCH)

EGO-1 SWITCH ----------------| | SET LESTMR1 = 0

|OR ---|

OPEN LOOP FUEL CONTROL-------| | --- ELSE ---

|

| COUNT UP LESTMR1

Additional logic associated with LESTMR1;

LESTMR1 >OR= BYPLES ----------------| SET LEGOFG1 = 1

LOESSW > 0 ---------------|

|AND ----| SET LEGOFG1 = 0

EGO-1 SWITCH -------------|

LESTMR2 - LACK OF EGO SWITCHING TIMER (TIME SINCE LAST EGO SWITCH)

EGO-2 SWITCH ----------------| | SET LESTMR2 = 0

|OR --|

OPEN LOOP FUEL CONTROL-------| | --- ELSE ---

|

| COUNT UP LESTMR2

Additional logic associated with LESTMR2.

LESTMR2 >OR= BYPLES -----------------| SET LEGOFG2 = 1

LOESSW > 0 ----------------|

|AND -----| SET LEGOFG2 = 0

EGO-2 SWITCH --------------|

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TIMERS - GUF1

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LUGTMR - LOM LOAD TRANSITION TIMER

LOAD > FN125 -------------------|

|OR ---| COUNT UP LUGTMR

APT = 1 (WIDE OPEN THROTTLE) ---| | (CLIP AT LUGTIM)

|

| --- ELSE ---

|

LOAD <OR= FN125 ----------------| |

|AND --| SET LUGTMR = 0

LUGSW = 1 ----------------------| |

|

| --- ELSE ---

|

| COUNT DOWN LUGTMR

| (CLIP AT 0)

MFATMR - MANAGED FUEL AIR TIMER

MFACTR >OR= SWTCNT -------------| SET MFAFLG = 1

| COUNT UP MFATMR

APT = 1 (WIDE OPEN THROTTLE) ---|

|

N > MFANHI + MFANHH ------------|

|

N < MFANLO - MFANLH ------------|

|OR --| SET MFAFLG = 0

PERLOAD < MFALL ----------------| | SET MFATMR = 0

|

PERLOAD > MFALH + MFALHH -------|

|

NDSFLG = 0 (NEUTRAL) -----------|

|

MFMFLG = 1 ---------------------|

|

AFMFLG = 1 ---------------------|

|

CFMFLG = 1 ---------------------|

|

BP < MPMNBP --------------------|

|

VSBAR < VSMPG -------| |

|AND ------|

VSTYPE NOT = 0 ------|

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TIMERS - GUF1

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SWTFLG LOGIC FOR MANAGED FUEL AIR TIMER MFATMR

"A" ------------------------------|

|

APT = 0 (PART THROTTLE) ----------|

|

CLOSED LOOP FUEL CONTROL ---------|

|

N > MFANLO -----------------------|

|

N < MFANHI -----------------------|AND ---|

| |OR --| SET SWTFLG = 1

|N - NDBAR| < MFASN --------------| | |

| | | --- ELSE ---

PERLOAD < MFALH ------------------| | |

| | | SET SWTFLG = 0

NDSFLG = 1 (DRIVE) ---------------| |

| |

BP >OR= MPMNBP + MPNBPH ----------| |

| |

VSBAR >OR= VSMPG + VSMPGH --| | |

|OR --| |

VSTYPE = 0 -----------------| |

|

MFAFLG = 1 -------------------------------|

MFACTR LOGIC FOR MANAGED FUEL AIR TIMER MFATMR

SWTFLG = 1 ------------------------| Increment MFACTR

| every EGO switch

|

| --- ELSE ---

|

| Set MFACTR = 0

STARTUP DELAY LOGIC FOR MANAGED FUEL AIR TIMER MFATMR

TCSTRT >OR= CTHIGH ---------|

|AND ---|

ATMR1 >OR= MFATM3 ----------| |

|

CTLOW <TCSTRT < CTHIGH -----| |OR --- "A"

|AND ---|

ATMR1 >OR= MFATM2 ---| | |

|AND --| |

ATMR2 >OR= MFATM5 ---| |

|

TCSTRT <OR= CTLOW ----------| |

|AND ---|

ATMR1 >OR= MFATM1 ---| |

|AND --|

ATMR2 >OR= MFATM4 ---|

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TIMERS - GUF1

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MULTMR - TIME SINCE INCREMENTING LAMMUL

Always -------------------------------------| COUNT UP MULTMR

(Note: MULTMR is periodically set to 0 within

the Open Loop Fuel Logic)

NACTMR - NOT AT CLOSED THROTTLE TIME

APT = 0 (PART THROTTLE mode)-----|

|OR ----| COUNT UP NACTMR

APT = 1 (WIDE OPEN THROTTLE mode)| |

| --- ELSE ---

|

| SET NACTMR = 0

NDDTIM - TIME SINCE NEUTRAL/DRIVE SWITCH STATE CHANGE

NEUTRAL/DRIVE SWITCH STATE CHANGE ------| SET NDDTIM = 0

|

| --- ELSE ---

|

| COUNT UP NDDTIM

NWOTMR LOGIC (NOT AT WIDE OPEN THROTTLE TIMER)

APT = 1 ------------------------| SET NWOTMR = 0

(Wide Open Throttle) |

| --- ELSE ---

|

| COUNT UP NWOTMR

PRGTMR - CANISTER PURGE TIMER

CANISTER PURGE OUTPUT ON --------------| COUNT UP PRGTMR

|

| --- ELSE ---

|

| FREEZE PRGTMR

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TIMERS - GUF1

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PUTMR - TIME SINCE CPU POWER-UP

CPU POWER ON --------------------------------| COUNT UP PUTMR

TSEGRE - ACCUMULATED TIME EGR IS ENABLED

TCSTRT > CTLOW ------------| SET TSEGRE = EGRMPT ('R' = 1)

|

| --- ELSE ---

|

EGR ENABLED ---------------| COUNT UP TSEGRE

(EGREN = 1) | (CLIP AT EGRMPT)

|

| --- ELSE ---

|

| FREEZE TSEGRE

TSLPIP - TIME SINCE LAST PIP

PIP INTERRUPT ---------------------------------| SET TSLPIP = 0

|

| --- ELSE ---

|

| COUNT UP TSLPIP

WCOTMR - A/C CLUTCH WOT CUTOUT TIMER

(0.125 SEC RESOLUTION)

In the calculation below, if TP - RATCH gives a negative value, then that

result should be clipped to zero before calculating FN087.

ACWTMR < FN087 (TP - RATCH) ---------------| SET WCOTMR = 0

|

| --- ELSE ---

|

| COUNT UP WCOTMR

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TIMERS - GUF1

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CHAPTER 21

FAILURE MODE MANAGEMENT

21-1

FAILURE MODE MANAGEMENT - GUF1

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FAILURE MODE STRATEGY

The Failure Mode (FMEM) strategy protects vehicle function from adverse

effects of an EEC component failure. The strategy recognizes open or short

circuit failure for six sensors: MAF, TP, ECT, ACT EVP/EPT, and BP. In

general, if the continuous Self-Test strategy recognizes a failure the FMEM

strategy will execute an alternative vehicle strategy. The alternative

strategy disables logic which relies on realistic sensor values. Some sensor

FMEM strategies also substitute a "safe" value for the bad sensor. A summary

of the alternate strategies is tabulated below.

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

| Sensors |

Alternate Strategy | MAF | TP | ECT | ACT | EGR | BP |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|\_\_\_\_\_|\_\_\_\_|\_\_\_\_\_|\_\_\_\_\_|\_\_\_\_\_|\_\_\_\_|

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

SUPERCHARGE - Not Bypassed | | X | | | | |

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

Adaptive Fuel - No Learning | X | X | X | X | | |

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

Idle Speed - Fixed Duty Cycle | X | X | | | | |

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

EGR - Disabled | X | X | X | X | X | X |

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

Thermactor Air - Bypass | X | X | X | X | | |

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

Decel Fuel Shutoff - Disable | X | X | X | X | X | |

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

Foreground Fuel - Disable | X | | | | | |

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

Managed Fuel Air - Disable | X | | X | X | | |

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

ECAD - Full Speed mode | X | X | X | X | | |

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

EDF - Turn on low speed | | | X | | | |

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

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FAILURE MODE MANAGEMENT - GUF1

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DEFINITIONS

INPUTS

Registers:

- ACT = Air Charge Temperature, deg F.

- AM = Air Mass Flow, lbm/min.

- APT = Part Throttle flag.

- ATMR1 = Time since Engine Startup, sec.

- BAPTMR = Timer indicating time since last BP sensor low to high

transition, seconds.

- C22FIL = Self-Test Register which counts the number of BP sensor

failures, counts.

- C31FIL = Self-Test Register which counts the number of EVP low failures.

- C35FIL = Self-Test Register which counts the number of EVP high failures.

- C51FIL = Self-Test Register which counts the number of ECT low failures.

- C53FIL = Self-Test Register which counts the number of TP-High failures.

It increments by C53UP each time a failure occurs and decrements by one

count each time the sensor data is valid.

- C54FIL = Self-Test Register which counts the number of ACT low failures.

- C61FIL = Self-Test Register which counts the number of ECT high failures.

- C63FIL = Self-Test Register which counts the number of TP-Low failures.

It increments by C63UP each time a failure occurs and decrements by one

each time the sensor data is valid.

- C64FIL = Self-Test Register which counts the number of ACT high failures.

- DEBYMA\_FM = ISC airflow adder for ARCHI when Mass Air Flow sensor fails

(units are lbma/min. same as DEBYMA, but without BP correction).

DEBYMA\_FM is readable in a register for use when calibrating.

- ECT = Engine Coolant Temperature, deg F.

- EOFF = The EGR valve reading when the valve is fully closed in A/D

counts.

- IBAP = Output of BP sensor transfer function FN000, in. mercury.

- IACT = A/D conversion of ACT sensor input, counts.

- IECT = A/D conversion of ECT sensor, counts.

- IEVP = A/D conversion of EVP sensor, counts.

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FAILURE MODE MANAGEMENT - GUF1

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- IMAF = Input Air Meter Reading. A/D counts.

- ITP = Throttle position value from A/D conversion, counts.

- MDELTA = Time between BP SCAP pulses, clock ticks. (1 clock tick = 2.4

usec for 15.0 MHz EEC; 1 clock tick = 3.0 usec fpr 12 MHz EEC)

- N = Engine RPM.

- RATCH = Closed throttle position, counts.

- TCSTRT = Temperature of ECT at cold start-up, deg F.

Bit Flags:

- AFMFLG = Flag indicating that ACT sensor has failed.

- BFMFLG = Flag indicating that the BP sensor has failed. 1 -> failure.

- CFMFLG = Flag indicating that ECT sensor is in/out of range.

- EFMFLG = Flag indicating that EVP EGR sensor has failed. (This flag

performs for both Sonic and PFE EGR.)

- IMFMFLG = Instantaneous mass air flow sensor FMEM flag.

- TFMFLG = Flag indicating that TP sensor has failed.

- UNDSP = Run/Underspeed Flag. (1 = Underspeed (or Crank), 0 = Run).

- WMEGOL = Indicates WRMEGO was 1 at least once.

Calibration Constants:

- ACTFMM = FMEM default value for ACT.

- ACTMAX = Maximum ACT (ACT Open), Counts.

- ACTMIN = Minimum ACT (ACT Shorted), Counts.

- BAPFMM = Default value for BP failure.

- C22LVL = Threshold for BP sensor failure, unitless.

- C31LVL = Threshold for EVP fault, unitless.

- C35LVL = Threshold for (PFE) EVP fault, unitless.

- C51LVL = Threshold for ECT Open fault, unitless.

- C53LVL = Threshold level for recognition of TP-High Failure. When C53FIL

equals (or exceeds) C53LVL, the Self-Test strategy will set an error code

53. NOTE: The value of C53LVL must be equal to 254.

- C54LVL = Threshold for ACT Open fault, unitless.

- C56LVL = Threshold level for fault 56.

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FAILURE MODE MANAGEMENT - GUF1

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- C61LVL = Threshold for ECT Short Fault, unitless.

- C63LVL = Threshold level for recognize of TP-Low failure. When C63FIL

equals (or exceeds) the Self-Test strategy will set an error code 63.

NOTE: The value of C63LVL must be equal to 254.

- C64LVL = Threshold for ACT short fault, unitless.

- C66LVL = Threshold level for fault 66.

- CTHIGH = Hot start minimum ECT, deg F. Range of 100 to 200.

- ECTFMM = FMEM default value for ECT, deg F.

- ECTMAX = Maximum engine ECT, Counts.

- ECTMIN = Minimum engine ECT, Counts.

- EVPMAX = Maximum EGR Valve position, counts.

- EVPMIN = Minimum EGR Valve position, counts.

- FILHYS = Hysteresis term to prevent spurious exit of Failure Mode

strategy.

- FMCTTP = Change in TP if not at idle (as indicated by AM). This

parameter is designed to permit Part Throttle operation.

- FN040(N) = Default ARCHI for failed Mass Air Flow sensor AND TP sensor.

- FN098(ITP-RATCH) = Normalized delta TP, used for MAF sensor failure table

lookup.

-

FN1358 (FN070,FN098) = Table lookup for failed Mass Air Flow Sensor,

replaces ARCHI, units lbma/PIP.

FN070 (N) = Normalized RPM

FN098 (ITP-RATCH) = Normalized delta TP.

- FN703 = ECT/ACT transfer function.

- IDLMAF = Maximum AM at Idle, lb/min.

- MFMHYS = Calibration for IMFMFLG background loop hysteresis, counts.

- OPCLT1 = ATMR1 timed delay to enter closed loop fuel after Cold Start,

sec.

- OPCLT2 = ATMR1 timed delay to enter closed loop fuel after medium start,

sec.

- OPCLT3 = ATMR1 timed delay to enter closed loop fuel after HOT start,

sec.

- OPCLT4 = ATMR2 timed delay to enter closed loop fuel after Cold Start,

sec.

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FAILURE MODE MANAGEMENT - GUF1

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- OPCLT5 = ATMR2 timed delay to enger closed loop fuel after Medium start,

sec.

- PFEHP = Switch to select EGR strategy; 0 = PFE and 1 = Sonic.

- RATIV = Inititializing value for RATCH, typically 250 counts.

- TAPMAX = Maximum valid TP value, counts. (Calibrated by Self-Test Design

Section)

- TAPMIN = Minimum valid TP value, counts. (Calibrated by Self-Test Design

Section)

- TCECT = Time constant for ECT, sec.

- VBPDL1 = Minimum BP sensor frequency, ticks.

- VBPDL2 = Maximum BP sensor frequency, ticks.

- VBPMAX = Maximum BP sensor period measured by BAPTMR, seconds.

- VMAMAX = Maximum MAF sensor reading, counts.

- VMAMIN = Minimum MAF sensor reading, counts.

- VMARPM = Maximum RPM for checking MAF sensor high limit.

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FAILURE MODE MANAGEMENT - GUF1

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OUTPUTS

Registers:

- ACT = Air Charge Temperature, deg F.

- ARCHI = Foreground corrected air charge value.

- ECT = Engine Coolant Temperature, deg F.

- EPTZER = Rolling average of the EPT sensor at Idle, counts.

- EVP = EGR valve position reading in A/D counts.

- IMFMCTR = Provides hysteresis for IMFMFLG, background loop counter,

counts.

- TP = Throttle position, counts.

Bit Flags:

- AFMFLG = Flag indicating that ACT sensor has failed.

- BFMFLG = Flag indicating that the BP sensor has failed. 1 -> failure.

- IMFMFLG = Instantaneous mass air flow sensor FMEM flag.

- CFMFLG = Flag indicating that ECT sensor is in/out of range.

- EFMFLG = Flag indicating that EVP EGR sensor has failed. (This flag

performs for both Sonic and PFE EGR.)

- MFMFLG = Flag indicating that MAF sensor has failed.

- TFMFLG = Flag indicating that TP sensor has failed.

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FAILURE MODE MANAGEMENT - GUF1

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FAILURE RECOGNITION

The FMEM strategy checks the "Continuous Self-Test Code" Filters to ascertain

whether a sensor has failed. If the sensor failure lasts long enough to

trigger a Self-Test Code, the FMEM strategy will substitute an alternate

value and strategy. Until the Self-Test filters exceed their fault

thresholds, the strategy continues to use the last known valid value. The

logic diagram below describes the entire Fault recognition and value

substitution strategy, in general. However, to more effectively use the

Self-Test Fault filters, the actual logic is divided into two sections; the

Fault Flag logic and the Sensor input process logic. (See Specific Sensor

FMEMs.)

SENSOR >OR= SENSOR MIN ---| | SENSOR WITHIN

| | ACCEPTABLE RANGE

C\*\*FIL < C\*\*LVL - FILHYS -| | UPDATE SENSOR INPUT

(sensor high fault | |

filter OK) |AND ------| Failure Flags = 0

| |

SENSOR <OR= SENSOR MAX ---| |

| |

C\*\*FIL < C\*\*LVL - FILHYS -| | --- ELSE ---

(sensor low fault |

filter OK) |

| SENSOR OUTSIDE

CRANK MODE (CRKFLG = 1) -------------| RANGE

(Optional) | SENSOR = INITIAL VALUE

|

| --- ELSE ---

(Fault present for a long time) |

|

C\*\*FIL > C\*\*LVL -----------| | SENSOR OUTSIDE

(sensor high fault) | | RANGE - NOT DUE TO

|OR ------| LOW BATTERY VOLTAGE

C\*\*FIL > C\*\*LVL -----------| | Failure Flags = 1

(sensor low fault) |

| ALTERNATE STRATEGY

| SENSOR = SUBSTITUTED

| VALUE

|

| --- ELSE ---

|

| SENSOR DATA IS NOT

| RELIABLE - DO NOT

| UPDATE UNTIL CHECK

| PROVES VALUE VALID.

21-8

FAILURE MODE MANAGEMENT - GUF1

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MASS AIR FLOW SENSOR FMEM

(Performed during MAF sensor engineering units conversion)

Check for sensor within limits:

MFMFLG = 0 -----------------------|

|

N >OR= VMARPM ---------| |

|OR -------|

IMAF <OR= VMAMAX ------| |AND -----| MAF Sensor output

| | within limits

IMAF >OR= VMAMIN -----------------| |

| --- ELSE ---

|

| Set IMFMFLG = 1

| Set IMFMCTR = MFMHYS

IMFMFLG and IMFMCTR logic:

CRKFLG = 1 ---------------------------------| Set IMFMFLG = 0

(sensor test disabled in crank mode) | Set IMFMCTR = 0

|

| --- ELSE ---

|

IMFMCTR = 0 --------------------------------| Set IMFMFLG = 0

|

| --- ELSE ---

|

| Decrement IMFMCTR

| (clip to zero)

NOTE: This logic provides a calibratible delay after the sensor

returns in range, equal to MFMHYS - 1 background loops,

before exiting FMEM.

ARCHG Calculations:

IMFMFLG = 0 --------------------------------| MAF sensor output

| within limits, use

| normal strategy.

| ARCHG = ARCHFG

|

| --- ELSE ---

MAF Sensor out of limits, but TP sensor OK: |

| FMEM: substitute

| immediately

|

TFMFLG = 0 ---------------------------------| ARCHG = [FN1358(N,TP) +

(TP sensor OK) | (DEBYMA\_FM / (N\*ENGCYL))]

| \* BP/29.9

|

| --- ELSE ---

|

TP sensor failed also: ---------------------| Both TP and MAF failed

| ARCHG = FN040(N)

21-9

FAILURE MODE MANAGEMENT - GUF1

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FAILURE FLAG LOGIC FOR MASS AIR FLOW SENSOR

Performed during continuous self test routines

C66FIL >OR= C66LVL -------------|

|OR ---| MFMFLG = 1

C56FIL >OR= C56LVL -------------| | (failed)

|

| --- ELSE ---

|

C66FIL < C66LVL - FILHYS -------| |

|OR ---| MFMFLG = 0

C56FIL < C56LVL - FILHYS -------| | (sensor OK)

NOTE: Failure Mode recognition using the continuous self test filters

controls MFMFLG. The IMFMFLG controls foreground/background fuel

and ARCHG calculations

21-10

FAILURE MODE MANAGEMENT - GUF1

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BP SENSOR FMEM

(Performed during engineering units conversion)

BPSSW = 0 -------------------| No BP sensor

| Do not do BP FMEM logic or

| IBAP calculations

| BP = KONBP

|

BFMFLG = 0 -----------| | --- ELSE ---

| |

BAPTMR <OR= VBPMAX ---| |

|AND --| IBAP = FN000

VBPDL1 <OR= MDELTA ---| | BP = BAPBAR

|

| --- ELSE ---

|

BFMFLG = 1 ------------------| IBAP = BAPFMM

| BP = BAPBAR

| BAPCNT = 0

| MINTIM2 = CLOCK

|

| --- ELSE ---

|

| Do not update IBAP,BP,or BAPBAR

FAILURE FLAG LOGIC (FOR BP SENSOR)

Continuous self-test

C22FIL < C22LVL - FILHYS ----------| BFMFLG = 0

| (BP Sensor OK)

|

| --- ELSE ---

|

C22FIL >OR= C22LVL ----------------| BFMFLG = 1

| (BP Sensor failed)

21-11

FAILURE MODE MANAGEMENT - GUF1

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TP SENSOR UPDATE

This logic is performed after A/D conversions during all engine modes,

including SELF-TEST. The FMEM strategy checks the continuous Self-Test Code

Filters to ascertain whether the TP sensor failed. If the sensor failure

lasts long enough to trigger a SELF-TEST code, FMEM strategy will infer

throttle position based upon airflow. AM has protective logic in the event

of a load sensor failure. (See the AM calculation contained in this section

and Systems Equation)

The TP sensor Update logic substitutes a function of MAF for a failed TP

sensor. This action permits recognition of the various throttle modes

(Closed, Part or WOT). However, AE fuel will be disabled due to lack of TAR

signal.

The load parameters have protective logic in event of load sensor failure.

(See the BP calculation in the EEC OVERVIEW Chapter.)

PERFORM DURING ENGINEERING UNITS CONVERSION

TFMFLG = 0 ------------|

|AND -------| TP = ITP

ITP >OR= TAPMIN -------| | (TP sensor within

| | acceptable range)

ITP <OR= TAPMAX -------| |

| --- ELSE ---

|

| (TP sensor out of limits)

CRANK MODE (CRKFLG = 1) ---| | TP = RATCH

|OR ----|

AM < IDLMAF ---------------| | --- ELSE ---

|

| (TP sensor out of limits

| but NOT due to Low

| battery voltage)

| RATCH = RATIV

|

TFMFLG = 1 ------------------------| TP = RATCH + FMCTTP

|

| --- ELSE ---

|

| (TP sensor data unreliable

| DO NOT update until

| confident data valid)

| NO CHANGE TO TP

21-12

FAILURE MODE MANAGEMENT - GUF1

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FAILURE FLAG LOGIC (FOR TP SENSOR)

CONTINUOUS SELF-TEST CHECK

C63FIL > C63LVL ---------------|

|OR -----| TFMFLG = 1

C53FIL > C53LVL ---------------| |

| --- ELSE ---

|

C63FIL < C63LVL - FILHYS ------| | TFMFLG = 0

|AND ----|

C53FIL < C53LVL - FILHYS ------|

21-13

FAILURE MODE MANAGEMENT - GUF1

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ECT SENSOR UPDATE

If the ECT Sensor fails, the FMEM strategy will substitute ACT (during CRANK)

or a default value (during ENGINE RUNNING Mode). The Normal engine strategy

will not recognize a need for Cold Weather Fuel compensation.

PERFORM DURING ENGINEERING UNITS CONVERSION

CFMFLG = 0 ----------|

|

IECT <OR= ECTMAX ----|AND ---| ECT = ROLAV

| | (FN703,TCECT)

| |

IECT >OR= ECTMIN ----| | --- ELSE ---

|

CRANK MODE -------------| |

(CRKFLG = 1) | |

| | ECT = ROLAV

TCSTRT >OR= CTHIGH -| | | (ACT,TCECT)

|AND-| |

ATMR1 < OPCLT3 -----| | |

|OR-|

TCSTRT < CTHIGH ----| | |

|AND-| |

ATMR1 < OPCLT2 -----| |

| --- ELSE ---

|

CFMFLG = 1 ------------------| ECT = ROLAV(ECTFMM,TCECT)

|

| --- ELSE ---

|

| DO NOT UPDATE ECT

FAILURE FLAG LOGIC (FOR ECT SENSOR)

CONTINUOUS SELF-TEST

C61FIL > C61LVL ---------------|

|OR ----| CFMFLG = 1

C51FIL > C51LVL ---------------| |

| --- ELSE ---

C61FIL < C61LVL - FILHYS ------| |

|AND ---| CFMFLG = 0

C51FIL < C51LVL - FILHYS ------|

21-14

FAILURE MODE MANAGEMENT - GUF1

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ACT SENSOR UPDATE

If the ACT Sensor fails, the FMEM Strategy will use the initial value for ACT

(by preventing an Update) until the failure is recognized as bona fide. An

ACT failure will cause incorrect airflow calculation (with some degradation

in fuel control).

PERFORM DURING ENGINEERING UNITS CONVERSION

AFMFLG = 0 -----------|

|

IACT <OR= ACTMAX ------|AND -------| ACT = FN703 (IACT)

| |

IACT >OR= ACTMIN ------| | --- ELSE ---

|

WMEGOL = 0 ------------------------| ACT = ECT

(Start up Open Loop) |

| --- ELSE ---

|

AFMFLG = 1 ------------------------| ACT = ACTFMM

|

| --- ELSE ---

|

| DO NOT UPDATE ACT

FAILURE FLAG LOGIC (FOR ACT SENSOR)

CONTINUOUS SELF-TEST

C64FIL < C64LVL - FILHYS ------|

|AND --| AFMFLG = 0

C54FIL < C54LVL - FILHYS ------| |

| --- ELSE ---

C64FIL > C64LVL ---------------| |

|OR ---| AFMFLG = 1

C54FIL > C54LVL ---------------|

21-15

FAILURE MODE MANAGEMENT - GUF1

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PFE SENSOR UPDATE (PFEHP = 1)

The EPT FMEM Logic checks the A/D value of the EPT sensor and compares it to

the permissible range of values (as defined by the Self-Test Strategy).

1. If the value is within the allowed range, the strategy clears a flag

(which permits normal EGR strategy execution).

2. If the sensor value is outside the allowed range long enough for

Self-Test to recognize and flag an error code, the strategy will force

the valve to close.

PERFORM DURING ENGINEERING UNITS CONVERSION

EFMFLG = 0 ----------|

|AND ----| Reinitial EPTZER

Previous EFMFLG = 1 -| | EPTZER = 650

FAILURE FLAG LOGIC (for PFE EGR Sensor)

CONTINUOUS SELF-TEST

APT NOT= -1 -------------------| Do NOT Do Failure

(Not Closed Throttle) | Mode Check

| --- ELSE ---

C31FIL > C31LVL -----| |

|OR ------| EFMFLG = 1

C35FIL > C35LVL -----| |

| --- ELSE ---

C31FIL < C31LVL - FILHYS -| |

|AND-| EFMFLG = 0

C35FIL < C35LVL - FILHYS -|

21-16

FAILURE MODE MANAGEMENT - GUF1

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EVP SENSOR UPDATE (PFEHP = 0)

The EVP sensor failure Mode strategy will force the EGR valve to close and

will have no adverse impact on Spark or Fuel.

PERFORM DURING ENGINEERING UNITS CONVERSION

EFMFLG = 0 -------|

|AND ----| EVP = IEVP

IEVP <OR= EVPMAX -| |

| | --- ELSE ---

IEVP >OR= EVPMIN -| |

|

EFMFLG = 1 ----------------| EVP = EOFF

|

| --- ELSE ---

|

| Do NOT update

| EVP

FAILURE FLAG LOGIC (for EVP Sensor)

CONTINUOUS SELF-TEST

C31FIL > C31LVL -----|

|OR ------| EFMFLG = 1

C35FIL > C35LVL -----| |

| --- ELSE ---

C31FIL < C31LVL - FILHYS -| |

|AND-| EFMFLG = 0

C35FIL < C35LVL - FILHYS -|

21-17

MALFUNCTION INDICATOR LIGHT - GUF0

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MALFUNCTION INDICATOR LIGHT

OVERVIEW

The MIL warning system was implemented to comply with California

regulations for the 1988 model year. To gain early field experience a pilot

MIL exposure is planned for selected car lines in 1987.

The warning system will be activated whenever the EEC module is using an

alternate strategy due to the failure of any of the monitored sensors. The

malfunction light, located in the instrument cluster, will flash at a

calibratable frequency (1/[2 \* MILTM1]) as long as the fault is present or

will be on full time if the EEC system is operating in hardware LOS.

MILTMR, a .125 second timer, is used to control the MIL logic. MILTMR

is allowed to count up only when self-test is not in progress, when not in

CRANK mode, and when an FMEM fault is present. It is reset to zero

otherwise. When MILTMR excedes a calibratable delay time (FMDTM), the light

will flash.

Additional features of the MIL are:

1. It is disabled during VIP tests.

2. It is turned on continuously in CRANK mode until a PIP is detected as a

bulb check. The bulb check can be disabled by setting MILLIM equal to

zero.

DEFINITIONS

INPUTS

Registers:

- C41FIL = Continuous Self-Test fault counter which counts the number of

EGO1 sensor failures.

- C91FIL = Continuous Self-Test fault counter which counts the number of

EGO2 sensor failures (Stereo EGO systems only).

- MILTMR = Timer used to record the time that an FMEM fault has been

present, sec.

Bit Flags:

- AFMFLG = Flag indicating the ACT sensor has failed.

- BFMFLG = Flag indicating that the BP sensor has failed: 1 -> failure.

- CFMFLG = Flag indicating the ECT sensor has failed.

- CRKFLG = Flag indicating status of CRANK MODE (1 -> in CRANK MODE, 0 ->

not in CRANK MODE).

- DISABLE\_NO\_START = Flag set to 1 when KOEO VIP test is entered. Disables

bulb check when KOEO test is exited.

21-18

MALFUNCTION INDICATOR LIGHT - GUF0

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- EFMFLG = Flag indicating the EVP/EPT sensor has failed.

- FIRST\_PIP = Flag set to 1 when the first PIP is detected. Reset to zero

on power-up or stall.

- IGNFL = Flag indicating the state of the Ignition Switch (1 -> switch on;

0 -> switch off).

- MFMFLG = Flag indicating the MAP sensor has failed.

- STIFLG = Flag indicating the state of STI (1 -> low, Self-Test requested;

0 -> high, Self-Test not requested).

- TFMFLG = Flag indicating the TP sensor has failed.

Calibration Constants:

- C41LVL = Threshold for EGO1 fault, unitless.

- C91LVL = Threshold for EGO2 fault, unitless (Stereo EGO only).

- FMDTM = Time delay after fault is detected to start flashing MIL, sec.

To disable MIL, set equal to 255.

- MILLIM = Software switch to enable/disable bulb check, unitless (1 ->

enable; 0 -> disable).

- MILTM1 = MIL flashing on/off period, sec. Flashing frequency = 1/[2 \*

MILTM1].

OUTPUTS

Registers:

- MILTMR = See above.

21-19

MALFUNCTION INDICATOR LIGHT - GUF0

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PROCESS

MIL LOGIC

STIFLG = 1 ------------------| DO NOT DO MIL LOGIC

(Self-Test requested) |

|--- ELSE ---

CRKFLG = 1 ------------| |

| |

IGNFL = 1 -------------| |

|AND -| DO BULB CHECK

DISABLE\_NO\_START = 0 --| | TURN MIL ON

| |

FIRST\_PIP = 0 ---------| |

| |

MILLIM = 1 ------------| |--- ELSE ---

|

MILTMR <OR= FMDTM -----------| TURN MIL OFF

|

|--- ELSE ---

|

| FLASH MIL

| TOGGLE EVERY MILTM1 SEC.

MILTMR LOGIC

STIFLG = 0 -------------|

|

CRKFLG = 0 -------------|

|

EGO FAILURE -------| |AND -| COUNT UP MILTMR

| | |

AFMFLG = 1 --------| | |--- ELSE ---

| | |

BFMFLG = 1 --------| | | MILTMR = 0

| | |

CFMFLG = 1 --------| |

|OR -|

EFMFLG = 1 --------|

|

MFMFLG = 1 --------|

|

TFMFLG = 1 --------|

21-20

CHAPTER 22

KEEP ALIVE MEMORY

22-1

KEEP ALIVE MEMORY - GUE0

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KEEP ALIVE MEMORY (KAM) QUALIFICATION TEST

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 B80 HEX

KAMQB BC9 HEX

KAMQC BF6 HEX

The KAM qualification test is normally performed each background loop when

the computer is running.

22-2

KEEP ALIVE MEMORY - GUE0

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DEFINITIONS

INPUTS

Registers:

- EPTZER = Rolling average of the EPT sensor at Idle, counts.

- ISCKAM1 = Idle Speed KAM IPSIBR cell 1.

- ISCKAM2 = Idle Speed KAM IPSIBR cell 2.

- ISCKAM3 = Idle Speed KAM IPSIBR cell 3.

- ISKSUM = Idle Adaptive airflow check sum.

- KAMQA = KAM Qualification test register 1.

- KAMQB = KAM Qualification test register 2.

- KAMQC = KAM Qualification test register 3.

Calibration Constants:

- VEPTHL = Self-Test lower Idle limit (defined in Self Test Strategy).

(Upper limit for KEYON EPTZER)

- VEPTLL = Self-Test upper Idle limit (defined in Self Test Strategy).

(Lower limit for KEYON EPTZER.)

OUTPUTS

Registers:

- EPTZER = See Inputs above.

- ISCKAM1 (2,3) = See Inputs above.

- ISKSUM = See Inputs above.

- KAMQA (B,C) = See Inputs above.

- KWUCTR = KAM warm\_up counter. Stores number of warm\_ups in KAM. Reset

to zero if KAM is corrupted. (battery disconnect, etc.)

Bit Flag:

- VIP\_KAM = Indicates KAM invalid for VIP.

22-3

KEEP ALIVE MEMORY - GUE0

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KAM QUALIFICATION TEST LOGIC

Performed each background loop.

KAMQA = 10101010 BINARY---|

|

KAMQB = 11000110 BINARY---|AND ------| SET KAMOK = 1

| | ASSUME KAM DATA IS VALID

KAMQC = 01110101 BINARY---| | ALL STRATEGY REFERENCES TO

| KAM WILL USE KAM DATA.

|

| --- ELSE ---

|

| CLEAR KAMOK = 0

| SET VIPKAM = 1

| ASSUME KAM DATA IS BAD.

| INITIALIZE ALL KAM

| LOCATIONS USED IN THE

| STRATEGY.

| WRITE THE SPECIAL

| BINARY PATTERNS TO KAM:

| KAMQA = 10101010 BINARY

| KAMQB = 11000110 BINARY

| KAMQC = 01110101 BINARY

|

| SET LTMTB1rc = 0.5

| SET LTMTB2rc = 0.5

| SET CHKSUM = 22016

| SET ISCKAMn = 0.0

| SET ISKSUM = 0.0

| SET EPTZER = 650

| KWUCTR = 0

22-4

KEEP ALIVE MEMORY - GUE0

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ADAPTIVE FUEL TABLE VALIDATION PROCEDURE (POWER UP SEQUENCE)

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;

|(SUM OF ALL ADAPTIVE | ASSUME THE ADAPTIVE FUEL

FUEL KAM CELLS) | DATA IN KAM IS VALID.

- CHKSUM| <OR= 1 ----------------| CHKSUM = SUM OF ADAPTIVE FUEL

| CELLS

|

| --- 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 LTMTB1rc = 0.5

| SET LTMTB2rc = 0.5

| 2) SET CHKSUM = 22016

| SET KWUCTR = 0

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.

22-5

KEEP ALIVE MEMORY - GUE0

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ISCKAM QUALIFICATION

(Done during Power-up sequence)

|ISCKAM0 + ISCKAM1 | | Assume the ISCKAMs are valid

+ ISCKAM2 + ISCKAM3 |-------| NO ACTION TAKEN

- ISKSUM| <OR= 1 Bit ---| | 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

22-6

KEEP ALIVE MEMORY - GUE0

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KAM QUALIFICATION (EPTZER)

During Power-up sequence, check the range of EPTZER.

EPTZER > VEPTLL --------| | EPTZER is OK

|AND --|

EPTZER < VEPTHL --------| | --- ELSE ---

|

| EPTZER is NOT OK

| Set EPTZER = 650

22-7

KEEP ALIVE MEMORY - GUE0

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22-8

CHAPTER 23

ROM IDENTIFICATION CODE

23-1

ROM IDENTIFICATION CODE - GUB0

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ROM IDENTIFICATION CODE

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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1988

ELECTRONIC FUEL INJECTION (SFI-MA2)

SELF-TEST STRATEGY BOOK

STRATEGY LEVELS "GUF1"

(VIP-60C)

FOR USE WITH EEC-IV MODULE

COMMENTS OR QUESTIONS SHOULD BE DIRECTED TO TOM MELVILLE ON

EXTENSION 76851

T. R. MELVILLE

SELF TEST DESIGN

POWERTRAIN ELEC-

TRONIC DEVELOPMENT

DEPARTMENT

FEBRUARY 12, 1987

REVISED 2/19/87

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30-1 TO 30-3 ERROR CODE DESCRIPTION

31-1 TO 31-6 VIP PARAMETER DICTIONARY

CHAPTER 24

EEC-IV SELF-TEST OVERVIEW

24-1

EEC-IV SELF-TEST OVERVIEW

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EEC-IV Self-Test Overview

Self-Test is divided into two types of testing, one which occurs

only at the "request" of the service technician (the "on-demand"

tests), and one which continuously surveys the system during

normal operating modes (the "continuous" tests). The on-demand

portion is further divided into "engine-running" and "engine-off"

tests.

The engine-off portion of the test "looks" for normal engine-off

sensor readings. Any out-of-limits, open, or shorted sensor

input is signalled by sending a service code. If all sensors are

within expected ranges, a "11" code is issued. Codes are

repeated to make it easier for the technician to verify the code

sequence. After the service codes, a single pulse occurs to

signal the technician that the next set of codes will be from the

continuous test. Continuous test codes are issued using the same

format as the service codes, and are also repeated. Finally, the

test enters the "output state test", which simply turns actuator

outputs "on" and "off" based on "requests" from the technician

(these consist of depressing the throttle and letting it return

to closed position). STO is also turned "on" and "off" in this

mode, so that the technician knows the state in which the other

outputs should be.

The engine-running portion signals that it has begun by sending

an "identification" code (=no. of cylinders/2). It then tests

inputs and EEC-IV-controlled functions by forcing various

conditions and "looking" for expected engine response to them. A

single output pulse is sent to signal the test operator to

"goose" the throttle, during which inputs are tested for dynamic

response. If no RPM change is detected, a special code (code 77)

will be sent to indicate that the test was incorrectly performed.

(No other 70-series codes will be sent except codes 74 and 75.)

When the "goose" test has completed, service codes are sent.

The "continuous" self-test monitors inputs during normal

operation, and stores information in keep-alive memory (KAM) when

errors are detected. In general, checks are made only for

open-or short-circuits. In a few cases, "irrational" sensor

readings are noted (eg: if engine coolant temperature changes

from cold to warm to cold again, an error is noted.) When the

number of errors in a given time period exceeds a calibratable

threshold, that code is stored in KAM. As a special diagnostic

aid, in engine-off conditions and when STI=GND and the on-demand

(running) test has completed, codes will be stored every time an

error is detected, and STO will be turned on as long as the fault

is present. This is designed to help isolate intermittent faults

(eg.: the test operator can "wiggle" the harness and connectors,

and STO will indicate when the intermittent fault recurs). Codes

which indicate faults that have not recurred in 20 engine warm-up

cycles are "erased". Codes can also be manually "erased" by

opening up STI while codes are being output in the engine-off

mode.

24-2

EEC-IV SELF-TEST OVERVIEW

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EEC-IV SELF-TEST BLOCK DIAGRAMS

"ON-DEMAND" TESTS (STI=GND)

ENGINE-OFF: ENGINE-RUNNING:

!-------------! !--------------!

! ENGINE-OFF ! ! I.D. CODE !

! TEST ! ! !

!-------------! !--------------!

| |

v v

!-------------! !--------------!

! SERVICE ! ! ENGINE !

! CODE ! ! RUNNING !

!-------------! ! TEST !

| !--------------!

v v

!-------------! !--------------!

! SINGLE ! ! SINGLE !

! PULSE ! ! PULSE !

!-------------! !--------------!

| |

v v

!-------------! !--------------!

! CONTINUOUS ! REQUIRES ! DYNAMIC !

! TEST ! MECHANIC----->! RESPONSE !

! CODES ! INTERVENTION ! TEST !

!-------------! | !--------------!

| | |

v | v

!-------------! | !--------------!

! OUTPUT !<--------| ! SERVICE !

! PULSING ! ! CODES !

!-------------! !--------------!

|

v

NOTE: TEST CODES CAN BE !--------------!

MANUALLY ERASED BY ! 2 MIN. DELAY !

UN-GROUNDING STI DURING !(TIMING CHECK)!

CODE OUTPUT (ENGINE-OFF). !--------------!

|

v

!--------------!

REQUIRES----->! "WIGGLE" !

MECHANIC ! TEST !

INTERVENTION !--------------!

"CONTINUOUS" TESTS (STI=OPEN)

ENGINE-OFF: ENGINE-RUNNING:

!-------------! !---------------!

! "WIGGLE" ! ! CONTINUOUS !

! TEST ! ! TEST MODE !

!-------------! !---------------!

24-3

EEC-IV SELF-TEST OVERVIEW

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

24-4

CHAPTER 25

SELF-TEST ENTRY/EXIT LOGIC

25-1

SELF-TEST ENTRY/EXIT LOGIC

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EFI SELF-TEST ENTRY LOGIC

ENGINE OFF AND VSC STATIC TEST

TIME SINCE POWER-UP > 4 SEC---------| !------------!

| ! ENTER !

SELF-TEST REQUESTED-----------------| AND--------! ENGINE OFF !

(STI INPUT=LOW) | ! TEST !

| !------------!

ENGINE-OFF TEST ENABLED-------------|

|

IN CRANK MODE-----------------------|

IN CRANK MODE-----------------------|

| !------------!

STI INPUT = HIGH--------------------| ! ENTER !

| AND--------! ENGINE-OFF !

VSTYPE = 2--------------------------| ! VSC TEST !

| !------------!

TS\_PIP > 1 SECOND-------------------|

|

PUTMR < 10 SECONDS------------------|

|

ON\_STATE = 1------------------------|

ENGINE RUNNING AND VSC DYNAMIC TEST

TIME SINCE POWER-UP > 6 SEC---------| !----------------!

| !. ENTER VSC !

SELF-TEST REQUESTED-----------------| ! DYNAMIC TEST !

(STI INPUT=LOW > 1 SEC ) | AND--------!.DISABLE ENGINE !

| ! RUNNING TEST !

VSTYPE = 2--------------------------| !----------------!

|

RUN MODE----------------------------|

|

VSC DYNAMIC TEST ENABLED------------|

|

ON\_STATE = 1------------------------|

|

PUTMR < VVSCET----------------------|

--------------ELSE-----------

!-------------!

TIME SINCE POWER-UP > 6 SEC---------| !.ENTER ENGINE!

| AND--------! RUNNING TEST!

SELF-TEST REQUESTED-----------------| !.DISABLE VSC !

(STI INPUT =LOW > 1 SEC ) | ! DYNAMIC TEST!

| !-------------!

RUN MODE----------------------------|

|

ENGINE-RUNNING TEST ENABLED---------|

25-2

SELF-TEST ENTRY/EXIT LOGIC

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EFI SELF-TEST ENTRY LOGIC (CONT'D)

CONTINUOUS TEST

!-------------!

TIME SINCE POWER-UP > 4 SEC---------| ! RUN !

| AND--------! CONTINUOUS !

NOT IN ENGINE-OFF OR----------------| ! TEST !

ENGINE-RUNNING TEST OR | !-------------!

VEHICLE SPEED CONTROL TEST |

|

IN UNDERSPEED OR RUN MODE----------|

25-3

SELF-TEST ENTRY/EXIT LOGIC

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EFI SELF-TEST EXIT LOGIC

IN ENGINE-OFF TEST----------------------| !---------------!

| !EXIT & DISABLE !

IN UNDERSPEED/RUN MODE------| | AND----! ENGINE-OFF !

|OR---------| ! TEST !

SELF TEST NOT REQUESTED-----| !---------------!

|

IN ENGINE RUNNING TEST------------------| !---------------!

| ! EXIT & DISABLE!

SELF-TEST NOT REQUESTED--------|OR------| AND----!ENGINE-RUNNING !

| ! TEST !

TRLOAD = 3 OR 4--------| | !---------------!

|AND----|

NDSFLG = 1 (DRIVE)-----|

VSC EXIT LOGIC

IN ENGINE-OFF VSC TEST------------------| !---------------!

| ! EXIT AND !

STI INPUT = LOW--------| |AND-----!DISABLE ENGINE !

|OR--------------| !OFF VSC TEST !

IN UNDERSPEED/RUN MODE-| !---------------!

IN ENGINE RUNNING VSC TEST--------------| !---------------!

| ! EXIT AND !

VSBAR > 2 MPH--------| |AND-----!DISABLE ENGINE !

| | !RUNNING VSC !

OFF\_BUT = 1----------| | ! TEST !

|OR----------------| !---------------!

STI=HIGH (UNGRDED)---|

|

BRAKE APPLIED--------|

25-4

CHAPTER 26

ENGINE-OFF SEQUENCE

26-1

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE OFF SEQUENCE

-----------

( ENTER )

-----------

|

v

!-----------!

! TURN !

! STO OFF !

!-----------!

|

/-----------\

/ DO MODULE \ FAIL

/ INSTRUCTION \--------------------|

\ TEST / |

\ / |

\-----------/ |

|PASS v

/--------\ FAIL !--------------!

/ TEST \--------------->! TURN STO ON !

\ KAM/RAM / ! CONTINUOUSLY !

\--------/ ! AND EXIT !

|PASS !--------------!

/---------\ FAIL !--------------!

/ TEST ROM \-------------->! SET !

\ / ! SERVICE CODE !

\---------/ !--------------!

|PASS |

| |

v |

!--------------------------! |

!SEND TWO 2MS PULSES ON STO! |

!2MS BETWEEN PULSES ! |

!--------------------------! |

| |

|----------->|<---------------------------|

| v

| /---------\

| NO / PUTMR > \

|------\ 4 SEC /

\---------/

|

|----------->|YES

| v

| /---------\

| /FUEL PUMP \

| NO / TURNED OFF \

|-----\ (TIMED OUT) /

\ /

\---------/

|YES

v

(B)

26-2

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE OFF SEQUENCE CONT'D

(B)

|

v

/-----------\ !-----------------!

/ TEST \ FAIL ! SET !

/ A/D'S AND \------------>! SERVICE CODE(S) !

\ SWITCHES / !-----------------!

\ / |

\-----------/PASS |

|<------------------------------|

v

/---------\ FAIL !-----------------!

FAIL /---------\ / TEST OCC \-------------->! SET !

|<-/FUEL PUMP \<-|\ / ! SERVICE CODE(S) !

| \CKT TEST\*\* / | \---------/ !-----------------!

| \---------/ | | PASS |

| | |------|<------------------------------|

| |

| |PASS!------------------------!

| |--->! . SEND SERVICE CODES !

v ^ !------------------------!

!--------! | |

! SET ! | v

!SERVICE !---| !--------------------------!

!CODE(S) ! ! . SEND SEPARATOR PULSE !

!--------! !--------------------------!

|

v

/---------\ YES !--------------!

/ VIPKAM =1 \------------->! SEND CODE 15\*!

\ ? / !--------------!

\---------/ |

| NO |

v |

!-------------------! |

! . SEND CODES FROM ! |

! CONTINUOUS TEST ! |

!-------------------! |

|<----------------------------|

v

!----------------------------!

! . ENTER OUTPUT TEST MODE !

!----------------------------!

\*See Normal Strategy KAM qualification test logic for setting

of VIPKAM=1. Code 15 is output during continuous code

output.

\*\* NOTE: FUEL PUMP CKT TEST MUST BE PERFORMED AFTER OCC TEST

26-3

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

KAM/RAM TEST

-----------

( ENTER )

-----------

|

v

!-----------------------------------!

! SET POINTER TO BEGINNING OF !

! EXT\_RAM !

!-----------------------------------!

|-------------------->|

| v

| !-------------------------!

| ! SAVE REGISTER CONTENTS !

| !-------------------------!

| |

| v

| !-------------------------!

| ! WRITE HEX AAAA TO !

| ! REGISTER !

| !-------------------------!

| |

| v

| !-------------------------!

| ! READ REGISTER CONTENTS !

| !-------------------------!

| |

| v

| /-------------\

| / IS CONTENTS \ NO

| \ = AAAA /-------------|

| \-------------/ |

| | YES |

| v |

| !------------------------! |

| ! WRITE HEX 5555 TO ! |

| ! REGISTER ! |

| !------------------------! |

| | |

| v |

| !------------------------! |

| ! READ REGISTER CONTENTS ! |

| !------------------------! |

| | |

| v |

| /---------\ |

| / IS \ NO |

| / CONTENTS \------------->|

| \ = 5555 / |

| \ / v

| \---------/ !-----------!

| | YES !TURN STO ON!

| v ! EXIT !

| (A) !-----------!

26-4

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

KAM/RAM TEST CONTINUED

(A)

|

| v

| !------------------!

| ! RESTORE REGISTER !

| ! CONTENTS !

| !------------------!

!-----------! |

!INCREMENT ! |

! POINTER ! |

!-----------! |

^ |

| NO /-------------\

|<-----------/ END OF 2K \

\ EXT-RAM ? /

\-------------/

| YES

|

v

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

( GO TO ROM\_TEST )

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

26-5

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

READ-ONLY MEMORY TEST (ROM)

-----------

( ENTER )

-----------

|

v

!----------------------------------!

! DO A 16-BIT ADDITION OF CONTENTS !

! OF ALL ROM LOCATIONS RETAINING !

! THE 16 LEAST SIGNIFICANT BITS !

! OF THE RESULT. !

!----------------------------------!

|

v

/---------\ NO !---------!

/ SUM=0 ? \-------->! SET !

\ / ! CODE 15 !

\---------/ !---------!

| YES |

|<------------------|

v

-----------

( EXIT )

-----------

NOTE: A specific location will contain checksum

such that sum of correct ROM contents

(including checksum)=0.

Location is labeled "Rom To" or "Rom Total".

26-6

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE-OFF A/D TESTS

-----------

( ENTER )

-----------

|

v

/---------\

/ TEST ECT \

\ /

\---------/

|

v

/---------\

/ TEST BP \

\ /

\---------/

|

v

/---------\

/ TEST TP \

\ /

\---------/

|

v

/---------\

/ TEST ACT \

\ /

\---------/

|

v

/---------\

/ TEST MAF \

\ /

\---------/

|

v

( A )

26-7

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE-OFF A/D TESTS (CONT'D)

( A )

|

/---------\

/ TEST EGR \

\ /

\---------/

|

v

/---------\

/ TEST \

\ ACC/NDS /

\---------/

|

v

/--------\

/ TEST \

\ IVPOWER /

\--------/

|

v

/---------\

/ TEST PSPS \

\ /

\---------/

|

v

-----------

( EXIT )

-----------

26-8

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ECT SENSOR TEST

-----------

( ENTER )

-----------

|

v

/---------\ NO !---------!

/ IECT >= \---------->! CODE 61 !---|

\ ECTMIN ? / !---------! |

\---------/ |

| YES |

|<------------------------------|

v

/---------\ NO !---------!

/ IECT <= \---------->! CODE 51 !---|

\ ECTMAX ? / !---------! |

\---------/ |

| YES |

v |

/---------\ |

/ VIECT1 \ NO !---------! |

/ <= IECT <= \--------->! CODE 21 !-->|

\ VIECT2 ? / !---------! |

\ / |

\---------/ |

| YES |

|<------------------------------|

v

-----------

( EXIT )

-----------

PARAMETER TYPICAL CALIB-

NAME DESCRIPTION RATION VALUE

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

ECTMIN MIN. ENGINE OFF ECT 40 COUNTS

ECTMAX MAX. ENGINE OFF ECT 935 COUNTS

VIECT1 MIN. COOLANT TEMP 717 COUNTS

VIECT2 MAX. COOLANT TEMP 63 COUNTS

26-9

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

BP SENSOR TEST

-----------

( ENTER )

-----------

|

v

/---------\NO

/BPSSW = 1 \---------------------->|

\ / |

\---------/ |

|YES |

v |

/---------\ NO |

/ BPTMR<= \----------------| |

\ VBPMAX ? / | |

\---------/ | |

| YES | |

v | |

/---------\ v |

/ VPBDL1 \ NO !---------! |

/ <= MDELTA<= \--------->! CODE 22 ! |

\ VBPDL2 / !---------! |

\ / | |

\---------/ | |

| YES | |

|<---------------------|<------|

v

-----------

( EXIT )

-----------

PARAMETER TYPICAL CALIB-

NAME DESCRIPTION RATION VALUE

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

VBPMAX MAX. TIME SINCE LAST BP UPDATE 15 MS

VBPDL1 MIN BP DURING ENGINE OFF VIP 1200 TICKS

VMDEL2 MAX BP DURING ENGINE OFF VIP 1563 TICKS

(FOR 15 MHZ)

RELATED INITIALIZATION PARAMETERS

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

26-10

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

TP SENSOR TEST

-----------

( ENTER )

-----------

|

v

/---------\ NO !---------!

/ ITP >= \---------->! CODE 63 !-->|

\ TAPMIN ? / !---------! |

\---------/ |

| YES |

| |

v |

/---------\ NO !---------! |

/ ITP <= \---------->! CODE 53 !-->|

\ TAPMAX ? / !---------! |

\---------/ |

| YES |

v |

/---------\ |

/ VTAP1 \ NO !---------! |

/ <=ITP <= \--------->! CODE 23 !-->|

\ VTAP2 ? / !---------! |

\ / |

\---------/ |

| YES |

|<------------------------------|

v

-----------

( EXIT )

-----------

PARAMETER TYPICAL CALIB-

NAME DESCRIPTION RATION VALUE

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

TAPMIN MIN. TP SENSOR READING 40 COUNTS

TAPMAX MAX. TP SENSOR READING 990 COUNTS

VTAP1 MIN. ENGINE-OFF THROTTLE POS 150 COUNTS

VTAP2 MAX. ENGINE-OFF THROTTLE POS 250 COUNTS

RELATED INITIALIZATION PARAMETERS

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

26-11

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ACT SENSOR TEST

-----------

( ENTER )

-----------

|

v

/---------\ NO !---------!

/ IACT >= \---------->! CODE 64 !---|

\ ACTMIN ? / !---------! |

\---------/ |

| YES |

| |

v |

/---------\ NO !---------! |

/ IACT <= \---------->! CODE 54 !---|

\ ACTMAX ? / !---------! |

\---------/ |

| YES |

v |

/---------\ |

/ VIACT1 \ NO !---------! |

/ =>IACT => \--------->! CODE 24 !-->|

\ VIACT2 ? / !---------! |

\ / |

\---------/ |

| YES |

|<------------------------------|

v

-----------

( EXIT )

-----------

PARAMETER TYPICAL CALIB-

NAME DESCRIPTION RATION VALUE

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

ACTMIN MIN ACT (ACT SHORTED) 40 COUNTS

ACTMAX MAX ACT (ACT OPEN) 935 COUNTS

VIACT1 MIN. CHARGE TEMP (ENGINE-OFF) 717 COUNTS

VIACT2 MAX. CHARGE TEMP (ENGINE-OFF) 63 COUNTS

RELATED INITIALIZATION PARAMETERS

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

26-12

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

MAF SENSOR TEST

--------

( ENTER )

--------

|

v

/--------\ NO

/ IMAF => \----------------->|

\ VMAFO1 / |

\--------/ |

| YES |

v |

/--------\ YES !-------! |

/ IMAF => \----->!CODE 56!-->|

\ VMAMAX / !-------! |

\--------/ |

| NO |

v |

!--------! |

! CODE 26! |

!--------! |

| |

|<-----------------------|

v

--------

( EXIT )

--------

26-13

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGR SENSOR TEST

(PFE)

-----------

( ENTER )

-----------

|

v

/---------\ YES -----------

/ PFEHP =2 \-------->( EXIT )

\ / -----------

\---------/

| NO

v (SONIC)

/---------\

/ PFEHP=1 \ NO /---------\ NO

\ ? /---------------------->/ PFEHP=0 \-------------------|

\---------/ \ ? / |

| YES \---------/ |

| | YES |

| v |

v /---------\ YES !---------! |

/---------\ / IEVP <= \--->! CODE 31 !--->|

/ IEPT<= \ YES !---------! \ EVPMIN / !---------! |

\ EPTMIN /---->! CODE 31 !----| \---------/ |

\---------/ !---------! | | NO |

| NO | v |

v | /---------\ YES !---------! |

/---------\ | / IEVP >= \--->! CODE 35 !--->|

/ IEPT >= \ YES !---------! | \ EVPMAX / !---------! |

\ EPTMAX /---->! CODE 35 !--->| \---------/ |

\---------/ !---------! | | NO |

| NO | v |

v | /---------\ YES !---------! |

/---------\ | / IEVP < \--->! CODE 32 !--->|

/ VEPTLL \ NO !---------! | \ VEVPLL ? / !---------! |

/ <= IEPT <= \--->! CODE 34 !--->| \---------/ |

\ VEPTHL / !---------! | | NO |

\ / | v |

\---------/ | /---------\ YES !---------! |

| YES | / IEVP > \--->! CODE 34 !--->|

|<-------------------------| \ VEVPHL ? / !---------! |

v \---------/ |

----------- | NO |

( EXIT ) |<------------------------|

----------- v

-----------

( EXIT )

-----------

26-14

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ACC/NDS INPUT TEST

------

( ENTER )

------

|

v

NO /--------\

|<------ /TRLOAD = \

| \ 3 OR 4 /

| \--------/

| | YES

| v

| /--------\ NO !-------!

| /IS NDSFLG \------->!CODE 67!

| \ = 0 / !-------!

| \--------/ |

| | YES |

|------------>|<-----------------|

|

v

/--------\ NO !-------!

/IS A3C=0? \------->!CODE 79!

\ / !-------!

\--------/ |

| YES |

|<-----------------|

|

v

------

( EXIT )

------

26-15

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

IVPWR INPUT TEST

----------

( ENTER )

----------

|

v

/---------\

/ IIVPWR \ YES !---------!

\ < VKYPWR /--------->! CODE 19 !

\---------/ !---------!

| NO |

|<--------------------|

v

---------

( EXIT )

---------

NOTE: This test is designed to check continuity of

the IVPWR circuit internal to the EEC module.

It is not to be used as a battery voltage

check. If the IVPWR circuit opens up, an

incorrect fuel pulse width will result.

COUNTS = IIVPWR \*.1786 \* 1023

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

VREF

IIVPWR = VREF \* COUNTS

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

.1786 \* 1023

RECOMMENDED VKYPWR VALUE: 200 COUNTS (5.47 VOLTS)

26-16

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

POWER STEERING PRESSURE SWITCH TEST

----------

( ENTER )

----------

|

|

v

/---------\ NO

/ PSPSHP=1 ?\----->( GO TO NEXT TEST )

\ /

\---------/

| YES

v

/-----------\

/ POWSFG = 1 \ YES !---------!

/ ? \-------->! CODE 52 !----|

\ (SWITCH OPEN) / !---------! |

\ / |

\-----------/ |

| NO |

|<-------------------------------|

v

-----------

( EXIT )

-----------

26-17

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUT CIRCUIT CHECK (OCC)

The OCC uses special module hardware to test certain output channels for open

circuits/shorted drivers. The hardware consists of a resistor- divider network

which is fed back into an A/D channel. The test begins by turning off all

outputs in the network. Outputs are then turned on and off, one at a time, and

the A/D channel is used to determine the change in voltage associated with each.

A voltage change smaller than expected causes a fault code to be registered.

The output channels, their associated fault codes, and expected voltage change

calibration parameters for each appear below.

OC# | CIRCUIT FUNCT. | CAL. PARAMETER | ERROR CODE

\_\_\_\_|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_\_\_\_

4 | EVR | OCCDT4 | 84

9X,NU 7 | FP | OCCDT7 | 87

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

1 | AM2 1) | OCCDT1 | 81

2 | AM1 1) | OCCDT2 | 82

LU 4 | EVR 2) | OCCDT4 | 84

5 | CANP 3) | OCCDT5 | 85

7 | FP | OCCDT7 | 87

9 | CCO 4) | OCCDT9 | 89

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

1 | AM2 1) | OCCDT1 | 81

2 | AM1 1) | OCCDT2 | 82

3 | HEDF 5) | OCCDT3 | 83

MU,GU 4 | EVR 2) | OCCDT4 | 84

5 | CANP | OCCDT5 | 85

7 | FP | OCCDT7 | 87

8 | EDF 6) | OCCDT8 | 88

MU ONLY 9 | LUS 10) | OCCDT9 | 89

| SCVNT 11) | OCCDTA | 81

| SCVAC 11) | OCCDTB | 82

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

1 | BOOST | OCCDT1 | 81

2 | HEDF | OCCDT2 | 82

4 | EGR-S/O | OCCDT4 | 84

1U 6 | FP | OCCDT6 | 86

7 | EDF | OCCDT7 | 87

8 | CCO | OCCDT8 | 88

26-18

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

OC# |CIRCUIT FUNCT. | CAL. PARAMETER | ERROR CODE

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

1 | SCVNT | OCCDT1 | 81 \*

2 | SCVAC | OCCDT2 | 82 \*

3 | HEDF 8) | OCCDT3 | 83

NQ 4 | EVR | OCCDT4 | 84

5 | CANP | OCCDT5 | 85

7 | FP | OCCDT7 | 87

8 | EDF | OCCDT8 | 88

9 | LUS 4) | OCCDT9 | 89

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

1 | SCVNT | OCCDT1 | 81 \*

2 | SCVAC | OCCDT2 | 82 \*

3 | HEDF | OCCDT3 | 83

CJ 4 | EVR 2) | OCCDT4 | 84

5 | CANP | OCCDT5 | 85

6 | AM-1 1) | OCCDT6 | 86

7 | FP | OCCDT7 | 87

8 | EDF | OCCDT8 | 88

9 | LUS/CCO 9) | OCCDT9 | 89

NOTES:

FP - FUEL PUMP

EVR - ELECTRONIC VACUUM REG.

1) ONLY IF THRMHP=1

2) ONLY IF PFEHP=0 OR 1

3) ONLY IF CANPHP-1 OR 2

4) ONLY IF TRANSW=0 OR 2

5) ONLY IF HEDFHP=1

6) ONLY IF EDFHP=1

7) ONLY IF TRANSW=0 (AXOD)

8) ONLY IF MTXSW=0 (ATX)

9) ONLY IF TRANSW=0(AXOD) OR =2 (A4LD)

10) ONLY IF TRTYPE=0 (AXOD) MU ONLY

11) ONLY IF VSTYPE=2 (Veh. Spd. Cont.)

\* Functioned during VSC Self Test Only

26-19

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

OCC TEST STRUCTURE

-----------

( ENTER )

-----------

|

!-------------------------!

!DE-ENERGIZE ALL OUTPUTS !

!(EXCEPT EDF)\*\*

! . OC=1 !

!-------------------------!

| NOTE: HEDF TEST MUST

!----------------! IMMEDIATELY FOLLOW

! DELAY 50 MSEC. ! EDF TEST

!----------------!

| \*\*ONLY WHEN EDF IS PRESENT

|---------------------->|

| !---------------------!

| ! SAVE IOCC IN OCCSAV !

| !---------------------!

| |

| !-----------------------!

| !ENERGIZE\* OUTPUT #(OC) !

| !-----------------------!

| | \*EXCEPT OC #8(EDF)\*\*WHICH

| !----------------! SHOULD BE DE-ENERGIZED

| ! DELAY 50 MSEC. ! DURING THIS STEP

| !----------------!

| |

| /-------------\ !-------------!

| / ABS[OCCSAV- \ NO ! SET !

| / IOCC] >= \-------->! APPROPRIATE !

| \ OCCDT(OC) COUNTS/ ! FAIL CODE !

| \ ? / ! (SEE TABLE) !

| \-------------/ !-------------!

| | YES |

| |<------------------------|

| v

(A) /--------\ YES !-----------!

/IS THIS \------->! DELAY !

\ EDF ? / !VDLEDF-SEC !

\--------/ !-----------!

|<------------------|

NO |

v

/--------\ YES !-----------!

/ IS THIS \------->! DELAY !

\ HEDF ? / !VDLHED-SEC !

\--------/ !-----------!

|<------------------|

N0 |

v

(B)

26-20

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

OCC TEST STRUCTURE

(B)

(A) |

^ v

| !--------------------------!

| !DE-ENERGIZE OUTPUT #(OC) !

| !--------------------------!

| |

| !----------------!

| ! DELAY 50 MSEC. !

!----------! !----------------!

! OC= OC+1 ! |

!----------! /---------\

| NO / IS \

|<---------------/ OC= LASTOC ?\

\ /

\ /

\---------/

| YES

v

-----------

( EXIT )

-----------

26-21

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

OCC PARAMETER DEFINITIONS

RANGE

NAME | DESCRIPTION | UNITS | MIN MAX | BASE

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

OC | OUTPUT CIRCUIT # | - | 0 9 | -

OCCSAV | SAVED OCC A/D |COUNTS | 0 1023 | -

IOCC | OCC A/D |COUNTS | 0 1023 | -

OCCDTx(1-9) | MIN A/D CHANGE |COUNTS | -1023 1023 | 36

26-22

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

FUEL PUMP CIRCUIT TEST

--------

( ENTER )

--------

|

v

NO /--------\

|<------------/ IS V\_ \

| \FPMFLG=1? /

| \--------/

| |YES

| v

| YES /--------\

|<------------/IS CODE \

| \ 87 SET? /

| \--------/

| |NO

| v

| !------------------!

| !1)TURN FP "ON" !

| !2)DELAY V\_FPMDLY !

| !------------------!

| |

| v

| /--------\ NO !---------!

| / IS FPM \-------->! CODE 96 !

| \ HIGH ? / !---------!

| \--------/ |

| |YES |

| |<------------------|

| v

| !------------------!

| !1)TURN FP "OFF" !

| !2)DELAY V\_FPMDLY !

| !------------------!

| |

| v

| /--------\ NO !----------!

| / IS FPM \-------->! CODE 95 !

| \ LOW ? / !----------!

| \--------/ |

| | YES |

|----------------->|<------------------|

v

--------

( EXIT )

--------

26-23

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

KAM QUALIFICATION TEST

PERFORMED EACH BACKGROUND LOOP

KAMQA= 10101010 BINARY----| | .SET KAMOK =1

| | .ASSUME KAM DATA IS VALID

KAMQB= 11000110 BINARY----| AND-----| .ALL STRATEGY REFERENCES

| | TO KAM WILL USE RAM DATA.

KAMQC= 01110101 BINARY----| |

| ---ELSE---

|

| .CLEAR KAMOK =0 & SET

| VIPKAM =1

| .ASSUME KAM DATA IS BAD.

| .INITIALIZE ALL KAM

| LOCATIONS USED IN THE

| STRATEGY.

| .WRITE THE SPECIAL BINARY

| PATTERNS TO KAM:

| KAMQA= 10101010 BINARY

| KAMQB= 11000110 BINARY

| KAMQC= 01110101 BINARY

| .SUBSTITUTE THE KAM INITIAL

| VALUES FOR ALL STRATEGY

| REFERENCES TO KAM.

|

| NOTE:

| VIPKAM INITIALIZED TO 0

| ON POWER-UP.

26-24

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUT TEST MODE

In this mode, normal outputs, EDF or HEDF can be turned on/off based on operator

requests.

NORMAL OUTPUTS ON/OFF LOGIC --------------------------- Move throttle part

mid-range, then release to turn on/off normal outputs.

EDF ON/OFF LOGIC ---------------- With STO high, move throttle past mid-range

and hold until Code 10 is displayed on Star Tester (approx. 10 sec.), then

release throttle to turn "on" EDF and normal outputs. To turn "off" outputs

move throttle past mid-range and then release.

HEDF ON/OFF LOGIC ----------------- With STO high, move throttle past mid-range

and hold until Code 10 and then Code 20 is displayed on Star Tester (approx. 15

sec.), then release throttle to run "on" HEDF and normal outputs. To turn "off"

outputs move throttle past mid-range and then release.

NORMAL OUTPUTS

1) AM1 2) EDF 3) HEDF

1) AM2 EVR ISC

CANP

5) SCVAC STO

SCVNT WAC

1) FUNCTION ONLY WHEN THRMHP=1

2) FUNCTION ONLY WHEN EDFHP=1

3) FUNCTION ONLY WHEN HEDFHP=1

4) FUNCTION ONLY WHEN TRTYPE=0 - MU ONLY

5) FUNCTION ONLY WHEN VSTYPE=2

26-25

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUT TEST MODE (CONT'D)

For Application with EDF or HEDF

1. RESET OUTTMR & VIP TIMER 2. CLEAR VLFNON & VHFN ON

PRIOR TO ENTRY

----- /--------\ YES -----

( ENTER )------->/ARE CODES \------>( EXIT )

----- / BEING \ -----

\ OUTPUTTED?/

\ /

\--------/

| NO

|<---------------|

v

/--------\ NO /--------\ NO /--------\ NO

/ ITP > \-------->/IS REQFLG \-------->/IS OUTTMR \----->|

\ VTAP5 / ^ ^ \ SET ? / ^ \=> 10 MIN / |

\--------/ | | \--------/ | \--------/ |

|YES | (B) | YES | | YES |

v | v | | |

!-------! | /--------\NO | | |

!. SET ! | / ITP <= \---| | |

!REQFLG ! | \ VTAP6 / | |

!-------! | \--------/ | |

| | |YES v |

v | | !----------! |

/-------\YES | v !TURN ALL ! |

/ARE OUT- \---| /--------\YES !ACTUATORS ! |

\PUTS ON? / /ARE OUT- \-------->!"OFF" IN- ! |

\-------/ \PUTS ON? / !CLUDING ! |

| NO \--------/ !EDF & HEDF! |

v |NO !----------! |

(A) | | |

v | |

!---------! YES/--------\ | |

!TURN "ON"!<----/IS "VLFN \ | |

! EDF ! \ON"FLG SET/ | |

!---------! \--------/ | |

| |NO | |

|--------------->| | |

!---------! YES/--------\ | |

!TURN "ON"!<----/IS "VHFN \ | |

! HEDF ! \ON"FLG SET/ | |

!---------! \--------/ | |

| |NO | |

|--------------->| | |

!---------------! !-------------! |

!TURN "ON" !---->!.CLEAR VLFNON! |

!REGULAR OUTPUTS! !VHFNON&REQFLG! |

!---------------! !.SET OUTTMR=0! |

!-------------! |

----- !---------! | |

( EXIT )<-----!SET VIP !<---------------------------|

----- !TMR =0 !

!---------!

26-26

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUT TEST MODE (CONT'D)

For Application with EDF or HEDF

(A)

|

v

!---------------!

!ALLOW VIP-TMR !

! TO RUN !

!---------------!

|

/--------\ NO

/IS HEDFHP \-----------|

\ =1 ? / |

\--------/ | /--------\ N0

| YES |---->/IS EDFHP \----->(B)

v | \ =1? /

/---------\NO | \--------/

/IS VIPTMR >\----------| | YES

\ VHFNTM / v

\---------/ /--------\NO

|YES /IS VIPTMR \-----------|

v \> VLFNTM / |

/---------\NO \--------/ |

/IS "VHFNON"\---------| |YES |

\ =0? / | v |

\---------/ | /--------\NO |

|YES | /IS VLFNON \---------->|

v | \ =0 ? / |

!-----------------! | \--------/ |

!.SET "VHFNON"=1 ! | |YES |

!.SET "VLFNON"=0 !----->| v |

!OUTPUT CODE 20 ! | !--------------! |

!-----------------! | !.SET VLFNON=1 !-------->|

| !OUTPUT CODE 10! |

| !--------------! |

v v

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

( EXIT ) ( EXIT )

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

26-27

ENGINE-OFF SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

26-28

CHAPTER 27

ENGINE-RUNNING SEQUENCE

27-1

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE-RUNNING

TEST STRUCTURE

-----------

( ENTER )

-----------

|

!---------------------!

! ENGINE-RUNNING !

! TEST INITIALIZATION !

!---------------------!

|

/--------------\

/HIGH RPM ISC \

\ TEST /

\--------------/

|

/---------------\

/ A/D AND \

\ SWITCH TESTS /

\---------------/

|

/-----------------\

/ FUEL AND \

\ THERMACTOR TESTS /

\-----------------/

|

/---------\

/ EGR \

\ TEST /

\---------/

|

/----------\

/ LOW RPM \ |---------->|<---------|

\ ISC TEST / | v |

\----------/ | NO /-----------\ |

| | |<-/IS CYLINDER \ |

| | | /BALANCE TEST \ |

| | | \ REQUESTED ? / |

| | | \ / |

| | | \-----------/ |

!--------------------! | | | YES |

! SEND SERVICE CODES !------>| | v |

!--------------------! | /-----------\ |

| / DO CYLINDER \ |

!-------------------! | \ BALANCE TEST/ |

! 2 MINUTE DELAY !<---------| \-----------/ |

! FOR TIMING CHECK ! | |

!-------------------! v |

| !----------! |

/---------\ ---- ! CYLINDER ! |

/ WIGGLE \--->(EXIT) ! BALANCE !---->|

\ TEST / ---- ! SERVICE !

\---------/ !----------!

27-2

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGOBAR FILTER AND STATE FLAGS

IEGO is filtered in EGOBAR (side) -where side =left or right on

stereo systems, left only on mono systems. Time constant for

EGOBAR is VTCEGO (a calibratible parameter). EGOSTE (side) is

the resultant ego state flag, determined as follows:

Non-shared ego{EGOBAR (side) > 855 counts-->EGOSTE (side)=lean(1)

{EGOBAR (side) <=855 counts-->EGOSTE (side)=rich(0)

Shared ego/STI{EGOBAR (side) > 425 counts-->EGOSTE (side)=lean(1)

{EGOBAR (side) <=425 counts-->EGOSTE (side)=rich(0)

27-3

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

DELAY LOGIC CLARIFICATION:

DELAY VDLY(x) MEANS:

!----------!

! SET !

! VIPTMR=0 !

!----------!

|

|<-------------|

v |

/---------\ YES |

/ VIPTMR < \--------|

\ VDLY(x) ? /

\---------/

| NO

|

v

CONTINUE

TIMER LOGIC CLARIFICATION:

"RESTART VIPTMR" MEANS:

SET VIPTMR=0

27-4

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE-RUNNING INITIALIZATION

N0 /-------\ -----------

|-----/VDISFM = \<----( ENTER )

| \ 0? / -----------

| \-------/

| |YES /--------------------\ !-----------!

| | /IS ANY OF THE FOLLOW- \YES !OUTPUT CODE!

| |--->/ING FMEMFLG SET =1? \----->!98 AND THE !

| \*\MFMFLG,TFMFLG,AFMFLG,OR / !CORRESPOND-!

| \ CFMFLG / !ING FMEM !

| \--------------------/ !FAULT CODE !

| | NO !-----------!

|--------------------------->| |

\*MAF FMEM FLAG IN GX | ------

| ( EXIT )

v ------

!----------------------------------!

! .LAMBSE1=LAMBSE2=VRLAM(OPEN LOOP)!

! .SPARK ADVANCE =VIPSPK !

! .KNOCKEABLE = 0 (DISABLE KTS !

! PULSES !

! .EVRDC = 0 !

! .AM1, AM2 AND CANP "OFF" !

! .DE-ACTIVATE DECELL FUEL SHUTOFF !

! .TURN WAC "OFF" (A/C OFF) !

! .KAMRF1=KAMRF2=KAMREF=1.0 !

! .ENABLE AE THROUGHOUT TEST !

! .DSDRPM = VISCN !

! .DISABLE TRANSIENT FUEL !

! .SET TCDESN=VTCDSN WHEN VTCDSN !

! NOT = 0 !

! .SET CODES 74,75 & 52 !

! .ENABLE SELF-TEST IEPT FILTER: !

! FIEPT=(1=VFIEPT)=FIEPT+VFIEPT= !

! IEPT !

! .DISABLE ADAPTIVE FUEL !

! .SET KPSIND = VPSIND !

! .SET KPSINU = VPSINU !

! .SET PSIBRM = VSIBRM !

! .SET PSIBRN = VSIBRN !

! .SET FN860 = V860 !

! .SET FN820B = V820A !

! .SET FN824 = 1.0 !

!----------------------------------!

|

v

(A)

27-5

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE-RUNNING INITIALIZATION (CONT'D)

(A)

|

v

NOTE: USE "ENGCYL" TO !------------------!

SELECT PROPER ENGINE ! SEND ENGINE I.D. !

ID CODE. ! CODE !

ID CODE= # OF CYL/2 !------------------!

| --WAIT HERE UNTIL PULSING

v IS COMPLETE

--------

( EXIT )

--------

27-6

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

HIGH RPM ISC TEST

--------

( ENTER )

--------

|

v

!-----------------------------!

! DO VIP DESIRED RPM !

! CALCULATION !

!-----------------------------!

|

v

!------------!

!DELAY VISDL1!

!------------!

|

NO /---------------------------------\

|--------/ (VISCN+ISUBND)>RPM>(VISCN-ISUBND) \

| \ ? /

| \---------------------------------/

| | YES

v v

!-----------! !--------------------!

!SET CODE 12!---------->!.FIX DC (OPEN LOOP) !

!-----------! !.IGNORE DSDRPM CALC.!

!--------------------!

|

v

---------

( EXIT )

---------

27-7

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE-RUNNING

A/D TEST STRUCTURE

-----------

( ENTER )

-----------

|

v

/---------\

/ TEST ECT \

\ /

\---------/

|

/---------\

/ TEST TP \

\ /

\---------/

|

/---------\

/ TEST ACT \

\ /

\---------/

|

/---------\

/ BRAKE \

\ ON/OFF /

\---------/

|

/---------\

/ PSPS \

\ /

\---------/

|

/---------\

/ TEST MAF \

\ /

\---------/

|

-----------

( EXIT )

-----------

27-8

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ECT SENSOR TEST

-----------

( ENTER )

-----------

|

v

/---------\

/ VIECT3 \ NO !---------!

/ <=IECT <= \---------->! CODE 21 !

\ VIECT4 ? / !---------!

\ / |

\---------/ |

| YES |

|<----------------------|

v

----------

( EXIT )

----------

PARAMETER TYPICAL CALIBRATION

NAME DESCRIPTION VALUE

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

VIECT3 MIN. COOLANT TEMP (ENGINE-ON) 235 COUNTS

VIECT4 MAX. COOLANT TEMP (ENGINE-ON) 63 COUNTS

RELATED INITIALIZATION PARAMETERS

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

27-9

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

TP SENSOR TEST

-----------

( ENTER )

-----------

|

v

/---------\

/ VTAP3 \ NO !---------!

/ <=ITP <= \--------->! CODE 23 !

\ VTAP4 ? / !---------!

\ / |

\---------/ |

| YES |

|<---------------------|

v

-----------

( EXIT )

-----------

PARAMETER TYPICAL CALIB-

NAME DESCRIPTION RATION VALUE

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

VTAP3 MIN. THROTTLE POSITION 150 COUNTS

VTAP4 MAX. THROTTLE POSITION 250 COUNTS

(CALIB. DEP)

RELATED INITIALIZATION PARAMETERS

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

27-10

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ACT SENSOR TEST

-----------

( ENTER )

-----------

|

v

/---------\

/ VIACT3 \ NO !---------!

/ <=IACT <= \---------->! CODE 24 !

\ VIACT4 ? / !---------!

\ / |

\---------/ |

| YES |

|<----------------------|

v

-----------

( EXIT )

-----------

PARAMETER TYPICAL CALI-

NAME DESCRIPTION BRATION VALUE

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

VIACT3 MIN. CHARGE TEMP. (ENGINE-ON) 670 COUNTS

VIACT4 MAX. CHARGE TEMP. (ENGINE-ON) 63 COUNTS

IF IN AIR CLEANER 760 COUNTS

RELATED INITIALIZATION PARAMETERS

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

27-11

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

BRAKE ON/OFF TEST

NO /--------\ --------

|<-----------/ VB1SW \<---( ENTER )

| \ = 1 / --------

| \--------/

| | YES

v v

!-------! /---------\

! CLEAR ! NO / BIHP=1 \

! CODES !<------\ ? /

!74 & 75! \---------/

!-------! |

| | YES

| v

| /---------\ !--------!

| / BIFLG=1 \ YES ! CLEAR !

| /(BRAKE ON \----->! CODE 74!

| \ BOO HIGH) ? / !--------!

| \ / |

| \---------/ |

| | |

| | NO |

| v |

| !----------! |

| !CLEAR CODE! |

| ! 75 ! |

| !----------! |

| | |

|---------------->|<----------------|

v

---------

( EXIT )

---------

NOTE: This test is run continuously from

I.D. code output to service code

output (including "Goose" test).

27-12

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

PSPS TEST

--------

( ENTER )

--------

|

v

/---------\NO

/ VPSSW = 1 \------------->|

\ / |

\---------/ |

| |

/---------\ NO |

/ PSPSHP=1? \------------->|

\ ? / |

\---------/ |

| YES |

| |

/-------------\YES !----------!

/PSPS CHANGED \----->! CLEAR !

\ STATE ? / ! CODE 52 !

\-------------/ !----------!

| NO |

|<-------------------|

v

--------

( EXIT )

--------

NOTE: TEST TO BE PERFORMED JUST AFTER THE "ENGINE I.D.

PULSE BY TURNING STEERING WHEEL 1/4 TO 1/2 TURN

THEN RELEASING.

27-13

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

MAF SENSOR TEST

--------

( ENTER )

--------

|

|

v

/----------------\ YES !--------!

/IMAF => VMAFR2 OR \-------->!CODE 26 !

\ IMAF <= VMAFR1 / !--------!

\----------------/ |

| NO |

| |

|<----------------------|

|

v

--------

( EXIT )

--------

27-14

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO SWITCHING TEST

(STEREO)

---------

( ENTER )

---------

| !-------------!

v !IF NUMEGO=1 ! !----------------!

/---------\ YES !SET CODE 42 &! !.RAMP FUEL LEAN !

/ NBAR >= \---->!IF NUMEGO=2 !----->! VIPLR1 !

\ VNMIN / !.SET CODES 42! ^ !.CLIP AT LEAN !

\---------/ !& 92 ! | ! LIMIT LEQV !

| NO !.START VIPTMR! | !----------------!

| !-------------! | |

| | v

| | /----------\ YES

| | / EGOSTE1=1 \------|

| | \ LEAN ? / |

| | \----------/ |

v | | NO v

-------------- !----------! | | !---------!

( EXIT ENGINE ) ! CONTINUE !--->| |<------! CLEAR !

RUNNING TEST ! RAMPING ! | ! CODE 42 !

------------- !----------! v !---------!

^ /----------\YES

| / EGOSTE2=1 \------|

| \ LEAN ? / |

| \----------/ |

| | NO v

| | !---------!

| NO |<------! CLEAR !

| | ! CODE 92 !

| v !---------!

/----------\ YES /----------\

/ VIPTMR >= \<--------/IS 42 OR 92 \

\ VIPTM3 / \ PRESENT /

\----------/ \----------/

| | NO

v v

!--------------! ( A )

!STORE CODE(s) !

!WHICH DID NOT !

! CLEAR !

!--------------!

|

v

(AA)

27-15

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO SWITCHING TEST (CONT'D)

!-----------------!

!IF NUMEGO=1 SET !

!CODE 41 & IF ! !------------------!

(A)------>!NUMEGO=2 THEN ! !.RAMP FUEL RICH AT!

!SET CODES 41 & 91!------>! VIPRR1 !

!START VIPTMR ! ^ !.CLIP AT RICH !

!-----------------! | ! LIMIT REQV !

| !------------------!

| |

|--------------------------->|

| ^ v

| | /---------\ YES

| | / EGOSTE1=0 \-------|

| | \ RICH ? / |

| | \---------/ |

| | | NO |

| !-----------! | v

| !CONTINUE ! | !----------!

| !RAMPING ! |<-----!CLEAR CODE!

| !ZERO VIPTMR! | ! 41 !

| !-----------! | !----------!

| ^ v

| | /---------\ YES

| | / EGOSTE2=0 \-------|

| | \ RICH ? / |

| | \---------/ |

| | | NO |

| | | v

| | | !----------!

| | |<-----!CLEAR CODE!

| |N0 | ! 91 !

| | | !----------!

| | |

/---------\ YES /---------\ YES/---------\

/ VIPTM >= \<--/IS LAMBSE \<-/IS 41 OR 91\

\ VIPTM4 / \ =< REQV ? / \ PRESENT ? /

\---------/ \---------/ \---------/

|NO | NO

v v

!-------------! -----------------

(AA)<---!STORE CODE(s)! ( EXIT TO NEXT TEST )

!WHICH DO NOT ! -----------------

! CLEAR !

!-------------!

!--------------! !----------! ----------------

(AA)--->!SET LAMBSE1 & !---->! DELAY !--->( EXIT TO EGR TEST )

!LAMBSE2=VRLAM ! ! VDLY8 ! ----------------

!--------------! !----------!

27-16

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

AIR TEST

(C) (C)

^ ^

|NO |NO

/--------\ YES /--------\ -----

/VAIRFL=1 \<-------/THRMHP=1? \<--------( ENTER )

\ / \ / -----

\--------/ \--------/

| YES

v

!------------!

!IF NUMEGO=1 !

!SET CODE 44 !

!& IF NUMEGO=!

!2 THEN ! !----------! !-------------!

!SET CODES 44!---->!RAMP FUEL !----->!AIR UPSTREAM,!

!& 94 START ! !RICH AT ! !AM1 & AM2 !

! VIPTMR ! !VIPRR1 ! ! BOTH ON !

!------------! !FOR VDLY1 ! !-------------!

!----------! |

|---------------------->|

| v

| /---------\ YES

| /EGOSTE1=1 \------|

| \ (LEAN) ? / |

| \---------/ |

| | NO |

| | !---------!

| |<------! CLEAR !

| | ! CODE 44 !

| | !---------!

| v

| /---------\ YES

| /EGOSTE2=1 \----->|

| \ (LEAN) ? / |

| \---------/ |

| NO | NO |

| | !---------!

| |<------! CLEAR !

| | ! CODE 94 !

| | !---------!

| |

/---------\ YES /----------\

/VIPTMR > \<---------/IS 44 OR 94 \

\ VIPTM2 / \ PRESENT /

\---------/ \----------/

| YES | NO

v v

!-----------------! ( B )

!STORE CODES WHICH!

! DID NOT CLEAR !

!-----------------!

|

v

( C )

27-17

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

AIR TEST (CONT'D)

( B )

|

v

!-----------------------!

!.AIR DOWN STREAM,AM1 !

! ON, AM2 OFF ! /--------\NO

!. START VIPTMR ! / VTABFL=1 \--->(C)

!-----------------------! |-------->\ /

| | \--------/

|--------------->| | |

| v | v

| /---------\ | !---------------!

| /EGOSTE1 OR \ YES | !AIR UPSTREAM & !

| /EGOSTE2 = 0 \------- !BYPASSED,AM1 !

| \ (RICH) ? / ^ ! OFF, AM2 ON !

| \ / | !DELAY VDLY2 !

| \---------/ | ! SEC !

| | NO | !---------------!

| | !--------! |

| | !SET CODE! |

| | ! 45 ! |

| | !--------! |

| | | v

| NO /----------\ YES | /-----------\ YES

|<--------/ VIPTMR >= \------>| / EGOSTE1 OR \----|

\ VATMR2 / \ EGOSTE2 =0 ?/ |

\----------/ \-----------/ |

| |

v |

!----------! |

!SET CODE !---->|

! 46 ! v

!----------! ( C)

( C )

|

!--------------! !-----------! --------

!SET LAMBSE1 & !-------->!DELAY VDLY8!------>( EXIT )

!LAMBSE2=VRLAM ! !-----------! --------

!BOTH AM1 & AM2!

! OFF !

!--------------!

27-18

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGR SYSTEM TEST

(PFE/SONIC)

(PFE)

---------

( ENTER )

---------

|

v

/---------\ YES -----------

/ PFEHP =2 \-------->( EXIT )

\ / -----------

\---------/

| NO

v (SONIC)

/---------\

/ PFEHP=1 \ NO /---------\ NO

\ ? /--------------------->/ PFEHP=0 \--------------------|

\---------/ \ ? / |

| YES \---------/ |

| | YES |

| v |

v /---------\ YES !---------! |

/---------\ / IEVP <= \---->! CODE 31 !--->|

/ FIEPT <= \YES !--------! \ EVPMIN ? / !---------! |

\ EPTMIN /---->!CODE 31 !----| \---------/ |

\---------/ !--------! | | NO |

| | v |

| NO | /---------\ YES !---------! |

v | / IEVP >= \---->! CODE 35 !--->|

/---------\ | \ EVPMAX ? / !---------! |

/ FIEPT >= \ YES !--------! | \---------/ |

\ EPTMAX /---->!CODE 35 !--->| | NO |

\---------/ !--------! | v |

| | /---------\ YES !---------! |

| NO | / IEVP < \---->! CODE 32 !--->|

v | \ VEVPLL ? / !---------! |

/---------\ | \---------/ |

/ FIEPT < \ YES !--------! | | NO |

\ VEPTRL /---->!CODE 32 !--->| v |

\---------/ !--------! | /---------\ YES !---------! |

| | / IEVP > \---->! CODE 34 !--->|

| NO | \ VEVPHL ? / !---------! |

v | \---------/ |

/---------\ | | NO |

/ FIEPT > \ YES !--------! | v |

\ VEPTRH /---->!CODE 34 !--->| ( B ) ( EXIT )<-----|

\---------/ !--------! |

| |

| NO |

v v

(A) ---------

( EXIT )

---------

27-19

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGR SYSTEM TEST (CONT'D)

(A)

|

v

!----------------------!

!.SET VIPTMR=0 !

!.SAVE FIEPT -> FEPTSV !

!----------------------!

|

|------------>|

| v

| !----------------------!

| !.RAMP EGRDC AT VEGRAT !

| ! START FROM VDCMIN TO !

| ! VDCMAX. !

| !.EGRDC=VDCMIN + !

| ! VEGRAT\*VIPTMR !

| !----------------------!

| |

| |

| v

| /---------\

| / FEPTSV- \ YES

| / FIEPT > \----|

| \ VEPTDL ? / |

| \ / |

| \---------/ |

| | NO |

| v |

| NO /---------\ |

|-------/ EGRDC >= \ |

\ VDCMAX ? / |

\---------/ |

| YES |

| |

| |

v |

!----------! |

! CODE 33 ! |

!----------! |

| |

| |

|<----------|

v

!---------------!

!.SET EGRDC=0 !

!.SET VIPTMR=0 !

!---------------!

|

|

v

---------

( EXIT )

---------

27-20

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

( B )

|

v

!---------------------!

!.SET VIPTMR =0 !

!.SAVE IEVP -> IEVPSV !

!---------------------!

|

|------------>|

| v

| !----------------------!

| !.RAMP EGRDC AT VEGRAT !

| ! START FROM VDCMIN TO !

| ! VDCMAX. !

| !.EGRDC=VDCMIN + !

| ! VEGRAT\*VIPTMR !

| !----------------------!

| |

| |

| |

| v

| /-----------\ YES

| / IEVP-IEVPSV \----|

| \ > VEVPDL ? / |

| \-----------/ |

| | NO |

| | |

| v |

| NO /---------\ |

|-------/ EGRDC >= \ |

\ VDCMAX / |

\---------/ |

| |

| |

| YES |

v |

!----------! |

! CODE 33 ! |

!----------! |

| |

| |

|<----------|

v

!---------------!

!.SET EGRDC=0 !

!.SET VIPTMR=0 !

!---------------!

|

|

v

---------

( EXIT )

---------

27-21

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

SPOUT CHECK TEST

-------- /--------\ NO ----

( ENTER )------>/IS VSPTEN \------>( EXIT )

-------- \ = 1? / ----

\--------/

| YES

v

!--------------------------!

! 1)SET SPK ADV TO "VSPRET"!

! 2)DELAY FOR "VSPTDL" SEC !

! 3)SAVE NBAR -> "VSPTN" !

!--------------------------!

|

v

!--------------------------!

! 1)SET SPK ADV TO "VSPADV"!

! 2)DELAY FOR "VSPTDL" SEC !

!--------------------------!

|

v

/------------------\ NO !--------!

/ NBAR - VSPTN => \----->!CODE 18 !

\ VSPRPM / !--------!

\------------------/ |

| YES |

|<--------------------|

v

!--------------------------!

!RESET SPK ADV TO "VIPSPK" !

!--------------------------!

|

v

-------

( EXIT )

-------

27-22

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

LOW RPM ISC TEST

-----------

( ENTER )

-----------

|

v

!---------------------------!

! .LOAD NGOOSE -> VIPRPM !

! .DO ISC DESIRED RPM !

! CALCULATION (EACH BG !

! LOOP !

!---------------------------!

|

v

!------------!

!DELAY VISDL3!

!------------!

|

v

!--------! NO /----------------------------------\

!SET CODE!<---/(NGOOSE+ISLBND)>RPM>(NGOOSE-ISLBND) \

! 13 ! \ /

!--------! \----------------------------------/

| | YES

|----------------------->|

v

-------

( EXIT )

-------

VTCDSN - Self test idle speed ramp down time

constant. This parameter takes the

place of the normal strategy filter

constant "TCDESN" when in self test.

Calibrating "VTCDSN" to zero will

result in defaulting to the "TCDESN"

value.

27-23

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

CYLINDER BALANCE TEST

-------

( ENTER )

-------

|

v

!----------------!

!SET ABORT FLG =0!

!CYL BAL FLG =0 !

!----------------!

|

(A)

|

v

1= /---------\

|<---/ ABORT FLG \

| \ STATE /

| \---------/

| | =0

| v

----- | 0= /--------\ > 0

( EXIT )<------/ VCBFLG \--------->|

----- | \ STATE / |

| \--------/ |

| | < 0 |

| v |------>(B)

| 1= /-------\ = 0 |

|<---/CYL BAL \---------->|

\FLG STATE/

\-------/

27-24

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

CYLINDER BALANCE TEST (CONT'D)

(B)

|

v

!-------------!

!.SET TPOFLG=0!

!.RESET VIPTMR!

!-------------!

|

|<------------------------|

(APT NOT= -1) v |

!------! OPEN /--------\ |

! SET !<-------/ TP \ |

!TPOFLG! \ STATE / |

! = 1 ! \--------/ |

!------! | CLOSE (APT = -1) |

| | |

|---------------->| |

v |

/-------\ = 0 | < 2 MIN

/ TPOFLG \------| |

\ STATE / | /--------\

\-------/ |----->/ TMR \

| = 1 | \ STATE /

| | \--------/

v | | > 2 MIN

CLOSE /-------\ OPEN | |

|<-------/ TP \-------| |

| \ STATE / v

| \-------/ ----------

| ( EXIT TO )

v WIGGLE TEST

(C) ----------

27-25

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

CYLINDER BALANCE TEST (CONT'D)

(C)

|

v

!------------------!

!SET: SPARK ADVANCE!

! =VIPSPK !

!CYLNUM=ENG CYL NO.! !---------!

!LAMBSE1=LAMBSE2= !---------->! DELAY !

! VLAMCB ! ! VCBDLY !

!DSDRPM(RVIPRPM)= ! !---------!

! VISCN1 ! |

!CLEAR ALL FAULT ! /-------------\YES

! CODES ! /IS RVIP-CYL.BAL\-------|

!OPEN LOOP FUEL ! \ =0 ? / |

!------------------! \-------------/ |

|NO v

| !--------------!

| !SET VCBPCT- !

| !THIS- TIME = !

| ! VCBPCT !

| !--------------!

v |

!----------------! |

!SET VCBPCT-THIS-! |

!TIME=(VCBPCT- ! |

!THIS-TIME)+ !------>|

!VCBPAD CLIP ! |

!TO VCBCLP ! |

!----------------! |

v

(D)

27-26

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

CYLINDER BALANCE TEST (CONT'D)

(D)

|

v

!-------------!

!RESET VIPTMR !

!-------------!

|

|<----------------|

!---------------! v | NO

!.CLEAR FAULTs) ! OPEN /-------\ CLOSE /-------\

! CODE(s) !<------/ TP \------>/IS VIPTMR\

!.SET ABORT FIG=!(ABORT \ STATE / \ VISDL4 /

! 1 ! \-------/ \-------/

!.TURN "ON" IN- !<------| |<--------- |YES

! INJECTOR I ! | !----------!

!.SET FAULT CODE! | !OPEN LOOP ! !-----------!

! 77 ! | !ISC-CONS- ! !DO "VCBHN" !

! ! | !TANT PULSE!-->!CALCULATION!

!---------------! | !WIDTH ! !-----------!

| | !----------! |

v | |-----|

(E) |----------| |

|OPEN v

!----------! /-------\ !------------------!

!DO "VCBLN"! NO/--------\ / TP \ !.SET VNPASSCB = & !

!CALCULA- !<--/IS VIPTMR \<- \ STATE /<------! (VCBHN)\*[1- !

!TION ! \< VISDL5 / \-------/ ^ ! (VCBPCT-THIS- !

!----------! \--------/ CLOSED | ! TIME)] !

| YES |---------------------- | !.RESET VIPTMR=0 !

v !.TURN "OFF" !

/-------\YES ! INJECTOR I = CYL-!

/IS VCBLN \ ! NUM (VCUTCOUT) !

/=> VNPASSCB\ !------------------!

\(VIPNORM 2)/---------------->|

\ / |

\-------/ |

| |

v |

!-------------! |

!.TURN "ON" ! |

! INJECTOR I ! |

!.SET CYL-NUM !<---| |

! =(CYL-NUM)-1! | |

!-------------! | |

| | v

v | !----------!

/---------\ YES |<---!SET FAULT !

/IS CYL-NUM \---| !CODE I0 !

\ > 0 / | !----------!

\---------/ |

|NO |-------------------------->(D)

|-------------->(E)

27-27

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

CYLINDER BALANCE TEST (CONT'D)

(E)

|

v

!----------------------------!

!SET: DSDRPM=NGOOSE !

! CLOSED IDLE SPD CONTROL!

! LAMBSE1=LAMBSE2=VRLAM !

!----------------------------!

|

v

!-------! YES /--------\

!OUTPUT !<------/ IS ANY \

! CODES ! ^ / CODE \

!-------! | \ PRESENT /

| | \----------/

| | | NO

| | v

| | !--------!

| |<---! SET !

| !CODE 90 !

| !--------!

|

|

|

|

v

!----------!

!SET CYL- !

!BAL-FLG = !--------->( A )

! 1 !

!----------!

27-28

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

"VCBHN" CALCULATION

------

( ENTER )

------

|

v

!------------------!

!.RESET VIPTMR !

!.CLEAR VCB-PIP-CNT!

!.SAVE LAST PIPTIME!

! IN "VLPTM" !

!------------------!

|

|<-------------------------|

v |

!------------------! |

!.WHEN PIPHIGH IN- ! |

! CREMENT ! |

! VCB-PIP-CNT ! |

!------------------! |

| |

| |

v |

/-----------\ N0 |

/IS VIPTMR => \-------------------|

\ VCBTM2 /

\-----------/

| YES

v

!----------------------------!

!.CALCULATE CYL. BAL HIGH RPM!

! !

! VCBHN = VCB-PIP-CNT 120 !

! ----------- \* --- !

!(VCBN) (LAST PIPTIME- NO. !

! TIME - VLPTM OF !

! CLY !

!----------------------------!

|

|

v

------

( EXIT )

------

27-29

ENGINE-RUNNING SEQUENCE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

"VCBLN" CALCULATION

------

( ENTER )

------

|

v

!------------------!

!.RESET VIPTMR !

!.CLEAR VCB-PIP-CNT!

!.SAVE LAST PIPTIME!

! IN "VLPTM" !

!------------------!

|

|<-------------------------|

v |

!------------------! |

!.WHEN PIPHIGH IN- ! |

! CREMENT ! |

! VCB-PIP-CNT ! |

!------------------! |

| |

| |

v |

/-----------\ N0 |

/IS VIPTMR => \-------------------|

\ VCBTM1 /

\-----------/

| YES

v

!----------------------------!

!.CALCULATE CYL. BAL LOW RPM !

! !

! VCBLN = VCB-PIP-CNT 120 !

! ----------- \* --- !

!(VCBN) (LAST PIPTIME- NO. !

! TIME - VLPTM OF !

! CLY !

!----------------------------!

|

|

v

------

( EXIT )

------

27-30

CHAPTER 28

CONTINUOUS TEST STRUCTURE

28-1

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS TEST STRUCTURE

----------

( ENTER )

-----------

|

/-----------------\

/ ECT TEST \

\ AND FILTERING /

\-----------------/

|

/-----------------\

/ ACT TEST \

\ AND FILTERING /

\-----------------/

|

/-----------------\

/ BP TEST \

\ AND FILTERING /

\-----------------/

|

/-----------------\

/ MAF TEST \

\ AND FILTERING /

\-----------------/

|

/-----------------\

/ EGR TEST \

\ AND FILTERING /

\-----------------/

|

/-----------------\

/ PIP AND IDM TEST \

\ AND FILTERING /

\-----------------/

|

/-----------------\

/ TP TEST \

\ AND FILTERING /

\-----------------/

|

/-----------------\

/ EGO TEST \

\ AND FILTERING /

\-----------------/

|

/-----------------\

/ VSS TEST \

\ AND FILTERING /

\-----------------/

|

(A)

28-2

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS TEST STRUCTURE (CONT'D)

(A)

| NOTE: "WIGGLE TEST IS

NO /---------\ DEFINED AS:

|------------------------/ IN WIGGLE \ 1) NOT IN SELF-TEST AND

| \ TEST ? / 2) STI=GND OR TIME SINCE

| \---------/ LAST PIP >1 SEC

| |

| /---------\

| !---------! NO / ANY \ YES !-------------!

| ! STO OFF !<--------/ FAULT FILTER\----->!.STO ON !

| !---------! \ > THRESHOLD?/ !.SET ADVLIM=0!

| | \ / !-------------!

| | \---------/ |

| | |

| v ----------- |

|---------------------->( EXIT )<------------|

-----------

28-3

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

FILTERING LOGIC

Each fault to be detected and stored requires an event

counter-timer which will be incremented by an "Up-count" value

(calibratable) each time a fault is detected, and decremented by

1 each time the fault is not detected. Fault detection and

up/down counting are done once per background loop. When the

counter-timer for a particular fault exceeds a "threshold" value

(calibratable) for that fault, the corresponding KAM fault code

will be stored.

The "Wiggle Test" is a special case. When STI is low and

Self-Test is not in progress, or in Engine-Off conditions when

Self-Test is not in progress, any time any event counter-timer

(filter) has exceeded its threshold, STO is turned "on"

(otherwise it will be "off").

-----------

( ENTER )

-----------

|

v

NO /---------\ YES

|-------------/ FAULT (N) \-------------|

| \ DETECTED ?/ |

v \---------/ v

!--------------! !--------------!

! CXXFIL = ! ! CXXFIL = !

! CXXFIL -1 ! ! CXXFIL + !

!--------------! ! CXXUP !

| !--------------!

| |

|------------->|<-----------------------|

v

(I1)

28-4

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

FILTERING LOGIC CONTINUED

(I1)

|

v

/---------\

/IS FAULT \ NO

/(N) 31,32,33,\-----------|

\ 34 OR 35 / |

\PRESENT ? / |

\---------/ |

| YES |

v |

/---------\ |

/ARE ANY \ N0 |

/CODES 31,32, \---------->|

\33,34,35 / |

\STORED IN / |

\ KAM ? / |

--------- |

| YES |

v |

/-----------\ |

N0 /IS FAULT (N) \ |

|<----/ SAME AS CODE \ |

| \ STORED IN KAM / |

| \ ? / |

| \-----------/ |

| | YES |

| |<-----------------|

| v

| /---------\

| / CXXFIL \ YES

| / > \----------------|

| \ CXXLVL / |

| \ ? / |

| \---------/ |

|----------->| NO v

v !---------------------!

----------- ! STORE KAM CODE (N) !

( EXIT )<-----! ZERO WARM-UP CYCLE !

----------- ! COUNTER (N) !

!---------------------!

28-5

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

FAULT THRESHOLD/UPCOUNT VALUE SELECTION

"WIGGLE" VERSUS NORMAL CONTINUOUS TEST

CRANK OR UNDERSPEED------| |

|AND--|

DISABLE NO START---------| | |

| OR| !------------------------!

NOT CRANK OR UNDERSPEED--| | | !"WIGGLE TEST:SET C32UP &!

|AND--| | AND---!C33UP,C34UP=0 & ALL !

DISABLE RUNNING----------| | | !THRESHOLDS=WIGLVL\* ALL !

| !NON-ZERO UPCOUNTS =255 !

STI=GND----------------------------| !------------------------!

-----ELSE-----

IN UNDERSPEED OR RUNNING------------------> (NORMAL CONTINUOUS TEST)

!--------------------------!

! USE CALIBRATED !

! THRESHOLD/UPCOUNT VALUES !

!--------------------------!

PARAMETER NAMES:

FAULT | FILTER |UPCOUNT|THRESHOLD|WARM-UP COUNTER

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

ERRATIC PIP | C14FIL | C14UP | C14LVL | C14CNT

IDM | IDM FAULT CNT | IDMUP | IDMLVL | IDM WARMUP CNT

ECT LOW | C61FIL | C61UP | C61LVL | C61CNT

ECT HIGH | C51FIL | C51UP | C51LVL | C51CNT

BP OUT OF RANGE | C22FIL | C22UP | C22LVL | C22CNT

ACT LOW | C64FIL | C64UP | C64LVL | C64CNT

ACT HIGH | C54FIL | C54UP | C54LVL | C54CNT

TP LOW | C63FIL | C63UP | C63LVL | C63CNT

TP HIGH | C53FIL | C53UP | C53LVL | C53CNT

1)EPT BELOW MIN | C31FIL | C31UP | C31LVL | C31CNT

2)EVP INPUT LOW | C31FIL | C31UP | C31LVL | C31CNT

1)EPT LOW | C32FIL | C32UP | C32LVL | C32CNT

2)EVP OUT OF LIM | C32FIL | C32UP | C32LVL | C32CNT

1)EPT ABOVE MAX | C35FIL | C35UP | C35LVL | C35CNT

2)EVP INPUT HIGH | C35FIL | C35UP | C35LVL | C35CNT

1)NO EGR FLOW | C33FIL | C33UP | C33LVL | C33CNT

2)NO EGR FLOW | C33FIL | C33UP | C33LVL | C33CNT

1)EPT HIGH | C34FIL | C34UP | C34LVL | C34CNT

2)EGR VALVE OUT | C34FIL | C34UP | C34LVL | C34CNT

OF LIMITS | | | |

LACK OF EGO SW | C41FIL | C41UP | C41LVL | C41CNT

LACK OF EGO SW | C91FIL | C91UP | C91LVL | C91CNT

VSS FAILURE | C29FIL | C29UP | C69LVL | C69CNT

FP RELAY | C87FIL | C87UP | C87LVL | C87CNT

MAF SHORT TO PWR | C56FIL | C56UP | C56LVL | C56CNT

MAF CKT OPEN | C66FIL | C66UP | C66LVL | C66CNT

28-6

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

FAULT THRESHOLD/UPCOUNT VALUE SELECTION (CONT'D)

PARAMETER NAMES

FAULT | FILTER |UPCOUNT|THRESHOLD|WARM-UP COUNTER

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

FP CKT OPEN ECA | C95FIL |C95UP | C95LVL |C95 CNT

TO MTR GND | | | |

FP CKT OPEN | C96FIL |C96UP | C96LVL |C96CNT

WIGLVL - Threshold for wiggle test- no units -range 0 to 255

resolution=1 Base value = 200 Cal level = CCV

1)PARAMETERS APPLY WHEN USING PFE EGR SYSTEMS (PFEHP SWITCH =1)

2)PARAMETERS APPLY WHEN USING SONIC EGR SYSTEMS (PFEHP SWITCH =0)

NOTE: SET C32UP, C33UP, C34UP AND C41AND C91UP TO ZERO WHEN IN

WIGGLE TEST MODE TO EXCLUDE CODE FROM WIGGLE TEST

28-7

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

KAM CODE ERASE LOGIC

Each KAM code has a counter for "Number of Engine warm-ups" since

fault was last detected. Each code is erased when its counter is

>= 40. Codes can also be manually cleared during Engine-Off code

output mode.

"WARM-UP" FLAG CLEAR--|

|

TCSTRT < VECT5--------|

| AND---|------SET "WARM-UP FLAG

ECT > VECT3-----------| |

| |

RUN MODE--------------| |

| !--------------------!

|---| ! INCREMENT ALL CODE !

| AND---! WARM-UP COUNTERS !

STI=OPEN----------| ! DISABLE FURTHER !

! INCREMENTS (UNTIL !

! NEXT POWER-UP) !

!--------------------!

IN ENGINE-OFF CODE OUTPUT MODE\*----|

| AND----ERASE ALL KAM CODE

SELF-TEST NOT REQUESTED------------|

WARM-UP COUNTER(N) >= 40--------------ERASE KAM CODE(N)

\* Note: This means during the output of any codes in Engine-Off

Self-Test; service codes, separator pulse, and continuous codes.

28-8

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ECT OPEN/SHORT TEST

-----------

( ENTER )

-----------

|

v

/---------\ NO !----------!

/ IECT >= \--------->! FAULT 61 !

\ ECTMIN ? / !----------!

\---------/ |

| YES |

v<---------------------|

!--------------!

! DO FAULT !

! FILTERING 61 !

!--------------!

|

v

/---------\ NO !----------!

/ IECT <= \--------->! FAULT 51 !

\ ECTMAX ? / !----------!

\---------/ |

| YES |

v<---------------------|

!--------------!

! DO FAULT !

! FILTERING 51 !

!--------------!

|

v

-----------

( EXIT )

-----------

28-9

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ACT SENSOR TESTS

-----------

( ENTER )

-----------

|

v

/---------\ NO !----------!

/ IACT >= \--------->! FAULT 64 !

\ ACTMIN ? / !----------!

\---------/ |

| YES |

|<---------------------|

v

!--------------!

! DO FAULT !

! FILTERING 64 !

!--------------!

|

v

/---------\ NO !----------!

/ IACT <= \--------->! FAULT 54 !

\ ACTMAX ? / !----------!

\---------/ |

| YES |

|<---------------------|

v

!--------------!

! DO FAULT !

! FILTERING 54 !

!--------------!

|

v

-----------

( EXIT )

-----------

28-10

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

BP SENSOR TEST

------

( ENTER )

------

|

v

/--------\ NO ------

/ BPSSW=1 \-------> ( EXIT )

\ / ------

\--------/

| YES

/---------\NO

/ BPTMR <= \-----------|

\ VBPMAX ? / |

\---------/ |

| YES v

/---------\ !----------!

/ VBPDL1 \------>! FAULT 22 !

/ <=MDELTA <= \ !----------!

\ VBPDL2 / |

\ / |

\---------/ |

| YES |

|<-----------------|

!------------!

! DO FAULT !

!FILTERING 22!

!------------!

|

v

-------

( EXIT )

-------

28-11

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

MAF SENSOR TEST

--------

( ENTER )

--------

|

v

/---------\ NO /---------\ YES !---------!

/ NBAR => \------>/ IMAF => \------>!FAULT 56 !

\ VMARPM / \ VMAMAX / !---------!

\---------/ \---------/ |

|YES | NO |

|<-------------------------------------|

|

v

!----------!

!DO FAULT !

!FILTERING !

! 56 !

!----------!

|

NO/--------\

|<----/ RUN MODE \

| \ /

| \--------/

| | YES

| v

| /---------\ NO /---------\ YES !--------!

| /IS TSLPIP \----->/ IMAF <= \------->!FAULT 66!

| / > \ \ VMAMIN / !--------!

| \ VMAFPIPLMT / \---------/ |

| \ / | NO |

| \---------/ | |

| |YES | |

| v | |

|--------------------------->|<------------------|

|

v

!-------------!

!DO FAULT !

!FILTERING 66 !

!-------------!

|

v

------

( EXIT )

------

NOTE: DO NOT CHECK FOR FAULT 66 DURING KOEO WIGGLE TEST.

AIR FLOW AND IMAF WILL BE AT OR NEAR ZERO.

28-12

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGR SYSTEM TEST (PFE/SONIC)

---------

( ENTER ) (PFE)

---------

|

/--------\ NO --------

/ PFEHP=>2 \------->( EXIT )

\ ? / --------

\--------/ (SONIC)

| NO

/--------\ NO

/ PFEHP=1 \----------------------------|

\ / |

\--------/ |

| YES | YES

/---------\ NO v

/ APT= -1 \-----------| /--------\ YES !----------!

\ / | / IEVP <= \---->! FAULT 31 !

\---------/ | \ EVPMIN ? / !----------!

| YES | \--------/ |

/---------\ NO | | NO |

/ NBAR < VN \---------->| |<---------------|

\ / v v

\---------/ (A) !-----------------------!

| YES ! DO FAULT FILTERING 31 !

!----------------------! !-----------------------!

!FIEPT=VROLAV(IEPT, ! |

! VTCEPT) ! |

!----------------------! v

| /--------\ YES !----------!

/---------\ YES !-------! / IEVP >= \---->! FAULT 35 !

/ FIEPT <= \---->! FAULT !-----| \ EVPMAX ? / !----------!

\ EPTMIN / ! 31 ! | \--------/ |

\---------/ !-------! | | NO |

| NO | |<---------------|

/---------\ YES !-------! | v

/ FIEPT >= \---->! FAULT !---->| !--------------! NOTE: For

\ EPTMAX / ! 35 ! | ! DO FAULT ! wiggle test

\---------/ !-------! | ! FILTERING 35 ! set C32UP,

| NO | !--------------! C33UP & C34UP

/---------\ YES !-------! | | = 0.

/ FIEPT < \---->! FAULT !---->| v

\ VEPTIL / ! 32 ! | /--------\ YES !----------!

\---------/ !-------! | / IEVP < \---->! FAULT 32 !

| NO | \ VEVPLL / !----------!

/---------\ YES !-------! | \--------/ |

/ FIEPT > \---->! FAULT !---->| | NO |

\ VEPTIH / ! 34 ! | |<---------------|

\---------/ !-------! | v

| NO | !--------------!

|<------------------------| ! DO FAULT !--->(B)

v ! FILTERING 32 !

( AA ) !--------------!

28-13

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGR SYSTEM TEST (CONT'D)

(PFE/SONIC)

( AA )

|

v

!---------------------!

!DO FAULT FILTERING 1)! 1) For Wiggle Test

!31, 35, 32 and 34 ! set C32UP and

!---------------------! C34UP = 0

|

v

---------

( EXIT )

---------

28-14

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGR SYSTEM TEST

(PFE/SONIC)

(A) (B)

| |

v v

/---------\ NO !-----------! NO /---------\

/ LOAD <= \-----------| !.SET EGRFG2!<---/ EGRDC =0 \

\ VEGRLOAD? / | !.VIPTMR=0 ! \ ? /

\---------/ | !-----------! \---------/

| YES | | | YES

v | v v

/---------\ NO v ( C ) /---------\ YES

/ EGRDC > \ !---------! / EGRFG2=1 \---|

\ VCRTDC ? /---->! SET !--| \ ? / |

\---------/ !EGRFG1=0 ! | \---------/ |

| YES !---------! | | NO |

| | v |

| | !--------------! |

| | !.SET EGRFG2 ! |

v | ! = 1 ! |

/--------\ N0 | !.START VIPTMR ! |

/ EGRFG1=1 \ !-------------! | !--------------! |

\ /--->!.SET EGRFG1=1! | | |

\--------/ !.SET VIPTMR=0! | |--->|<---|

| YES !-------------! | |

| | | v

|<---------------| | YES /---------\ YES /---------\

v | |----/ VIPTMR < \<----/ IEVP > \

!------------------! | | \ VEITMR ? / \ VEVPHL ? /

!CFIEPT=VROLAV ! | | \---------/ \---------/

!(IEPT,VTCEPT) ! | | | NO | NO

! ! | | v v

!------------------! | | !----------! !-------------!

| | | ! FAULT 34 !--->! DO FAULT !

v | | !----------! ! FILTERING 34!

/---------\ YES | | !-------------!

/ CFIEPT < \------------------>| | |

\ VEPTCL / | |--------------------------->|

\---------/ | v

| NO | ----------

v | ( EXIT )

/---------\ NO !----------! | ----------

/ VIPTMR < \--->! FAULT 33 !-->|

\ VECTMR / !----------! |

\---------/ v

| YES !--------------------------!

v<-----------! DO FAULT FILTERING 33 (2 !

--------- !--------------------------!

( EXIT )

--------- (2 For wiggle test

set C33UP=0

28-15

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGR SYSTEM TEST (CONT'D)

(PFE/SONIC)

( C )

|

v

NO /---------\

|---------/ LOAD <= \

| \ VEGRLOAD ?/

| \---------/

| | YES

| v

| NO /---------\

|---------/ EGRDC > \

| \ VCRTDC ? /

| \---------/

| | YES

| v

v /---------\ YES

!-----------! / EGRFG1 \---------|

!.SET EGRFG1! \ =1 ? / |

(C)<---! = 0 ! \---------/ |

!.SET VIPTMR! | NO |

! = 0 ! | |

!-----------! v |

!-------------! |

!.SET EGRFG1 ! |

--------- ! =1 ? ! |

|----->( EXIT ) !.START VIPTMR! |

| --------- !-------------! |

| ^ | |

| | |<--------------|

| | YES v

| /---------\ NO /---------\

| / VIPTMR < \<--/ IEVP > \

| \ VECTMR ? / \ VEVPCL ? /

| \---------/ \---------/

| | NO | YES

| v |

| !----------! |

| ! FAULT 33 !--------->|

| !----------! |<-----------(C)

| v

| !-------------!

| ! DO FAULT !

|---------------------! FILTERING 33!

!-------------!

28-16

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

PIP AND IDM TEST

A new continuous PIP/IDM routine has been implemented for 1986.

Instead of the rather complex hand shaking method as used in

previous IDM versions, the new routine basically checks if time

since last pip (TSLPIP) and time since last idm (TSLIDM) have

exceeded a calibrated timeout period.

Additional decisions are made in softwre to assure the engine is

running and stabilized before the test is executed.

Both the PIP and IDM timers are free-running and high speed

digital inputs are used to re-start the timers.

Each transition of pip starts a new time-out function. When the

time since last pip > VPIPTM, a pip fault is present.

If a pip fault has been detected, software bypasses the IDM test.

This feature has been added to discriminate between a true pip

failure or idm (tach) failure once pips have been restored.

28-17

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

Time since last IDM is determined by a buffered tach signal used

as input, and the timer resets on the rising edge of this

buffered signal.

|\^----

| | VBATT

| ^^^^------|

TACH --------| | |---------

| |

| |

| |

GND -------

-------

| |

| |

| |

TACH BUFFER | |

OUTPUT --------------------------| |---------

^

NOTE: RISING EDGE OF BUFFER OUTPUT

IS BASED ON VBATT-->GND TRANSITION.

Each VBATT--->GND transition of tach starts a new time-out

function When the time since the last transition is > VIDMTM, an

idm failure is present.

Faults are filtered by an event-counter method, as done for all

continuous test faults, and the first "upcount" will occur on the

first time the PIP/IDM routine determined that a fault has

occured.

NOTE: DEPENDING ON THE STATE OF THE IDM BYPASS FLAG, TSLIDM IS

ACTUALLY ONE OF TWO FUNCTIONALLY DIFFERENT TIMERS. (1) WHEN

IDM\_BYPASS FLAG IS CLEAR ( =0 ), THEN TSLIDM IS THE TIME SINCE

THE LAST IDM. (2) WHEN IDM\_BYPASS FLAG IS SET ( =1 ), THEN

TSLIDM IS THE TIME SINCE THE IDM\_BYPASS FLAG WAS SET.

28-18

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

PIP/IDM LOGIC

(FOR TACH BUFFER)

YES/------------\ -----------

|--/IS IGNFG = 1 \<------( ENTER )

| \ \* ? / -----------

| \------------/

v |NO

/---------\YES v !-----------! -------

/ IS N < \------->! SET !------->( EXIT )

\ VLORPM ? / ^ ! TSLIDM =0 ! -------

\---------/ | !-----------! \*APPLIES TO NU, NX,

| NO | & 9X STRATEGIES

v |------------------ ONLY

!---------------! ^

! CLEAR ERROR ! | NO

!DETECTED FLAGS ! /----------\

!---------------! / KPRTMR > \* \

|-------------------->\ VKPRTM /

\----------/

!---------------------------! | YES

!.SET ERROR DETECTED FLAG=1 ! v

!.SET IDM\_BYPASS FLAG=1 ! YES /---------\

!.RESET IDM\_FAULT CNT=0 !<------/ TSLPIP \

!.RESET TSLIDM =0 ! \ > VPIPTM ?/

!---------------------------! \---------/

| | NO

|-------------------------->|

v

!------------!

! CALL FAULT !

! FILTER C14 !

!------------!

|

!-----------! YES /---------\ NO /-------------\ YES

!.SET ERROR !<----/ TSLIDM \<----/ IS IDM\_BYPASS \----|

! DETECTED ! \ > VIDMTM ?/ \ FLAG =1? / |

! FLAG =1 ! \---------/ \-------------/ |

!-----------! | NO |

| | YES /------------\

|---------------->| |---/ IS TSLIDM > \

| | \ VIDMST ? /

| | \------------/

v !------------------! |NO

!------------------! !.CLEAR IDM\_BYPASS ! |

!.CALL FAULT FILTER! ! FLAG ! |

! IDM\_FAULT\_CNT C18! !.SET TSLIDM=0 ! |

!------------------! !------------------! |

| | |

----------- v |

( EXIT )<------------------------|

-----------

NOTE: Pip fault filtering uses C14LVL.

IDM fault filtering uses IDMLVL.

28-19

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

TP SENSOR TESTS

-----------

( ENTER )

-----------

|

v

/---------\ NO !----------!

/ ITP >= \--------->! FAULT 63 !

\ TAPMIN ? / !----------!

\---------/ |

| YES |

|<---------------------|

v

!--------------!

! DO FAULT !

! FILTERING 63 !

!--------------!

|

v

YES /---------\

|-------------/ CTFFLG \

| \ SET ? /

| \---------/

| | NO

| v

| /---------\ NO !----------!

| / ITP <= \--------->! FAULT 53 !

| \ TAPMAX ? / !----------!

| \---------/ |

| | YES |

| |<---------------------|

v v

!----------! !--------------!

! FAULT 53 ! ! DO FAULT !

!----------! ! FILTERING 53 !

| !--------------!

| |

|------------------>|

v

-----------

( EXIT )

-----------

28-20

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS VEHICLE SPEED SENSOR TEST

The vehicle speed sensor is tested under conditions that cannot be

acheived unless the vehicle is moving.

Manual Transmission - Engine is being motored as indicated

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

by a low map value, closed throttle and high engine speed.

Automatic Transmission - Transmission is in drive and engine

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

speed is above the torque convertor stall speed.

If the above conditions are true for a prolonged period of time,

(VSSTMR >= VVSTIM) then the vehicle speed sensor is checked

against a minimum value. The continuous VSS test may be calibrated

out by setting VIP calibration parameter VSSSW to 0

The VSS test will use traditional fault filtering if a VSS fault

is detected.

28-21

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONTINUOUS VSS TEST CONT'D

VSSSW=1 ----------------|

|

VSTYPE > 0--------------| |

| | VSS FAILURE

N >=VSMMIN -------------| | SET CONTINUOUS CODE 29

(ENGINE SPEED HIGH) | AND----|

Manual & Auto | |

| |

VSSTMR >=VSSTIM --------| |

(STABLE TEST CONDITIONS)| |

| |

VSBAR < VSSMN1 ---------| |

(NO VSS READING) |---------ELSE------------

|

| VSS IS OK

| USE FAULT FILTERING 29

|

VSSTMR - VEHICLE SPEED SENSOR TIMER (.125 SEC)

VSSTMR INCREMENTS WHEN THE PROPER CONDITIONS

EXIST TO PERFORM A VSS TEST.

TFMFLG=0---------|

(TP Sensor OK) |

|

TRLOAD < 4-------|

(MANUAL TRANS) |

|

APT= -1 ---------| AND---|

(CLOSED THROTTLE)| | OR----|

| | | INCREMENT VSSTMR

LOAD<= VSLOAD ---| | |

(DECEL MODE) | | |

| | |

| |

| |-------ELSE---------

TRLOAD = 4-------| | |

| | |

NDSFLG=1 --------| AND---| | SET VSSTMR=0

(AUTO IN DRIVE) | |

|

N >= VSAMIN -----|

(ENGINE SPEED HIGH)

For Auto Trans.

28-22

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO SWITCHING TEST

PART THROTTLE COUNTER (PTCNT)

-----------

( ENTER )

-----------

|

v !-------------------!

/-------\ YES ! SET PART THROTTLE !

/ IS APT \------->! FLAG (VPTFLG)=1 !

\ = 0 ? / !-------------------!

\-------/ |

| NO |

|<----------------------|

v !-----------------!

/-------\ YES /--------\ YES ! .PTCNT=PTCNT+1 !

/ IS APT \------->/ IS \------->! .CLEAR VPTFLG=0 !

\ = -1 ? / \ VPTFLG=1?/ !-----------------!

\-------/ \--------/ |

| NO | NO |

|<------------------| |

| |

| |

|<------------------------------------------|

|

v

-----------

( EXIT )

-----------

\* INITIALIZE VPTFLG TO ZERO ON POWER-UP

28-23

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO SWITCHING TEST CONT'D

-----------

( ENTER )

-----------

|

v

NO /-------\

|------/ VEGOBP \

| \ =1 ? /

| \-------/

| | YES

| v

| NO /-------\

|<-----/ ATMR2 > \

| \ VEGOTM ?/

| \-------/

| | YES

| v

| /---------\

| YES / IS ECT \NO /---------\ NO

|<---/ ACT, TP OR \---->/ THRMHP=1 \---|

| \ MAP FMEM / \ / |

| \ SET ? / \---------/ |

| \---------/ |YES |

| | NO | |

| v | |

| YES /---------\ | |

|<----/ IS AIR \<---------- | NOTE:| FOR APPLICATIONS

| \ UPSTREAM? / | WITH SECONDARY

| \---------/ | AIR ONLY

v | NO |

!----------------! | |

! CLEAR PART ! |<---------------------------|

!THROTTLE COUNTER! |

! (PTCNT) ! |------------------|

!----------------! |

| |

|------| v

v /-----------\

NO/--------\ /PART THROTTLE\ YES

(C)<-----/ VEGOBP \ /COUNTER (PTCNT)\---->(B)

\ = 1 / \ > VPTCNT ? /

\--------/ \ /

| YES \-----------/

v |NO

------ |

( EXIT )<-----------------|

------

28-24

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO SWITCHING TEST CONT'D

(B)

|

/----------\ NO !---------!

/ EGOSS1 > \------->!FAULT 41 !

\ VEGOSW / !---------!

\----------/ |

|YES |

(C)---------->| |

!------------! |

! DO FAULT !<-----------|

!FILTERING 41!

!------------!

|

/-----------\ YES ----

/ NUMEGO =1? \------->( EXIT )

\ / ----

\-----------/

|NO

/-----------\NO !---------!

/EGOSS2>VEGOSW\------>!FAULT 91 !

\ / !---------!

\-----------/ |

(C)---------->| YES |

!------------! |

! DO FAULT !<-----------|

!FILTERING 91!

!------------!

|

|

v

-------

( EXIT )

-------

28-25

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

FUEL PUMP CIRCUIT TEST

-------- /--------\ NO ------

( ENTER )----->/ IS V\_ \----->( EXIT )

-------- \FPMFLG SET/ ------

\--------/

| YES

v

/--------\NO

|-----------| / IS FP \--->(A)

v | \ "OFF" /

/--------\ | \--------/

/IS VIP\_FP \NO | |YES

/MTMR=>V\_ \--| | v

\ FPMTM / | | NO /--------\

\ / v |<----/IS RMSPRU \

\--------/ | \ = 1 /

|YES | \--------/

v | |YES

NO /--------\ | |

|<------/ IS FPM \ | v

| \ LOW ? / | !------------------------!

| \--------/YES | !.DE-ENERGIZE ALL OUTPUTS!

v |<--------| !.DELAY 50 MSEC. !

!--------! | !.SAVE IOCC IN OCCSAV !

! FAULT ! | !.ENERGIZE FUEL PUMP !

! 95 !------->| !.DELAY 50 MSEC !

!--------! | !------------------------!

v |

!------------! v

! DO FAULT ! /----------\

!FILTERING 95! /ABS [OCCSAV \NO !----------!

!------------! / -IOCC] >= \-->! FAULT 87 !

| \ OCCDT7 ? / !----------!

| \ / |

| \----------/ |

| |YES |

| |<---------------|

| v

| !------------------!

| !TURN OFF FUEL PUMP!

| !CLEAR "RMSPRU"=0 !

| !------------------!

| |

| !------------!

| ! DO FAULT !

| !FILTERING 87!

| !------------!

|---------------------->|

v

-------

( EXIT )

-------

NOTE: TEST MUST BE PERFORMED AS LONG AS POWER IS "ON" AND NOT

JUST IN RUN MODE.

28-26

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

FUEL PUMP CIRCUIT TEST CONT'D

(A)

|

v

!--------------------!

! RESET VIP-FPMTMR !

!--------------------!

|

|

v

/---------\NO

/ IS FPM \---------->|

\ HIGH / |

\---------/ |

| YES |

| v

| !-------!

| ! FAULT !

|<-----------! 96 !

| !-------!

v

!-------------!

! DO FAULT !

!FILTERING 96 !

!-------------!

|

v

-------

( EXIT )

-------

28-27

CONTINUOUS TEST STRUCTURE

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

28-28

CHAPTER 29

VEHICLE SPEED CONTROL SELF TEST

29-1

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

VSC ENGINE-OFF TEST INITIALIZATION

AND TEST STRUCTURE

---------

( ENTER )

---------

|

|

v

!------------------!

!.EXIT WIGGLE TEST !

!.STO OFF !

!.EDF ON !

!.HEDF OFF !

!------------------!

|

v

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

(SEND 1/2 SECOND )

PULSE

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

|

v

!-----------------!

!DO STATIC INPUT !

! TEST !

!-----------------!

|

v

!-----------------!

!DO VSC OUTPUT !

! CIRCUIT CHECK !

!-----------------!

|

v

!-----------------!

!SEND FAST & SLOW !

!SERVICE CODES ! Use same format

!-----------------! as Engine Self

| Test

v

---------

( EXIT )

---------

29-2

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE OFF

STATIC INPUT TEST

---------

( ENTER )

---------

|

v

!-----------!

!SET CODES !

!67,74,75 !

!SET FLAGS !

!VSB1,VSB2, !

!VSB3,VSB4 !

!-----------!

|

v

!----------------!

!ZERO AND START !

! VIPTMR !

!----------------!

|

(B)----------->|

v

/---------\ YES !---------!

/IS OFF\_BUT \-------->! CLEAR !

\ = 1 ? / !FLAG VSB1!

\---------/ !---------!

| NO |

|<-------------------|

v

/---------\ YES !---------!

/IS COAST\_ \-------->! CLEAR !

\BUT = 1 ? / !FLAG VSB2!

\---------/ !---------!

| N0 |

|<-------------------|

v

/---------\ YES !---------!

/IS ACCEL\_ \-------->! CLEAR !

\BUT = 1 ? / !FLAG VSB3!

\---------/ !---------!

| NO |

|<-------------------|

v

/---------\ YES !---------!

/IS RESUM\_ \-------->! CLEAR !

\BUT = 1 ? / !FLAG VSB4!

\---------/ !---------!

| NO |

|<-------------------|

v

(A)

29-3

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

STATIC INPUT TEST CONTINUED

(A)

|

v

!-----------!

!SET CODE 48!

!-----------!

|

v

/---------\

NOTE:LoHold & Hi-/ LOHOLD \ YES !---------!

Hold are / < VSCCS < \------->! CLEAR !

normal strat- \ HIHOLD / ! CODE 48 !

egy parameters \ / !---------!

NOT self test \---------/ |

calibratible. | NO |

|<-------------------|

v

/---------\ YES !---------!

/ IS \Brake On ! CLEAR !

/ BIFLG = 1 \------->! CODE 74 !

\ ? / !---------!

\ / |

\---------/ |

| NO |

| |

v |

!---------! |

! CLEAR ! |

! CODE 75 ! |

!---------! |

| |

|<-------------------|

v

(A1)

29-4

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

STATIC INPUT TEST CONTINUED

(A1)

|

v

NOTE: Clutch /-----------\

pedal must be / IS NDSFLG= \ YES (Drive)

depressed / 1 ? \-----------------|

once during \ / |

the test \ / |

\-----------/ |

| NO |

| |

v |

!---------! |

! CLEAR ! |

! CODE 67 ! |

!---------! |

| |

|<------------------------|

v

/-----------\

/ARE ALL OF \ YES

/CODES 48,67,74,\------------> (D)

\75 & FLAGS VSB1/

\VSB2,VSB3,VS-/

\B4 CLEARED /

\---------/

| NO

v

/-----------\ N0

/IS VIPTMR > \------------> (B)

\ VIPT1 ? /

\-----------/

| YES

v

(C)

29-5

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

STATIC INPUT TEST (CONTINUED)

(C)

|

v

/---------\ NO

/ IS CODE \--------------------------------|

\48 CLEARED?/ |

\---------/ |

| YES |

v |

/---------\ /---------\ |

/ ARE ALL \ NO / ARE ANY OF\NO !-----! |

/FLAGS VSB1, \--->/ THE FLAGS \-->! SET !->|

/VSB2,VSB3,VSB4 \ /VSB1,VSB2,VSB3 \ !CODE ! |

\ CLEARED ? / \ VSB4 CLEARED ?/ ! 49 ! |

\ / \ / !-----! |

\ / \ / |

\---------/ \---------/ |

| YES | YES |

| v |

| !------------! |

| !SET CODE 47 ! |

| !------------! |

| | |

v v |

(D)<-----------------------------------|

|

v

NOTE: TP Test /---------\ NO !------------!

same as engine / ITP => \------>!SET CODE 63 !--------|

self test key \ TAPMIN / !------------! |

on engine off \---------/ |

| YES |

v |

/---------\ NO !------------! |

/ ITP <= \------>!SET CODE 53 !------->|

\ TAPMAX / !------------! |

\---------/ |

| YES |

v |

/---------\ |

/ VTAP1 \ NO !------------! |

/ <=ITP <= \----->!SET CODE 23 !------->|

\ VTAP2 / !------------! |

\ / |

\---------/ |

| YES |

|<---------------------------------|

v

----------

( EXIT )

----------

29-6

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

VSC OUTPUT CIRCUIT CHECK

---------

( ENTER )

---------

|

v

!------------!

!.DE-ENERGIZE!

! ALL OUTPUTS!

! EXCEPT EDF !

! ON !

!.SET OC=1 !

!------------!

|

v

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

( DELAY 50 MSEC. )

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

|

|---------------->|

| v

| !------------!

| ! SAVE IOCC !

| ! IN OCCSAV !

| !------------!

| |

| v

| /---------\ NO !---------!

| / IS OC =1 \------>!ENERGIZE !

| \ / ! SCVAC !

| \---------/ !---------!

| | YES |

| v |

| !---------! |

| !ENERGIZE ! |

| ! SCVNT ! |

| !---------! |

| | |

| |<-----------------|

| v

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

| ( DELAY 50 MSEC. )

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

--------- |

(OC = OC + 1) v

--------- /----------\

^ /ABS[OCCSAV- \ NO !-------------!

| / IOCC] => \------->!SET APPROPRI-!

| \OCCDT (OC) / !ATE FAIL CODE!

| \ COUNTS / !(SEE TABLE) !

| \----------/ !-------------!

| | YES |

| |<---------------------|

| v

(A)

29-7

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

VSC OUTPUT CIRCUIT CHECK (CONTINUED)

(A)

|

v

| /---------\

| NO /IS OC = 2 \

|----------\ /

\---------/

| YES

v

!-------------!

!DE-ENERGIZE !

!SCVNT & SCVAC!

!-------------!

|

v

---------

( EXIT )

---------

29-8

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

OCC PARAMETER DEFINITIONS

RANGE

NAME | DESCRIPTION | UNITS | MIN MAX | BASE

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

OC | OUTPUT CIRCUIT # | -- | 0 9 | --

OCCSAV | SAVED OCC A/D |COUNTS | 0 1023 | --

IOCC | OCC A/D |COUNTS | 0 1023 | --

OCCDIX(1-9) | MIN A/D CHANGE |COUNTS |-1023 1023 | 36

|OUTPUT TO BE |

|FUNCTIONED DURING|

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

OC #| CODE | FUNCTION | CAL. PAR. | VSC OCC | OCC |

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

1 | 81 | SCVNT | OCCDTA | X | - |

2 | 82 | SCVAC | OCCDTB | X | - |

3 | 83 | HEDF | OCCDT3 | - | X |

4 | 84 | EVR | OCCDT4 | - | X |

5 | 85 | CANP | OCCDT5 | - | X |

7 | 87 | FP | OCCDT7 | - | X |

8 | 88 | EDF | OCCDT8 | - | X |

9 | 89 | LUS | OCCDT9 | - | X |

29-9

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

DYNAMIC VSC TEST

(ENGINE RUNNING)

---------

( ENTER )

---------

|

v

!-----------------------------!

! SEND 1/2 SECOND PULSE !

!-----------------------------!

|

!---------------------!

!.ON-STATE =1 !

!.VSCDT =1 !

!.ALLOW NORMAL CONTROL!

! OF EDF AND HEDF !

!---------------------!

|

v

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

( DELAY VDLY10 )

SECS.

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

|

!--------------------!

!SUBSTITUTE RPM FOR !

!MPH MPH = N/32 !

!--------------------!

|

v

-----------

( ZERO AND )

START VIPTMR

-----------

|<----------------|

v |

!-------------------! |

!INCREASE VEHICLE ! |

!SPEED (N/32) ! |

!.SET VVSFL1=1 ! |

!.RESUM\_SPEED=VRSS ! |

!-------------------! |

| |

v v

/---------\ /---------\

/ IS MPH > \ NO /IS VIPTMR \ YES !------!

/VRSS - VRSH \-->/ => VIPT2 ? \--->! SET !

\ ? / \ / ! CODE !

\ / \ / ! 36 !

\---------/ \---------/ !------!

| YES |

v v

(1) (C)

29-10

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

DYNAMIC VSC TEST (CONTINUED)

(1)

|

v

!------------------!

!.CLEAR ALL STATES !

! EXCEPT ON-STATE !

!.CLEAR VVSFL1 !

!.TURN SCVNT ON AND!

! SCVAC OFF !

!------------------!

|

v

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

( DELAY VDLY11 )

SEC.

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

|

v

!------------------!

!SAVE CURRENT TP !

! IN TPSAV !

!------------------!

|

v

----------

( ZERO AND )

START VIPTMR

----------

|

(B)------------>|

|

v

(A)

29-11

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

DYNAMIC VSC TEST (CONTINUED)

(A)

|

/---------\ YES !--------!

/IS TPSAV- \--->!SET CODE!----------|

\TP > VTPLD / ! 27 ! |

\---------/ !--------! |

| NO |

/---------\ YES !--------! |

/ IS TP- \--->!SET CODE!--------->|

/ TPSAV > \ ! 28 ! |

\ VTPLU / !--------! |

\ / |

\---------/ |

| NO v

/---------\ NO (C)

/IS VIPTMR \------->(B)

\=> VIPT3 ? /

\---------/

|

!---------------!

!DECREASE SPEED ! NOTE: Rate will be depen-

!TURN SCVNT AND ! dent upon engine inertia

! SCVAC OFF ! and/or ISC dashpot.

!---------------!

|

----------

( ZERO & START )

VIPTMR

----------

|<-----------------|NO

/---------\ /---------\ !------!

/IS MPH < \ NO /IS VIPTMR \ YES ! SET !

\ VMLO ? /----->\=> VIPT4 ? /---->! CODE !

\---------/ \---------/ ! 37 !

| YES !------!

(C)<--------------------------------|

|

v

!-----------------!

!VSCDT =0 !

!RESUM\_SPEED =0 !

!SCVNT & SCVAC OFF!

!RETURN MPH REGIS-!

!TER TO NORMAL !

!-----------------!

|

!-----------------!

!SEND FAST AND ! use same code format

!SLOW CODES ! as engine self test

!-----------------!

|

--------

( EXIT )

--------

29-12

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

DYNAMIC VSC TEST VEHICLE SPEED RAMP EQUATIONS

SELF TEST SET\_SPEED RAMP FOR

RESUME STATE AND ACCEL STATE

This logic ramps the SET\_SPEED up to RES\_SPEED at a rate of VACRR

MPH/sec, to provide smooth acceleration. The rate of acceleration is

clipped to MPH + NSTRAT1 to prevent the SET\_SPEED from accelerating

too fast.

ACCEL = REQUIRED ----------|

|AND---| SET\_SPEED = SET\_SPEED

SET\_SPEED < MPH + NSTRAT1--| | +VACRR \* (Time since

| last update)

|

| ---ELSE---

|

| SET\_SPEED = MPH + NSTRAT1

SELF TEST VSC\_DC OUTPUT ROUTINE

For purposes of Strategy Description, the VSC\_DC OUTPUT Routine is

divided into two subroutines: VSC\_DC Calculation and DUTY CYCLE

OUTPUT.

VSC\_DC CALCULATION

The VSC\_DC is based on the difference between the set speed and the

actual vehicle speed with some adjustments for relative throttle

position. The calculation is done in two steps to more closely model

the analog system.

VSC\_ERROR = VDCBIA+[VSTGN\*SET\_SPEED]

-[VVHGN\*MPH] - VTPGN\*(TP-RATCH)

VSC\_DC = VSC\_ERROR - NSTRAT2

SELF TEST CALIBRATION PARAMETERS

VDCBIA = Self Test DC correction factor

VSTGN = Self Test SET\_SPEED proportional gain

VVHGN = Self Test Vehicle Speed proportional gain

VTPGN = Self Test throttle position proportional

gain

VACRR = Self Test acceleration ramp rate, MPH/sec

NSTRAT1= Normal strategy term - Max. increment

above MPH to which set speed can increase

MPH.

NSTRAT2= Normal strategy term - Duty cycle offset

29-13

VEHICLE SPEED CONTROL SELF TEST

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

29-14

CHAPTER 30

ERROR CODE DESCRIPTION

30-1

ERROR CODE DESCRIPTION

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ERROR CODE DESCRIPTION

SELF TEST SECTION

ERROR| |-----------------------|

CODE | DESCRIPTION | K.O.E.O| E.R. | CONT |

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

10 |CYL #1 LOW -CYL BALANCE TEST | | X | |

11 |PASS | X | X | X |

12 |RPM NOT WITHIN SELF-TEST UPPER | | X | |

| RPM LIMIT BAND | | | |

13 |RPM NOT WITHIN SELF-TEST LOWER | | X | |

| RPM LIMIT BAND | | | |

14 |PIP CKT FAULT | | | X |

15 |ROM TEST FAILED/KAM IN CONTIN- | X | | X |

| UOUS | | | |

16 |RPM TOO LOW TO PERFORM FUEL TEST| | X | |

18 |LOSS OF TACH INPUT TO PROCESSOR-| | | X |

| SPOUT CKT. GROUNDED | | | |

18 |SPOUT CKT. OPEN | | X | |

19 |FAILURE IN EEC REFERENCE VOLTAGE| X | | |

20 |CYL. #2 LOW -CYL BALANCE TEST | | X | |

21 |INDICATES ECT OUT OF SELF-TEST | X | X | |

| RANGE | | | |

22 |INDICATES MAP/BP OUT OF SELF- | X | X | X |

| TEST RANGE | | | |

23 |INDICATES TP OUT OF SELF-TEST | X | X | |

| RANGE | | | |

24 |INDICATES ACT OUT OF SELF-TEST | X | X | |

| RANGE | | | |

26 |MAF SENSOR OUT OF RANGE | X | X | |

27 |SERVO LEAKS DOWN DURING IVSC |VEHICLE SPEED CONTROL |

| TEST | TEST |

28 |SERVO LEAKS UP DURING IVSC TEST |VEHICLE SPD CNTRL TEST |

29 |INSUFFICIENT INPUT FROM V.S.S. | | | X |

30 |CYL #3 LOW -CYL BALANCE TEST | | X | |

31 |EPT/EVP BELOW MINIMUM VOLTAGE | X | X | X |

32 |EVP VOLTAGE BELOW CLOSED LIMIT | X | X | X |

| (SONIC) | | | |

33 |EGR VALVE NOT OPENING(PFE,SONIC)| | X | X |

34 |EVP VOLTAGE ABOVE CLOSED LIMIT | X | X | X |

| (SONIC) | | | |

35 |EPT/EVP CKT. ABOVE MAX. VOLTAGE | X | X | X |

36 |INSUFFICIENT RPM INCREASE DURING|VEHICLE SPD CNTRL TEST |

| IVSC TEST | | | |

37 |INSUFFICIENT RPM DECREASE DURING| X | X | X |

| IVSC TEST | | | |

40 |CYL #4 LOW -CYL BALANCE TEST | | X | |

41 |EGO SENSOR CKT INDICATES SYSTEM | | X | |

| LEAN | | | |

41 |NO EGO SWITCH DETECTED | | | X |

42 |EGO SENSOR CKT INDICATES SYSTEM | | X | |

| RICH | | | |

44 |THERMACTOR AIR SYSTEM INOPER- | | X | |

| ATIVE(CYL. 1-4, DUAL EGO) | | | |

30-2

ERROR CODE DESCRIPTION

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ERROR CODE DESCRIPTION (CONT'D)

SELF TEST SECTION

ERROR| |-----------------------|

CODE| DESCRIPTION |K.O.E.R.| E.R. | CONT.|

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

45 |THERMACTOR AIR UPSTREAM DURING | | X | |

| SELF-TEST | | | |

46 |THERMACTOR AIR NOT BYPASSED | | X | |

| DURING SELF-TEST | | | |

47 |SPEED CONTROL COMMAND SWITCH(S) |VEHICLE SPD CNTRL TEST |

| -CKT NOT FUNCTIONING | | | |

48 |SPEED CONTROL COMMAND SWITCH(S) |VEHICLE SPD CNTRL TEST |

| STUCK -CKT. GROUNDED | | | |

49 |SPEED CONTROL GROUND CKT. OPEN |VEHICLE SPD CNTRL TEST |

50 |CYL. #5 LOW -CYL. BALANCE TEST | | X | |

51 |-40 DEGREES F INDICATED ECT - | X | | X |

| SENSOR CKT. OPEN | | | |

52 |PSPS CKT. OPEN | X | | |

53 |TPS CKT ABOVE MAX VOLTAGE | X | | X |

54 |-40 DEGREES F INDICATED ACT - | X | | X |

| SENSOR CKT. OPEN | | | |

56 |MAF SENSOR CKT SHORT TO PWR | X | | X |

60 |CYL #6 LOW -CYL BALANCE TEST | | X | |

61 |254 DEGREES F INDICATED ECT - | X | | X |

| CKT. GROUNDED | | | |

63 |TPS CKT. BELOW MIN. VOLTAGE | X | | X |

64 |254 DEGREES F INDICATED ACT - | X | | X |

| CKT. GROUNDED | | | |

66 |MAF SENSOR CKT OPEN | | | X |

67 |NDS CKT. OPEN - A/C ON DURING | X | | |

| SELF-TEST | | | |

70 |CYL #7 LOW -CYL BALANCE TEST | | X | |

74 |BOO SWITCH CKT. OPEN | | X | |

75 |BOO SWITCH CKT. CLOSED - ECA | | X | |

| INPUT OPEN | | | |

77 |OPERATOR ERROR -(DYNAMIC | | | |

| RESPONSE/CYL BALANCE TEST) | | | |

79 |A/C ON DURING SELF-TEST | X | | |

80 |CYL. #8 LOW -CYL BALANCE TEST | | X | |

81 |AIR MANAGEMENT 1(AM1)CKT FAILURE| X | | |

81 |SPEED CONTROL VENT (SCVNT) CKT |VEHICLE SPD CNTRL TEST |

| FAILURE | | | |

82 |SPEED CONTROL VACUUM(SCVAC) CKT |VEHICLE SPD CNTRL TEST |

| FAILURE | | | |

82 |AIR MANAGEMENT 2(AM2)CKT FAILURE| X | | |

83 |ELECTRO DRIVE FAN (EDF) CKT | X | | |

| FAILURE | | | |

84 |ELECTRONIC VAC REGULATOR (EVR) | X | | |

| CKT FAILURE | | | |

85 |CANNISTER PURGE(CANP)CKT FAILURE| X | | |

87 |FUEL PUMP CKT FAILURE | X | | X |

88 |ELECTRO DRIVE FAN (EDF) CKT | X | | |

| FAILURE | | | |

30-3

ERROR CODE DESCRIPTION

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

ERROR CODE DESCRIPTION (CONT'D)

SELF TEST SECTION

ERROR| |------------------------|

CODE| DESCRIPTION |K.O.E.O | E.R. | CONT |

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

90 |PASS (CYL BALANCE TEST) | | X | |

91 |EGO SENSOR INPUT INDICATES SYS. | | X | |

| LEAN - NO EGO SWITCH | | | |

92 |EGO SENSOR INPUT INDICATES SYS. | | X | |

| RICH | | | |

94 |THERMACTOR AIR SYS. INOPERATIVE | | X | |

95 |FP CKT OPEN -ECA TO MTR GND | X | | X |

96 |FP CKT OPEN - BAT TO ECA | X | | X |

98 |HARD FAULT PRESENT | | X | |

30-4

CHAPTER 31

VIP PARAMETER DICTIONARY

31-1

VIP PARAMETER DICTIONARY

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

VIP PARAMETER DICTIONARY

PARAMETER CALIB. DESCRIPTION

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

ACTMAX 935 MAX ACT (ACT OPEN) UNITS ARE COUNTS

ACTMIN 40 MIN ACT (ACT SHORTED) UNITS ARE COUNTS

BIHP 1 BRAKE INPUT HDWR PRESENT 0=NOT PRESENT

BPSSW 1=DO TEST; 0=DO NOT DO TEST

C14LVL 200 THRESHOLD FOR PIP FAULT -UNITLESS

C14UP 202 UPCOUNT VALUE FOR PIP FAULT FIL. -UNITLESS

C22LVL 200 THRESHOLD FOR BP FAULT -UNITLESS

C22UP 210 UPCOUNT FOR BP FAULT FILTER -UNITLESS

C29LVL 254 THRESHOLD FOR VSS FAULT -COUNTS

C29UP 10 UPCOUNT FOR VSS FILTER -COUNTS

C31LVL 200 THRESHOLD FOR EVP FAULT -UNITLESS

C31UP 100 UPCOUNT FOR EVP FAULT FILTER -UNITLESS

C32LVL 254 THRESHOLD FOR EVP OUT-OF-LIMIT

C32UP 20 UPCOUNT VALUE FOR EVP OUT-OF-LIMIT

C33LVL 200 THRESHOLD FOR NO EGR FLOW

C33UP 10 UPCOUNT VALUE FOR NO EGR FLOW

C34LVL 254 THRESHOLD FOR EGR VALUE OUT-OF-LIMIT

C34UP 20 UPCOUNT VALUE FOR EGR VALUE OUT-OF-LIMIT

C35LVL 200 THRESHOLD FOR EVP INPUT HIGH

C35UP 100 UPCOUNT VALUE FOR EVP INPUT HIGH

C41LVL 200 THRESHOLD FOR EGO FAULT -COUNTS

C41UP 100 UPCOUNT FOR EGO FAULT -COUNTS

C51LVL 200 THRESHOLD FOR ECT OPEN FAULT -UNITLESS

C51UP 100 UPCOUNT FOR ECT OPEN FAULT -UNITLESS

C53LVL 200 THRESHOLD FOR TP OPEN FAULT FIL. -UNITLESS

C53UP 100 UPCOUNT FOR TP OPEN FAULT FILTER -UNITLESS

C54LVL 200 THRESHOLD FOR ACT OPEN FAULT -UNITLESS

C54UP 100 UPCOUNT FOR ACT OPEN FAULT FIL. -UNITLESS

C56LVL 200 THRESHOLD LEVEL FOR FAULT 56

C56UP 20 UPCOUNT FOR FAULT 56

C61LVL 200 THRESHOLD FOR ECT SHORT FAULT -UNITLESS

C61UP 100 UPCOUNT FOR ECT SHORT FAULT FIL. -UNITLESS

C63LVL 200 THRESHOLD FOR TP SHORT FAULT -UNITLESS

C63UP 100 UPCOUNT FOR TP SHORT FAULT -UNITLESS

C64LVL 200 THRESHOLD FOR ACT SHORT FAULT -UNITLESS

C64UP 100 UPCOUNT FOR ACT SHORT FAULT -UNITLESS

C66LVL 200 THRESHOLD LEVEL FOR FAULT 66

C66UP 100 UPCOUNT FOR FAULT 66

C87LVL 200 THRESHOLD FOR FP RELAY FAULT -COUNTS

C87UP 255 UPCOUNT FOR FP RELAY FAULT -COUNTS

C91LVL 200 THRESHOLD FOR EGO FAULT -COUNTS

C91UP 100 UPCOUNT FOR EGO FAULT -COUNTS

C95LVL 200 THRESHOLD FOR CODE 95 -COUNTS

C95UP 100 UPCOUNT FOR CODE 95 -COUNTS

C96LVL 200 THRESHOLD FOR CODE 96 -COUNTS

C96UP 100 UPCOUNT FOR CODE 96 -COUNTS

31-2

VIP PARAMETER DICTIONARY

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

VIP PARAMETER DICTIONARY (CONT'D)

PARAMETER CALIB DESCRIPTION

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

ECTMAX 935 MAX. ENGINE OFF ECT -UNITS ARE COUNTS

ECTMIN 40 MIN. ENGINE OFF ECT -UNITS ARE COUNTS

EDFHP 0 FAN HARDWARE PRESENT SWITCH

EPTMAX 985 MAX. EPT READING -COUNTS

EPTMIN 40 MIN. EPT READING -COUNTS

EVPMAX 985 MAX. EVP READING -UNITS ARE COUNTS

EVPMIN 40 MIN. EVP READING -UNITS ARE COUNTS

FMDTM 0 TIME DELAY BEFORE MIL IS ACTIVATED -SEC

HEDFHP 0 TWO SPEED FAN PRESENT

IDMLVL 200 THRESHOLD FOR IDM -UNITLESS

IDMUP 100 UPCOUNT VALUE FOR IDM -UNITLESS

ISLBND 250 GOOSE IDLE TEST CONTROL BAND LIMIT

ISUBND 250 EXTENDED IDLE TEST CONTROL BAND LIMIT

LEQV 1.3 LEAN LIMIT FOR LAMBDA -UNITS ARE LAMBDAS

LOWBAT 11 LOW BATTERY VOLTAGE -VOLTS

MILLIM 1 MAX. TIME FOR MIL ROUTINE -SEC

MILTM1 0 FLASH RATE FOR MIL -SEC.

NGOOSE 1100 GOOSE TEST DESIRED RPM

NUMEGO 2 NUMBER OF EGO SENSORS

OCCDT1 25 MIN. CHANGE IN OCC AM1 -UNITS ARE COUNTS

OCCDT2 25 MIN. CHANGE IN OCC AM2 -UNITS ARE COUNTS

OCCDT3 0 MIN. CHANGE IN OUTPUT CKT CHECK -COUNTS

OCCDT4 30 MIN. CHANGE IN OCC EVR -UNITS ARE COUNTS

OCCDT5 30 MIN. CHANGE IN OCC CANP -UNITS ARE COUNTS

OCCDT7 30 MIN. CHANGE IN OCC FP -UNITS ARE COUNTS

OCCDT8 0 MIN. CHANGE IN OUTPUT CKT CHECK -COUNTS

OCCDTA 25 MIN. CHANGE IN OCC SCVNT -COUNTS

OCCDTB 25 MIN. CHANGE IN OCC SCVAC -COUNTS

PFEHP 0 SWTCH TO SELECT EGR STRAT, 1=PFE 0=SONIC

PSPSHP 0 PSPS HARDWARE, NO PRESSURE SWITCH

REQV 0.75 RICH LIMIT FOR LAMBDA -UNITS ARE LAMBDAS

TAPMAX 990 MAX. TP SENSOR READING -UNITS ARE COUNTS

TAPMIN 40 MIN. TP SENSOR READING -UNITS ARE COUNTS

THRMHP 1 THERMACTOR AIR HARDWARE SWITCH

V820A 1 ISC DUTY CYCLE MULTIPLIER

V860 5 C/L PACING FUNCTION

VACRR 4 VEH. SPEED RAMP RATE MPH/SEC

VAIRFL 1 SECONDARY AIR TEST FLAG 1=DO TEST

VATMR2 10 TIME TO WAIT BEFORE DOWN STREAM AIR TEST

-SEC.

VBISW 0 BRAKE ON/OFF TEST, 1=ENABLE 0=DISABLE

VBPDL1 1200 MIN. BP DURING VIP TEST -TICKS

31-3

VIP PARAMETER DICTIONARY

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

VIP PARAMETER DICTIONARY CONT'D

VIP PARAMETER DICTIONARY

PARAMETER DESCRIPTION

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

VBPDL2 1563 MAX. BP DURING VIP TEST - TICKS

VBPMAX 0.15 MAX. TIME SINCE LAST BP UPDATE -SEC

VCBCLP .065 MAX. CLIP ON DROP REQD FOR CYL BAL TEST

RPM/100

VCBDLY 22 DELAY BEFORE STARTING CYL BAL TEST -SEC.

VCBFLG 1 FLAG:0=BYPASS TEST, -1=ALLOW TEST 1=ALLOW

MULTIPLE TEST ENTRY

VCBPAD 0.0075 ADDED TO VCBPCT EA. REPEAT OF C.B. TEST

VCBPCT .05 % RPM DROP REQ'D FOR CYLINDER BAL. TEST

VCBTM1 3 TIME TO AVG. N, ALL INJECTORS ON -SEC

VCBTM2 3 TIME TO AVG. N, ALL INJECTORS OFF -SEC

VCRTDC .85 EVR DC FOR CRUISE TEST -DC

VDCBIA 2.3 VEH. SPEED DC BIAS

VDCMAX .85 MAX. EVR DC FOR ENGINE-ON EGR TEST -DC

VDCMIN .25 MIN. EVR DC FOR ENGINE-ON EGR TEST -DC

VDISFM 0 FMEM FAULT BYPASS FLAG

VDLEDF 4 MIN. TIME TO HOLD ON LOW FAN WHILE PER-

FORMING OCC TEST -SEC

VDLHED 2 MIN. TIME TO HOLD ON HI FAN WHILE PER-

FORMING OCC TEST -SEC

VDLY1 1 DELAY FOR FUEL RICH TEST -UNITS ARE SEC

VDLY10 15 DELAY BEFORE STARTING SPEED RAMP -SEC

VDLY11 3 DELAY AFTER SPEED RAMP -SEC

VDLY2 3 TIME TO DELAY BEFORE DUMP/UPSTREAM AIR -SEC

VDLY8 0 DELAY BEFORE EXIT FROM FUEL TEST

VECT3 150 MIN. COOLANT TEMP. (ENGINE-ON)-DEG. F

VECT5 120 STARTING COOLANT TEMP. FOR WARM-UP CNT -DEG

VECTMR 2 TIMER FOR EGR CRUISE TEST -SEC

VEGOBP 1 EGO SWITCHING TEST 1=ENABLE

VEGOSW 8 NO. OF EGO SWITCHES REQ'D TO PASS

VEGOTM 240 MIN. TIME TO ENABLE EGO TEST AFTER REACHING

CLOSED LOOP TEMP

VEGRAT .07 EVR DC RATE FOR ENGINE-ON EGR TEST DC/SEC

VEGRLOAD .35 MAX. LOAD TO DO CONT. EGR FLOW TESTD

VEGVAC 7 MIN. MAN. VAC. FOR EGR CRUISE TEST -IN HG

VEPTIL 605 EPT LOW LIMIT AT IDLE

VEPTLL 610 EPT LOW LIMIT ENG OFF -COUNTS

VEPTRH 850 EPT HIGH LIMIT, ENG. RUN -COUNTS

VEPTRL 615 EPT LOW LIMIT, ENG RUN -COUNTS

VEVPCL 160 EVP CRUISE LIMIT TEST -COUNTS

VEVPDL 80 EVP DELTA FOR ENGINE-ON EGR TEST -COUNTS

VEVPHL 138 EVP UPPER LIMIT -COUNTS

VEVPLL 60 EVP LOWER LIMIT -COUNTS

31-4

VIP PARAMETER DICTIONARY

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

VIP PARAMETER DICTIONARY

VIP PARAMETER DICTIONARY

PARAMETER CALIB DESCRIPTION

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

V\_FPMDLY 2 DELAY PRIOR TO ENG OFF F.P. CKT TEST -SEC

V\_FPMFLG 1 F.P. CKT FLAG, 1=DO TEST

V\_FPMTM 1 TIME DELAY PRIOR TO CONT. F.P. TEST -SEC

VFPREQ 1 FUEL PUMP RELAY TEST, 1=DO TEST

VHFNTM 15 MIN. TIME TO HOLD DOWN TP TO ENABLE HI

FAN OUTPUT -SEC

VIACT1 717 MIN. CHARGE TEMP. (ENGINE-OFF)- COUNTS

VIACT2 63 MAX. CHARGE TEMP. (ENGINE-0FF) -COUNTS

VIACT3 761 MIN. CHARGE TEMP. (ENGINE-ON) -COUNTS

VIACT4 63 MAX. CHARGE TEMP. (ENGINE-ON) -COUNTS

VIDMST 4 TIME FOR IDM BYPASS AFTER PIP RECOVERY

-SEC

VIDMTM 130 TIME OUT FOR IDM FAULT -UNITS ARE MILLI-

SECONDS

VIECT1 717 MIN. COOLANT TEMP. (ENGINE-OFF) -COUNTS

VIECT2 63 MAX. COOLANT TEMP. (ENGINE-OFF) -COUNTS

VIECT3 235 MIN. COOLANT TEMP. (ENGINE-ON) -COUNTS

VIECT4 63 MAX. COOLANT TEMP. (ENGINE-ON) -COUNTS

VIPLR1 .025 RATE TO RAMP LEAN -LAMBDAS/SEC

VIPRR1 .05 RATE TO RAMP RICH -LAMBDAS/SEC

VIPSPK 30 VIP SPARK ADVANCE -DEG.

VIPT1 20 MAX. TIME IN STATIC VSC TEST -SEC

VIPT2 20 MAX. RAMP TIME VSC TEST -SEC

VIPT3 15 MAX. TIME IN HOLD TEST -SEC

VIPT4 15 MAX. TIME FOR SPEED DECREASE -SEC

VIPTM2 10 TIME TO WAIT FOR EGO SWITCH -SEC

VIPTM3 20 TIME IN LOOP FOR LEAN FUEL -SEC

VIPTM4 10 TIME TO WAIT FOR EGO RICH -SEC

VISCN 1600 VIP DESIRED RPM

VISCN1 1550 DESIRED RPM TO DO CYLINDER BALANCE TEST

VISDL1 16 ISC DELAY TIME -SEC

VISDL3 10 GOOSE IDLE DELAY TIME -SEC

VISDL4 6 DELAY PRIOR TO CYLINDER BALANCE TEST

VISDL5 6 TIME TO WAIT FOR RPM DROP IN CYL. BALANCE TEST

VKYPWR 200 IV POWER LOWER LIMIT -COUNTS

VLAMCB .955 LAMBDA FOR CYLINDER BALANCE TEST

VLFNTM 10 MIN. TIME TO HOLD DOWN TP TO ENABLE LOW FAN

-SEC

VLORPM 500 MIN RPM FOR PIP/IDM TEST -RPM

VMAF01 20 MAF ENG. OFF VIP LOW LIMIT -COUNT

VMAFPIPLMT 50 MASS AIR FLOW PIP LIMIT -MSEC

VMAFR1 200 MAF. ENG RUNNING VIP LOWER LIMIT -COUNT

VMAFR2 400 MAF ENG RUNNING VIP UPPER LIMIT -COUNT

VMAMAX 1000 MAF CONT. VIP SHORT TO PWR LIMIT -COUNT

VMAMIN 100 MAF CONT. VIP OPEN CKT LIMIT -COUNT

VMARPM 4500 MAF THRESHOLD RPM FOR FAULT 56 -RPM

VML0 35 LOW MPH LIMIT FOR SPD DECREASE IN VSC TEST

VN 900 MAX. IDLE SPEED FOR EPT TEST

VNMIN 900 MIN. RPM FOR FUEL TEST -RPM

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VIP PARAMETER DICTIONARY

EEC-EPCD, FoMoCo, PROPRIETARY & CONFIDENTIAL

VIP PARAMETER DICTIONARY CONT'D

PARAMETER CALIB DESCRIPTION

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VPIPTM 60 TIME OUT FOR PIP FAULT -MSEC

VPSIND .000035 VIP GAIN FOR OVERSPEED CONDITIONS

VPSINU .000045 VIP GAIN FOR UNDERSPEED CONDITIONS

VPSSW 0 POWER STEERING PRESS. SWITCH TEST, 1=ENABLE

VPTCNT 10 NO. OF CLOSED TO PART THROT. TRANS. TO ENABLE

VRLAM 0.9 LAMBDA FOR EGO TEST

VRSH 3 BAND FOR VEH. SPD TEST

VRSS 60 SET SPEED FOR VEH. SPEED TEST

VSAMIN 2000 MIN. RPM TO DO VSS TEST WITH A/T

VSIBRM 0.6 MAX. ALLOWED VALUE FOR IPSIBR

VSIBRN -0.6 MIN. ALLOWED VALUE FOR IPSIBR

VSLOAD .266 MAX DECEL LOAD M/T VSS TEST

VSMAPL 7 MAX. DECEL MAP TO DO VSS TEST M/T, IN HG

VSMMIN 1250 MIN. RPM TO DO VSS TEST WITH M/T

VSPADV 30 SPARK ADVANCED FOR SPOUT TEST

VSPRET 10 RETARDED SPARK FOR SPOUT TES

VSPRPM 200 MIN. RPM TO PASS SPOUT TEST

VSPTDL 5 MIN. STABILIZED TIME FOR SPOUT TEST

VSPTEN 1 SPOUT TEST ENABLE SWITCH WHEN =1

VSSMN1 5 MIN. VEH. SPD TO PASS VSS TEST

VSSSW 1 VSS TEST ENABLE SWITCH WHEN =1

VSSTIM 3 MIN. STABILIZED TIME BEFORE VSS TEST

VSTGN .014 SET SPD PROPORTIONAL GAIN -D.C./MPH

VSTYPE 2 VSC SYSTEM PRESENT WHEN =1

VTABFL 1 FLAG TO DO THERMACTOR TEST 1=DO TEST

VTAP1 150 MIN. ENGINE-OFF THROTTLE POSITION -COUNTS

VTAP2 250 MAX. ENGINE-OFF THROTTLE POSITION -COUNTS

VTAP3 150 MIN. TP -COUNTS

VTAP4 250 MAX. TP -COUNTS

VTAP5 400 UPPER LIMIT OF TP FOR OUTPUT TEST -COUNTS

VTAP6 350 LOWER LIMIT OF TP FOR OUTPUT TEST -COUNTS

VTCDSN 2.75 DSDRPM TIME CONSTANT FOR VIP -SEC

VTCEGO 1.250 TIME CONSTANT FOR EGO -SEC

VTCEPT 0.025 TIME CONSTANT FOR EPT -SEC

VTPGN .005 THROT POS PROPORTIONAL GAIN, DC/COUNT

VTPLD 10 MIN. TP GAIN FOR VSC TEST -COUNTS

VTPLU 10 MAX. TP GAIN FOR VSC TEST -COUNTS

VVHGN .014 VEH. SPD PROPORTIONAL GAIN, DC/MPH

VVSCET 60 MAX. TIME IN VSC TEST -SEC

WIGLVL 200 UPCOUNT VALUE IN WIGGLE TEST -UNITLESS

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