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PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

POWERTRAIN ELECTRONIC CONTROL STRATEGY BOOK

| STRATEGY LEVEL "LHBH1"

FOR USE WITH 2ND GENERATION EEC-IV MODULE: EFI-SD20

THE PROCEDURE FOR OBTAINING COPIES OF THIS BOOK OR ANY OTHER AVAILABLE "LH"

DOCUMENTATION IS EXPLAINED ON THE NEXT PAGE.

LARRY SIERSMA

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STRATEGY PLANNING & PROCESS DESIGN SECTION

CONTROL SYSTEMS DEPT

POWERTRAIN ELECTRONICS

DEVELOPMENT - PTE

| SOFTWARE RELEASE DATE: MARCH 24, 1993

| STRATEGY BOOK RELEASE DATE: MARCH 25, 1993

OBTAINING DOCUMENTATION - LHBH0

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"LH" 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,

SYS3, SYS4, ETC.) and issuing one or more of the following VAX/DCL commands.

Generally, two 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. The file name format is LH\*\*\*UP.MEM, where \*\*\* is the desired new

strategy level.

2. COMPLETE BOOKS - The file name format is LH\*\*\*.MEM, where \*\*\* is the

desired strategy level. Changes in text which have occurred since the

previous level book will be indicated with 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:LH\*\*\*.MEM

DIR STRATEGY:LH\*\*\*UP.MEM

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

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

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

XEROX STRATEGY:LH\*\*\*.MEM/DEST=EEE/USERNAME=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:

EDTS

AT THE EDTS MAIN MENU, SELECT "Standard Reports Menu" (number 6)

THEN, SELECT "EMR's Within EMR Group" (number 3)

TO DETERMINE THE STATUS OF STRATEGY BOOK DOCUMENTATION, TYPE:

@STRATEGY:BOOKSTATUS

OBTAINING DOCUMENTATION - LHBH0

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TABLE OF CONTENTS LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

LAST

PAGES SUBJECT REVISION

| 1-1 to 1-28 STRATEGY EVOLUTION LHBH1

2-1 to 2-18 SYMBOLOGY LHBD0

3-1 to 3-6 EEC OVERVIEW LHAS0

4-1 to 4-6 CRANK/UNDERSPEED/RUN MODE SELECTION LHJ0

5-1 to 5-4 THROTTLE MODE SELECTION LHE0

6-1 to 6-104 FUEL STRATEGY

6-2 to 6-4 OVERVIEW LHAQ0

6-5 to 6-8 ACCELERATION ENRICHMENT LHBD0

6-9 to 6-11 WARM EGO LOGIC LHAQ0

6-12 to 6-13 LAMMUL RESET LOGIC LHAH0

6-14 to 6-16 OPEN LOOP FLAG DETERMINATION LHBC0

6-17 to 6-18 CALCULATION OF LAMAVE LHAT0

6-19 to 6-30 OPEN LOOP LAMBSE CALCULATION LHBH0

6-31 to 6-39 CLOSED LOOP LAMBSE CALCULATION LHBD0

6-40 DAC REGISTER CALCULATION LHAQ0

6-41 to 6-57 ADAPTIVE FUEL LOGIC LHBE0

6-58 to 6-59 KAM ADAPTIVE FUEL LOGIC LHAQ0

6-60 to 6-66 TRANSIENT FUEL COMPENSATION LHAQ0

6-67 to 6-68 HOT INJECTOR COMPENSATION LHAQ0

6-69 to 6-70 INJECTOR DELAY LOGIC LHAQ0

6-71 to 6-74 IDLE FUEL MODULATION LHAV0

6-75 to 6-80 DECEL FUEL SHUT-OFF LOGIC LHBE0

6-81 to 6-89 BACKGROUND PULSEWIDTH DETERMINATION LHBH0

6-90 FUEL PUMP CONTROL LOGIC LHAS0

6-91 PPCTR CONTROL LHAQ0

6-92 to 6-101 FUEL SERVICE ROUTINE LHBD0

6-102 to 6-106 INJECTOR TIMING ROUTINE LHAQ0

7-1 to 7-68 IGNITION TIMING STRATEGY

7-2 to 7-24 BASE SPARK LHBH0

7-25 to 7-31 DWLBSE/DWLCOR CALCULATION LHJ0

7-32 to 7-35 DWELL\_CALCULATION LHJ0

7-36 to 7-39 MKAY/SIGKAY CALCULATION LHL0

7-40 to 7-42 TRANSIENT SPARK COMPENSATION LHKO

7-43 to 7-44 PIP\_DATA LHK0

7-45 to 7-50 SPOUT\_KNOCK ROUTINE LHJ0

7-51 to 7-52 VIP, EOS\_IDM LHJ0

7-53 to 7-68 INDIVIDUAL CYLINDER KNOCK LHL0

8-1 to 8-20 EGR STRATEGY

8-2 to 8-6 EGR SELECT LOGIC LHBE0

8-7 to 8-16 SONIC EGR LHBE0

8-17 to 8-20 EVR CONTROL ALGORITHM LHF0

TABLE OF CONTENTS LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

9-1 to 9-52 IDLE SPEED CONTROL

9-2 to 9-10 GENERIC IDLE SPEED CONTROL LHAX0

9-11 to 9-23 DESIRED RPM CALCULATION LHBH0

9-24 to 9-26 RPM ERROR CALCULATION LHBH0

9-27 to 9-32 DASPOT CALCULATIONS LHAX0

9-33 to 9-39 MODE SELECT LHAP0

9-40 to 9-43 KAM UPDATE LHAX0

9-44 to 9-46 DUTY CYCLE CALCULATION LHAU0

9-47 to 9-52 IPSIBR CALCULATION LHBG0

10-1 to 10-4 GOVERNOR MAP SIGNAL STRATEGY LHAX0

11-1 to 11-8 CANISTER PURGE STRATEGY LHBA0

12-1 to 12-10 THERMACTOR AIR STRATEGY LHBG0

13-1 to 13-38 DATA COMMUNICATIONS LINK

13-2 to 13-6 OVERVIEW LHI0

13-7 to 13-29 DIAGNOSIS MODE LHAZ0

13-30 to 13-34 PID TABLES AND BIMAP DEFINITIONS LHAZ0

13-35 to 13-38 UART MESSAGE CHECK LHBH0

14-1 to 14-8 DATA OUTPUT LINK

14-2 to 14-4 DATA OUTPUT LINK LHAX0

14-5 to 14-8 PULSE CALCULATION LHBD0

15-1 to 15-6 ALTERNATIVE CALIBRATION

15-2 to 15-3 CALIBRATION INITIALIZE LOGIC LHBH0

15-4 to 15-6 CALIBRATION CLEAR LOGIC LHBH0

16-1 to 16-44 SHIFT CONTROL

16-2 to 16-4 E4OD TRANSMISSION STRATEGY OVERVIEW LHAP0

16-5 to 16-8 PRNDL BASED DESIRED GEAR

DETERMINATION LHL0

16-9 to 16-14 GR\_DS, PRNDL = 3 OR 4 LOGIC LHAV0

16-15 to 16-18 DELAY/VERIFY SHIFT LOGIC LHD0

16-19 to 16-23 PRNDL BASED COMMANDED GEAR

DETERMINATION LHBB0

16-24 to 16-25 GR\_CM, PRNDL = 1 LOGIC LHAP0

16-26 to 16-27 GR\_CM, PRNDL = 2 LOGIC LHAP0

16-28 GR\_CM, PRNDL = 3 or 4, DOWNSHIFT LOGIC LHAP0

16-29 to 16-32 LOAD SHIFT IN PROGRESS TIMER LHL0

16-33 to 16-36 DETERMINE SHIFT SOLENOID STATES LHL0

16-37 to 16-44 SHIFT VALIDATION LOGIC LHBA0

17-1 to 17-48 ELECTRONIC PRESSURE CONTROL

17-2 to 17-15 ELECTRONIC PRESSURE CONTROL GUIDE LHBG0

17-16 START-UP TV LOGIC LHAS0

17-17 to 17-18 COAST BOOST LOGIC LHM0

17-19 to 17-25 ENGAGEMENT/STALL TV LOGIC LHBG0

17-26 to 17-32 NORMAL TV CALCULATION LHBB0

17-33 to 17-34 TQ\_IALPHA CALCULATION LHG0

17-35 to 17-39 DYNAMIC TV CALCULATION LHAX0

17-40 to 17-43 OFMFLG LOGIC LHBB0

17-44 to 17-45 TV VFS OUTPUT ROUTINE LHA0

17-46 to 17-48 TRANSMISSION OVERTEMPERATURE TEST LHBB0

TABLE OF CONTENTS LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

18-1 to 18-48 CONVERTER CLUTCH SOLENOID CONTROL STRATEGY

18-2 to 18-5 CONVERTER CLUTCH CONTROL LHBB0

18-6 to 18-14 UNCONDITIONAL UNLOCK LOGIC LHL0

18-15 to 18-16 SHIFT UNLOCK LOGIC LHH0

18-17 INITIALIZE DOWNSHIFT LHH0

18-18 to 18-19 DOWNSHIFT CONVERTER CLUTCH LHAP0

18-20 to 18-24 INITIALIZE UPSHIFT LHAZ0

18-25 to 18-28 UPSHIFT CONVERTER CLUTCH LHAZ0

18-29 to 18-33 SCHEDULED LOCK/UNLOCK LOGIC LHAS0

18-34 to 18-36 WOT LOCK-UP LOGIC LHAS0

18-37 to 18-38 HIGH SPEED UPSHIFT LHI0

18-39 to 18-41 CONVERTER CLUTCH VALIDATION LHBE0

18-42 to 18-45 COAST CLUTCH CONTROL LHBE0

18-46 to 18-48 FAILURE MODE MANAGEMENT LOCK-UP LHBB0

19-1 to 19-26 TRANSMISSION INPUT CONVERSIONS

19-2 to 19-6 TRANSMISSION CONTROL INDICATOR LIGHT LHBB0

19-7 TCIL OUTPUT LHBB0

19-8 to 19-11 TORQUE CALCULATIONS LHAS0

19-12 to 19-15 E40D TRANSMISSION CALCULATIONS LHAS0

19-16 VSBART\_FM CALCULATION LHAY0

19-17 ETV OVERCURRENT MONITOR VOLTAGE LHAS0

19-18 to 19-19 TRANSMISSION CONTROL SWITCH LHBB0

19-20 to 19-21 4 X 4 LOW SWITCH LHAS0

19-22 to 19-26 RT\_NOVS\_KAM CALCULATION LHBG0

20-1 to 20-72 SYSTEM EQUATIONS

20-2 to 20-26 SYSTEM EQUATIONS LHAS0

20-27 to 20-28 VS\_RATEPH CALCULATIONS LHAU0

20-29 to 20-44 MANIFOLD ABSOLUTE PRESSURE LHAZ0

20-45 to 20-48 ENGINE SPEED CALCULATION LHH0

20-49 to 20-51 SPEED DENSITY AIR MASS CALCULATION LHAZ0

20-52 to 20-55 ROLLING AVERAGE ROUTINE LHAS0

20-56 to 20-57 TCSTRT, ACSTRT, INIT\_TOT ROUTINE LHF0

20-58 PIP NOISE FILTERING LHA0

20-59 to 20-60 POWER MODE LHA0

20-61 to 20-62 COLD TEMPERATURE TV SOLENOID OPERATION LHAS0

20-63 to 20-64 DYNAMIC TV DUE TO COLD TRANSMISSION LHC0

20-65 to 20-66 COLD SHIFT MULTIPLIER LHAS0

20-67 to 20-72 MLPS CONVERSION LHBB0

21-1 to 21-22 TIMERS LHBB0

22-1 to 22-24 FAILURE MODE MANAGEMENT

22-2 OVERVIEW LHAQ0

22-3 to 22-4 FAILURE RECOGNITION LHAQ0

22-5 to 22-7 ACT SENSOR UPDATE LHAQ0

22-8 to 22-11 ADAPTIVE FUEL TABLE FMEM LHAS0

22-12 to 22-15 ECT SENSOR UPDATE LHAQ0

22-16 to 22-17 EVP SENSOR FMEM LHAQ0

22-18 to 22-19 TOT SENSOR FMEM LHAQ0

22-20 to 22-24 TP SENSOR FMEM LHAQ0

TABLE OF CONTENTS LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

23-1 to 23-10 INFERRED BAROMETRIC PRESSURE STRATEGY LHA0

24-1 to 24-6 KEEP ALIVE MEMORY LHAS0

25-1 to 25-4 EEC-IV SELF TEST OVERVIEW

25-2 EEC-IV SELF TEST OVERVIEW LHBB0

25-3 to 25-4 EEC-IV SELF TEST BLOCK DIAGRAMS LHBB0

26-1 to 26-8 SELF TEST ENTRY/EXIT LOGIC LHBB0

27-1 to 27-34 ENGINE OFF SELF TEST

27-2 to 27-4 ENGINE OFF SELF TEST SEQUENCE LHBB0

27-5 to 27-6 KAM/RAM TEST LHBB0

27-7 READ-ONLY MEMORY TEST (ROM) LHBB0

27-8 to 27-9 ENGINE COOLANT TEMPERATURE SENSOR LHBB0

27-10 to 27-12 MANIFOLD ABSOLUTE PRESSURE SENSOR TEST LHBB0

27-13 THROTTLE POSITION SENSOR LHBB0

27-14 AIR CHARGE TEMPERATURE SENSOR TEST LHBB0

27-15 to 27-16 TRANSMISSION OIL TEMPERATURE SENSOR

TEST LHBB0

27-17 EXHAUST GAS RE-CIRCULATION SENSOR TEST LHBB0

27-18 A/C SWITCH TEST LHBB0

27-19 to 27-20 MANUAL LEVER POSITION SENSOR INPUT

TEST LHBB0

27-21 4X4L SWITCH INPUT TEST LHBB0

27-22 POWER STEERING PRESSURE SWITCH TEST LHBB0

27-23 IVPWR INPUT TEST LHBB0

27-24 OUTPUT CIRCUIT CHECK LHBB0

27-25 to 27-26 OUTPUT CIRCUIT CHECK TEST STRUCTURE LHBB0

27-27 to 27-30 FUEL PUMP MONITOR TEST LHBB0

27-31 to 27-32 ELECTRONIC PRESSURE CONTROL SOLENOID

TEST LHBB0

27-33 to 27-34 OUTPUT TEST MODE LHBB0

28-1 to 28-46 ENGINE RUNNING SEQUENCE

28-2 to 28-3 ENGINE RUNNING TEST STRUCTURE LHBB0

28-4 EGOBAR FILTER AND STATE FLAGS LHBB0

28-5 DELAY LOGIC CLARIFICATION LHBB0

28-6 to 28-10 ENGINE RUNNING INITIALIZATION LHBB0

28-11 to 28-13 GENERIC IDLE SPEED CONTROL LHBB0

28-14 HIGH RPM ISC TEST LHBB0

28-15 ECT SENSOR TEST LHBB0

28-16 MAP SENSOR TEST LHBB0

28-17 THROTTLE POSITION SENSOR LHBB0

28-18 AIR CHARGE TEMPERATURE SENSOR TEST LHBB0

28-19 TRANSMISSION OIL TEMPERATURE SENSOR LHBB0

28-20 to 28-21 BRAKE ON/OFF TEST LHBB0

28-22 to 28-23 POWER STEERING PRESSURE SWITCH TEST LHBB0

28-24 to 28-25 TRANSMISSION CONTROL SWITCH TEST LHBB0

28-26 to 28-28 EGO SWITCHING TEST LHBG0

28-29 to 28-30 THERMACTOR AIR TEST LHBB0

28-31 to 28-32 SPARK CONTROL TEST LHBB0

28-33 to 28-34 EXHAUST GAS RE-CIRCULATION SYSTEM TEST LHBB0

28-35 LOW RPM ISC TEST LHBB0

28-36 to 28-40 GOOSE TEST LHBB0

28-41 to 28-46 THROTTLE PLATE ADJUSTMENT MODE LHBB0

TABLE OF CONTENTS LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

29-1 to 29-76 CONTINUOUS TEST STRUCTURE

29-2 FILTERING LOGIC LHBB0

29-3 to 29-4 FAULT THRESHOLD/UPCOUNT VALUE

SELECTION LHBB0

29-5 KAM CODE WARM\_UP COUNTER/ERASE LOGIC LHBB0

29-6 to 29-11 COOLING SYSTEM TEST LHBB0

29-12 ECT OPEN/SHORT TESTS LHBB0

29-13 ACT SENSOR TESTS LHBB0

29-14 TRANSMISSION OIL TEMPERATURE SENSOR LHBB0

29-15 MANIFOLD ABSOLUTE PRESSURE SENSOR LHBB0

29-16 to 29-20 MAP SENSOR VACUUM CIRCUIT TEST LHBB0

29-21 to 29-29 SONIC EGR LHBE0

29-30 to 29-31 EGR SYSTEM SELECT LHBE0

29-32 to 29-34 IGNITION DIAGNOSTIC MONITOR LHBB0

29-35 CONVERTER CLUTCH VALIDITY TEST LHBB0

29-36 ELECTRONIC PRESSURE CONTROL SOLENOID LHBB0

29-37 THROTTLE POSITION SENSOR TEST LHBB0

29-38 to 29-40 VEHICLE SPEED SENSOR TEST LHBF0

29-41 to 29-45 BRAKE ON/OFF CIRCUIT TEST LHBB0

29-46 to 29-50 ADAPTIVE TABLE CLIP TEST LHBB0

29-51 to 29-66 EGO SWITCHING TEST LHBH0

29-67 to 29-70 FUEL PUMP CIRCUIT TEST LHBB0

29-71 to 29-76 MALFUNCTION INDICATOR LIGHT LHBB0

30-1 to 30-4 ERROR CODE DESCRIPTION LHBB0

31-1 to 31-2 ROM IDENTIFICATION CODE LHA0

| INDEX LHBH1

TABLE OF CONTENTS LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CHAPTER 1

STRATEGY EVOLUTION

1-1

STRATEGY EVOLUTION - LHBH1

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STRATEGY EVOLUTION

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

RELEASE BASE ERD/ EMR

FILE FILE URD NO. NO. DESCRIPTION OF CHANGE

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

| LHBH1 LHBH0

| (03/24/93

| 10169 94-1237 COMMUNICATION - DCL - Running change

| needed to correct lose of ISCDTY.

| 10394 94-1247 COMMUNICATION - DCL - Update code to

| properly set bits in DCL BITMAP\_1

| register.

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

LHBH0 LHBG0

(09/28/92)

8143 93-769 IDLE SPEED - IPSIBR CALC - IPSIBR not

updating during RUNNING SELF-TEST.

8384 93-77 EGR - OTHER - Bypass EGR enabled check

during wiggle for 327/337.

8629 93-775A EGR - EGR FMEM - EMR # 93-775, was

improperly implemented in LHBGA and

LHBH0.

7682 94-745 SPARK - OTHER - Add anti plug fouling

strategy.

8458 94-820C OBD-I CONT TEST EGO SWITCHING TEST -

update LH ego test.

8458 94-820D OBD-I CONT TEST EGO SWITCHING TEST -

lazy/buzz logic not in code.

8458 94-820E OBD-I CONT TEST EGO SWITCHING TEST -

associate parameter with LH.

8458 94-820F OBD-I CONT TEST EGO SWITCHING TEST -

change V\_EGO\_BYPS := 0 to ... := 1

8392 94-858 GENERAL - OTHER - ALT\_CAL\_FLG is set

during PWR UP aftr battery discon-

nect.

8447 94-873 SPARK - OTHER - Documentation clean up.

8559 94-92 SPARK - OTHER - Corrections to anti

plug fouling strategy.

7564 95-122 FUEL - CRANK - Allow greater flexi-

bility with de-choke and APT.

7564 95-122A FUEL - CRANK - Strat. err:

TP\_REL>TP\_DECHOKE should be

TP\_REL<=TP\_DECHOKE.

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

LHAG0 LHAF0

(07/15/92)

2185 91-303 SELF-TEST - KOER - Greater flexibility

for RUNNING EGO SENSOR TEST.

7781 93-761 FUEL - ADAPTIVE - Function enhancement.

7005 94-588B TRANSMISSION - SELF TEST/FMEM - 4X4 low

input error detection.

7005 94-588C TRANSMISSION - SELF TEST/FMEM - 4X4 low

input error detection.

7082 94-603 TRANSMISSION - SHIFT CONTROL - Improve

engagm't strategy by using TOT and NEBART.

7231 94-641 IDLE SPEED - OTHER - Induction of the

A/C pressure switch in 94-E&F CALIB.

1-2

STRATEGY EVOLUTION - LHBH1

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7231 94-641A IDLE SPEED - OTHER - Induction of the

A/C pressure switch in 94-E&F CALIB.

7741 94-718 TRANSMISSION - EPC - EPC spikes during

engagements.

7184 95-102 GENERAL - OTHER - RPM calc. does not

take advantage of full 0.25 accuracy.

7783 95-141 THERMACTOR - UP/DOWN STREAM - Allow

capability to dump thermactor during

closed loop fuel.

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

LHBF0 LHBE0

(06/04/92)

7202 93-740 TRANSMISSION - SELF TEST/FMEM - Replace

N with nebart in vehicle speed sensor

test.

7519 93-746 EGR - EGR CONTROL - Correct software

error in EGR RATE calculation.

7745 93-757 EGR - EGR CONTROL - Software: omitted

FN240(WOTTMR) from EGRATE calculation.

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

LHBE0 LHBD0

(05/29/92)

7078 93-710A EGR - EGR CONTROL - Change EGR logic to

enable EGR for periods at WOT.

7078 93-710B EGR - EGR CONTROL - Change EGR at WOT

logic to provide MAP hysteresis.

7405 93-734 THERMACTOR - UP/DOWN STREAM - Modify

Thermactor Dump as a f'n of RPM, avoid

backfires.

7405 93-734A THERMACTOR - UP/DOWN STREAM - Correct

error in flop flop. Required change.

7705 93-734B THERMACTOR - UP/DOWN STREAM - Revise

thermactor dump at low TP\_REL to allow

air at idle.

7408 93-737 FUEL - ADAPTIVE - Function enhancement

that will allow more adaptive learning.

6049 94-280 SELF-TEST - KOER - Correct spark control

test in koer - software only.

1-3

STRATEGY EVOLUTION - LHBH1

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7523 94-477B FUEL - ADAPTIVE - Do not use reference

cell values for update rates.

7025 94-551C OBD-I CONT TEST EGR - Lock out 327, 337

til EGR enabled. Convert to ladder

diagram.

7025 94-551H EGR - EGR ENABLE - Correct strategy

error in EGR enable logic.

7025 94-551I OBD-I CONT TEST EGR - Match strategy to

existing software. Sonic EGR test.

7005 94-588 TRANSMISSION - SELF TEST/FMEM - 4X4

low input error detection.

7385 94-647 OBD-I ENG OFF - OUTPUT TEST MODE -

Software error in output test mode

self-test.

7637 94-690 FMEM - FAILURE RECOGNITION - Many

failures of code 628 have been reported.

7667 94-702 FUEL - DECEL FUEL SHUT-OFF - Software

error found in fuel pulsewidth

calculation.

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

LHBD0 LHBC0

(05/01/92)

6727 92-562A TRANSMISSION - SELF TEST/FMEM -

Modify FMEM action for Transmission

Overtemperature - LH,AC.

5089 93-150G SELF-TEST - CONTINUOUS - Create

variant strategy for 5.8l/o to

alter ego test.

7035 93-708 GENERAL - OTHER - Avoid future

software/strategy errors.

6623 94-431 COMMUNICATION - DOL - Addition of

distance-to-empty feature (DOL).

6834 94-471 GENERAL - OTHER - Update SYMBOLOGY

chapter to current symbology usage.

6862 94-477 FUEL - ADAPTIVE - Four adaptive

improvements.

7302 94-477A FUEL - ADAPTIVE - Random number

algorithm will not function properly.

7241 94-589 FUEL - OTHER - FUEL\_SUM should be in

ticks for LL and LH.

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

LHBC0 LHBB1

(01/23/92)

6100 93-657 FUEL - ADAPTIVE - Include logic to limit

the time to adapt in WOT.

6100 93-657A FUEL - ADAPTIVE - Correct parameter

XMAPPA base value in Parameter Dictionary.

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

LHBB1 LHBB0

(11/11/91)

6076 93-616 TRANSMISSION - MLPS - IPDL getting

intermittant values outside correct

range.

6098 93-621 TRANSMISSION - EPC - Fix TV from going

to 127.5 every background loop.

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

1-4

STRATEGY EVOLUTION - LHBH1

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LHBBO LHBAO

(10/02/91)

4724 93-333 TRANSMISSION - Revise coverter clutch

validation error code setting logic.

5409 93-365B FUEL - DFSO - Thermactor and DFSO need

different d\_tp\_dt terms.

5056 93-396 TRANSMISSION - FMEM - Rename OCIL, ASML,

and ASMIL to TCIL.

5056 93-396H TRANSMISSION - FMEM - Correct Parameter

Transactions for LH.

5264 93-432 TRANSMISSION - NORM TV CALC - SCSLPXXX,

and SCSLPX cal constants overflow a byte.

5340 93-454 TRANSMISSION - DET SHFT SOL - Main

Control Rev'ns require calibratible sol.

states in Neu.

5359 93-461 TRANSMISSION - FMEM - Request to Improve

FMEM Action for E4OD.

5359 93-461A TRANSMISSION - FMEM - Add C657\_KAM\_BIT

to AC, LH, and AG.

5359 93-461D TRANSMISSION - FMEM - Define TOT\_OTEMP

for LH,AC and AG strategies.

5437 93-500 SELF-TEST - KOEO - MLPS test improvement.

5437 93-500D SELF-TEST - KOEO - New MLPS test

improvement.

5563 93-534 FUEL - CLOSED LOOP - allow switching

into/out-of closed loop for f450

superduty.

5713 93-546 TRANSMISSION - NORM TV CALC - Calculate

converter clutch torque capacity.

5713 93-546A TRANSMISSION - NORM TV CALC - Calculate

converter clutch torque capacity.

5707 93-564 FMEM - UNKNOWN - Driveability in FMEM.

5714 95-037 TRANSMISSION - OTHER - Coast Clutch

Control Software Error.

1-5

STRATEGY EVOLUTION - LHBH1

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5714 95-037A TRANSMISSION - OTHER - Coast Clutch

Control Software Error.

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

LHBA0 LHAZ1

(06/10/91)

4516 91-589 OTHER - N/A - Software documentation

needs 1991 copyright date.

4650 93-327 TRANSMISSION - Revise shift validation

logic error codes, improve FMEM.

5271 93-327A TRANSMISSION - Delete OCIL\_HP from LH

strategy.

4834 93-334 OTHER - Revise purge strategy for 7.5L.

4579 93-365 FUEL - DFSO - Add d/dt(TP) to DFSO and

THERMACTOR to control backfire.

4579 93-365A FUEL - DFSO - Match timer resolution to

strategy.

5355 93-453 MISCELLANEOUS - INFERRED BP - Incorrect

read done for BPPTWTLO for rolav.

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

LHAZ1 LHAZ0

(03/20/91)

4922 92-507 EGR - EVR CONTROL - EGRACT and EGRERR were

incorrectly calculated.

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

LHAZ0 LHAY0

(03/04/91)

4204 92-324L MISCELLANEOUS - Provide a separate LAMMAX

for PURGE logic; documentation error.

3541 92-325 SELF TEST - CONTINUOUS - TRLOAD is byte

value, but loaded as word.

3123 92-368 SYSTEM COMM - DCL - Verify BITMAP\_x

definition and add new PID codes.

3123 92-368A SYSTEM COMM - DCL - Replace PID code 2E

(adder of LTMTB1) with IOCC.

3123 92-368D SYSTEM COMM - DCL - Revisions to PID

tables and BITMAPS.

4494 92-469 SELF TEST - CONTINUOUS - False SELF TEST

code 173 (EGO1 sensor fault-rich).

4513 92-477 TRANSMISSION - Lack of power complaint

after light throttle 1-2 upshifts.

4307 93-055A FUEL - Provide a reset calibration switch

for CRKPIP\_CTR.

3494 93-074 MISCELLANEOUS - Ensure validity of queue

subroutine pointers.

3774 93-150 SELF TEST - Byte thrift.

4527 93-150C SELF TEST - CONTINUOUS - PURGING and

PRGFLG not representative of state of

purge.

3719 93-191 SELF TEST - Allow KOEO self test in

neutral instead of PARK, E4OD.

3876 93-196 FUEL - OPEN LOOP - 7.0L thermactor switch

open loop error.

2830 93-221 TRANSMISSION - Some of the governor

parameters are incorrectly defined.

4533 93-273 SELF TEST - KOEO - Software in KOEO

canister purge OCC test.

1-6

STRATEGY EVOLUTION - LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

4554 93-283 TRANSMISSION - Filter MAP\_WORD for

transmission TQ\_NET calculation.

4554 93-283A TRANSMISSION - Clarify MAP\_WORD filtering

technique for transmission use.

4612 93-304 MISCELLANEOUS - PURGE - Improve base

calibration for PURG\_ADP\_SF.

4581 93-320 FUEL - PURGE - Remove the 2nd canister

purge output.

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

LHAY0 LHAXA

(10/29/90)

1758 91-158B TRANSMISSION - ENGAG/STALL TV; START\_UP

TV; TV PRES GUIDE - Correct errors in

EMR 91-158.

4133 92-139C SELF TEST - KOEO - Implementation of EMR's

92-139 and 92-139B was not correct.

4107 92-324K SELF TEST - CONTINUOUS - Revise Canister

Purge Filter.

3364 92-356 MISCELLANEOUS - INPUT CNVRT - Calculate

VSBART\_FM -based on NIBART, NOBART or

NEBART.

3938 92-391 TRANSMISSION - EPC - Improve VFS

temperature compensation.

3936 92-431 ISC - IPSIBR CALC - Remove IPSIBR reset to

0 on closed to part throttle change.

4212 92-442 AIR MEASUREMENT - MAP SAMPLE - Fuel drops

out during high speed wot to pt tip outs.

3321 93-055 FUEL - Fix CRKPIPCTR logic so that a

partial reset is possible.

3343 93-116B TRANSMISSION - FMEM - Limit VS with VSS

failure.

4080 94-010H TRANSMISSION - GRCMKIV appears in EDTS for

LH, but not code/strategy book.

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

LHAXA LHAX0

(09/13/90)

3995 91-409Y SELF TEST - CONTINUOUS - Protect EGO

test from vacuum controlled purge

overload.

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

LHAX0 LHAW0

(09/07/90)

3752 91-409W SELF TEST - CONTINUOUS - Prevent rich EGO

failure due to purging.

0140 92-139 MISCELLANEOUS - Protect background from

infinite loop with watchdog.

3346 92-139B MISCELLANEOUS - Change parameter

dictionary for RAM/ROM byte thrift.

3146 92-200 FUEL - INJECTOR OUTPUT - Collision with

3177 asynchronous AE may cause improper fuel

pulse.

3146 92-200A FUEL - INJECTOR OUTPUT - Collision with

3177 asynchronous AE may cause improper fuel

pulse.

3597 92-313 TRANSMISSION - Allow application of coast

clutch for PDL = 4, GR\_CM < 4/

1-7

STRATEGY EVOLUTION - LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

3820 92-324B SELF TEST - MIL - Lack of HEGO switching

codes 173 and 177 are being set.

3863 92-324D OTHER - Purge strategy resolution

improvement.

3863 92-324F OTHER - Add EDTS parameter transaction for

PRG\_INIT\_FLG.

4004 92-324G MISCELLANEOUS - Purge decrement clipping

normal purge.

4004 92-324H MISCELLANEOUS - PURGE - Limit PRG\_DEC

0.99 to make code shorter.

4028 92-324I FUEL - MIL light turns on/off/on during

rich purge condition.

3728 92-366 TRANSMISSION - CSDYN cold TV modifier

problem.

3887 92-408 ISC - ISCKAM UPDATE - Documentation

commonality needed for ISCKAM UPDATE

logic.

2858 93-060 MISCELLANEOUS - Match engine parameters

to MY 91-1/2 7.0L LL strategy.

2858 93-060A MISCELLANEOUS - Match engine parameters

to MY 91-1/2 7.0L LL strategy.

3334 93-060B MISCELLANEOUS - Want to transfer engine

calibration from LL calibration.

3769 93-115 ISC - DASHPOT - Minimum DASPOT clip logic

was not governed with respect to N/D.

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

LHAW0 LHAV0

(05/24/90)

2096 91-229 SELF TEST - Unused IGNCNT should be

removed from dictionary and code.

3446 91-568 MISCELLANEOUS - Incorrect description of

parameter V\_EGO\_ENA in DOC file.

3318 92-241 TRANSMISSION - OFMFMG - Force TV\_COUNTS

to zero when ETV\_TEST = 1 (FN622 > 15).

3300 92-242 SELF TEST - KOER - Logic gates for Engine

Running Self Test initialization

incorrect.

3429 92-253 ISC - Unable to calibrate FN825A and

FN825B using cal-console.

3503 92-287 TRANSMISSION - DYN TV CALC - Harsh shifts.

NONE 93-064A OTHER - Documentation change from DDVS to

VSLIM.

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

LHAV0 LHAU2

(04/20/90)

1651 91-178 SELF TEST - KOER - Provide new logic and

add throttle adjust modes to strategies.

1775 91-230 SELF TEST - KOER - Surge during VIP.

2732 91-230A SELF TEST - KOER - Documentation for

EMR 91-230.

2964 91-483 SELF TEST - MIL - Change strategy book

to use DISABLE\_NOSTART.

NONE 91-531A TRANSMISSION - DYN TV CALC - Inappropriate

upshift TV ramp during verification.

2764 91-540 TRANSMISSION - SHIFT VAL - TP Failure and

Shift Validation.

3236 91-554 TRANSMISSION - FMEM - Software error in

1-8

STRATEGY EVOLUTION - LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

LHAT2.

NONE 92-155K TRANSMISSION - DSRD GEAR DET - PPH -

Correct parameter specifications.

NONE 92-155L TRANSMISSION - DSRD GEAR DET - PPH -

Correct parameter specifications.

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

LHAU2 LHAU1

(03/26/90)

3299 91-565 TRANSMISSION - EPC - FN622(TOT) does

not return signed results, but should.

3280 92-223 OTHER - RCON macros corrupt SMP.

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

LHAU1 LHAU0

(03/06/90)

3217 91-555 TRANSMISSION - NORM TV CALC - Software

errors in LHAU0.

2131 91-556 TRANSMISSION - SHIFT CONTROL - Make

FN12\_DC, FN23\_DC, and FN34\_DC signed

functions.

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

LHAU0 LHAT1

(02/16/90)

1542 91-199 SELF TEST - KOER - Engine running

initialization revisions and new

documentation.

NONE 91-199A SELF TEST - KOER - Engine running

initialization revisions and new

documentation.

NONE 91-199C SELF TEST - KOER - Documentation to

support EMR 91-199/B and 3-digit codes.

2582 91-412 SPARK - Thrift; reduce resolution of

SPK\_LAMBSE.

3171 91-412A TRANSMISSION - NORM TV CALC - EMR

91-412 cannot be implemented as written.

NONE 91-428A ISC - Improvement to LOWVOL strategy.

2623 91-435 SELF TEST - KOER - Delete the old E.R.

spout test.

2629 91-437 TRANSMISSION - EPC - Shift quality varies

with temperature.

2310 91-440 ISC - DUTY CYCLE - Improve ISC's DEBYMA

output.

2863 91-454 TRANSMISSION - EPC - Inconsistent shift

qualify with altitude.

2832 91-464 SELF TEST - CONTINUOUS - Remove VIP

EGO switching repetitive one-shot test.

NONE 91-464A FMEM - EGO SENSOR - EMR 91-464 did not

cover the FMEM chapter.

3005 91-527 TRANSMISSION - EPC - TVCHARGE and cold

engagement strategies may not work.

2856 91-528 MISCELLANEOUS - THERMACTOR - OBD-1

implementation with thermactor.

2976 91-537 OTHER - Delay in AM2 turn-off.

NONE 91-537A OTHER - Timer resolution, AM2 turn-off.

3167 91-542 AIR MEASUREMENT - MAP SAMPLE - Incorrect

long MAP averaging at wide open throttle.

3186 91-543 SELF TEST - KOER - Extend clips on band

limits for running idle adjust test.

1-9

STRATEGY EVOLUTION - LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

3200 91-546 TRANSMISSION - FMEM - Remove VSFMFLG

being set by C452\_KAM\_BIT on power-up.

1891 92-086 MISCELLANEOUS - Cannot load two

regions into calibration console.

NONE 92-155D MISCELLANEOUS - INPUT CNVRT - Specify

VS\_RATEPH calculation.

NONE 92-155G TRANSMISSION - DSRD GEAR DET - To prevent

powertrain hunting with E-transmissions.

NONE 92-155H TRANSMISSION - DSRD GEAR DET - To prevent

powertrain hunting with E-transmissions.

2540 92-161 SELF TEST - CONTINUOUS - Upgrade fuel

pump test and documentation.

2937 92-161A SELF TEST - CONTINUOUS - Error in EMR

92-161, calibration parameter name

used for RAM flag.

3134 92-161B SELF TEST - Correct typo's in fuel pump

test.

2913 92-170 MISCELLANEOUS - Correct potential

problem.

3041 92-178 TRANSMISSION - FMEM - OFMFLG is always

set using base calibration.

3100 92-201 MISCELLANEOUS - Install shadow

instruction for IPPC(R-CON) function.

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

LHAT1 LHAT0

(01/22/90)

3018 91-126F SELF TEST - CONTINUOUS - MIL light

remains on after correction of EGR

flow fault.

2947 91-170G SELF TEST - CONTINUOUS - Bulletproofing

of continuous BOO test.

3037 91-394C FMEM - Problem with FMEM fuel when

MAP vacuum failure recognized.

NONE 91-394D SELF TEST - CONTINUOUS - Correction in

self test strategy.

2987 91-409N SELF TEST - CONTINUOUS - EGO test/

mechanical purge.

3016 91-409O SELF TEST - CONTINUOUS - V\_LEGOTMR1

is held to zero after a jumpback with

failure present.

2773 91-411 SELF TEST - KOER - Revise running

self test code 998 abort with

corresponding code 128.

2945 91-466 SELF TEST - Software coding error.

2988 91-485 SELF TEST - CONTINUOUS - Change

3-digit slow code pulsewidth to 0.4

seconds.

2968 91-487 SELF TEST - CONTINUOUS - Adaptive test

prevents ECT open test from failing.

2762 91-500 TRANSMISSION - CLUTCH VAL - Erroneous

VIP code 62's.

2849 91-503 FMEM - VSS failure detection.

NONE 91-503A SELF TEST - KOEO - MLPS service code

in KOEO.

NONE 91-503B SELF TEST - CONTINUOUS - Amend EMR

91-503 for accuracy.

NONE 91-503C FMEM - Modify setting and clearing of

flag VSFMFLG.

1-10

STRATEGY EVOLUTION - LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

3000 91-509 SELF TEST - CONTINUOUS - Software error

in continuous ego software test.

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

LSAT0 LHAS0

(12/12/89)

2829 91-170F SELF TEST - CONTINUOUS - Documentation.

2790 91-191C SELF TEST - KOEO - DCL documentation

and VIP executive.

NONE 91-409M SELF TEST - CONTINUOUS - Add constraint

on adaptive clip test.

2209 91-414 OTHER - Prevent thermactor in WOT.

1656 91-439 ISC - BYPASS - RPM flairs when

restarting a warm engine.

2860 91-442 SELF TEST - V\_LESTMR will not count

up due to software error.

2877 91-445 FUEL - Improve the LAMBDA average

calculation for VIP test.

2930 91-462 SELF TEST - CONTINUOUS - STO turns

on when starting engine with STI

grounded.

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

LHAS0 LHAR0

(11/16/89)

NONE 89-554E TRANSMISSION - Rename FNXXDC's to

FNXX\_DC's for AC, LD and LH.

NONE 89-554I TRANSMISSION - Document TP\_REL high

byte is the X-input to fox function.

904 90-190A SELF TEST - CONTINUOUS - Cleanup of EGO

switching test.

904 90-190C SELF TEST - CONTINUOUS - Provide a level

of fuel system testing.

1995 90-190E SELF TEST - CONTINUOUS - More specific

failure criteria for continuous EGO/fuel.

NONE 90-190G SELF TEST - CONTINUOUS - More specific

failure criteria for continuous EGO/fuel.

NONE 90-190H SELF TEST - CONTINUOUS - EGO test

modifications.

NONE 90-190J SELF TEST - CONTINUOUS - Development.

NONE 90-190K SELF TEST - CONTINUOUS - Development.

NONE 90-241M SELF TEST - CONTINUOUS - Development.

2376 90-362A MISCELLANEOUS - THERMACTOR - Thermactor

air does not bypass with failed ego.

NONE 90-362B MISCELLANEOUS - THERMACTOR - Incorrect

VIP codes; change from 41 to 144.

2693 90-369B TRANSMISSION - TV PRES GUIDE - TP failure

at altitude.

NONE 91-126A SELF TEST - Changes made in base EMR

91-126 are also required in LL.

NONE 91-126B SELF TEST - MIL - Additional MIL

changes are required for 1991

production.

2425 91-126C SELF TEST - MIL - Allow codes 194 and

195 to control EGO FMEM flags.

1795 91-161 SELF TEST - CONTINUOUS - Thermostat

warranty returns with no trouble found.

NONE 91-161A SELF TEST - CONTINUOUS - Thermostat

warranty returns with no trouble found.

1-11

STRATEGY EVOLUTION - LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

NONE 91-161B SELF TEST - CONTINUOUS - Revisions

required to implement EMR 91-161A.

NONE 91-170C SELF TEST - CONTINUOUS - To add

continuous BOO test.

NONE 91-170D SELF TEST - CONTINUOUS - To add

continuous BOO test.

NONE 91-190A MISCELLANEOUS - INPUT CONVERTER - VS

is calculated regardless of VSTYPE -

Electronic Transmission.

2034 91-191 SELF TEST - Prevent entry into Self Test

if vehicle is in Drive or moving.

2130 91-191A SELF TEST - Conflicting pages (16 and 17)

for LH strategy.

2751 91-191B SELF TEST - KOEO - Documentation for

EMR 91-191.

NONE 91-247B SELF TEST - Erroneous code 29; VSSTMR

runs with key on-engine off.

2523 91-272B MISCELLANEOUS - Revise open loop fuel

flag logic; add TP\_REL criteria.

2329 91-289 EGR - ENABLE LOGIC - Incorrect DOC

file definitions.

NONE 91-289A EGR - ENABLE LOGIC - Incorrect DOC

file definitions.

2538 91-289B EGR - EMRS 91-289,A not applicable to

LL, LH, LU strategies.

2327 91-299 SELF TEST - KOEO - ACC/NDS test revisions.

NONE 91-299A SELF TEST - KOEO - Documentation

correction for A/C switch test EMR 91-299.

2341 91-301 MISCELLANEOUS - SMP vector will be

incorrect in production strategies.

2419 91-313 SELF TEST - MIL - MIL light will not

turn on if fault 32 is present.

2507 91-336 SELF TEST - CONTINUOUS - Revisions to the

Cooling System Test.

NONE 91-336A SELF TEST - CONTINUOUS - Revisions to the

Cooling System Test.

2152 91-339 SELF TEST - Lansdale request for CPU/

RAM/ROM test output pulse spec.

NONE 91-339A SELF TEST - Lansdale request for CPU/

RAM/ROM test output pulse spec.

2508 91-350 FUEL - Eliminate fuel pump drop-out at

power-up.

2534 91-358 SELF TEST - LH strategy must have same

EGR updates as all other strategies.

2543 91-367 SELF TEST - KOER - Hot Injector

Compensation not correct during

Self Test.

2571 91-369 SELF TEST - Software error; incorrect

continuous VIP codes can be transmitted.

2286 91-380 SELF TEST - EOL - Unexpected 35 msec

pulse on STO during Lansdale Test.

2678 91-382 SPARK - Base value for DWL\_XS\_MIN

inadequate for generic modules.

2679 91-383 SELF TEST - CONTINUOUS - Change required

to Adaptive Test.

NONE 91-383A SELF TEST - CONTINUOUS - Change required

to EGO Test.

NONE 91-383C SELF TEST - Corrections.

NONE 91-383G SELF TEST - Corrections.

1-12

STRATEGY EVOLUTION - LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

2171 91-394 SELF TEST - Enhancement to continuous MAP

sensor test.

NONE 91-394A SELF TEST - Change logic of continuous MAP

VAC test for robustness.

2708 91-396 SPARK - Error found on DV tester in ICCD

mode output.

2753 91-409 SELF TEST - CONTINUOUS - Software

reviewers' convenience.

NONE 91-409D SELF TEST - Consolidation of EMRS.

NONE 91-409H SELF TEST - Eliminate EGO test failure

void.

2819 91-423 SELF TEST - Commonality of VIP software

used by AA, AC, GT, LL and LH.

2729 91-427 SELF TEST - Change from stereo to mono

ego.

2553 92-137 FMEM - Remove TOTFMFLG logic in all

strategies.

2395 93-017 MISCELLANEOUS - Background loop times for

generic strategies are high.

2467 93-027 MISCELLANEOUS - 7.0L governor strategy

required in LH strategy.

NONE 93-027A MISCELLANEOUS - 7.0L governor strategy

required in LH strategy.

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

LHAR0 LHAQ0

(09/14/89)

2486 90-345C TRANSMISSION - Comp torque calculation

in EMR 90-345 needs additional variable.

2398 91-310 ISC - Add ISC-BPA KAM adaptive clips

and zero KAM if outside clip.

2541 91-353 TRANSMISSION - Torque calculation/

engine calibration issues.

NONE 91-353A TRANSMISSION - Define AMT and AMPEMT

which were used in the base EMR.

NONE 91-353D TRANSMISSION - Torque calculation/

engine calibration issues.

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

LHAQ0 LHAP0

(08/29/89)

NONE 89-130B SELF TEST - Spout circuit test

documention clarification.

NONE 89-554D TRANSMISSION - Revise base calibration

for FNXXT and X-input for FNXXDC.

945 90-089 SELF TEST - Strategy documentation

improvements.

NONE 90-089A SELF TEST - Documentation clarification

for EMR 90-089.

1977 90-348 SELF TEST - Convert from two digit to

three digit self test codes.

NONE 90-348E SELF TEST - Create three digit self test

parameters for LH strategy.

NONE 90-348P SELF TEST - Miscellaneous corrections for

three digit codes.

NONE 90-348T SELF TEST - Miscellaneous corrections for

three digit codes.

NONE 90-348V SELF TEST - Miscellaneous corrections for

three digit codes.

1-13

STRATEGY EVOLUTION - LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

2468 90-373 FUEL - Correct error in bias table lookup.

2021 91-190 MISCELLANEOUS - VS is calculated

regardless of VSTYPE.

895 91-235 SYSTEM COMMUNICATION - Revise DCL

diagnostic mode protocol for self test

codes.

1596 91-254 SELF TEST - Eliminate the possibility of

setting a false code 33.

2170 91-256 MISCELLANEOUS - Document the use of

NEW\_PIP.

2121 91-257 FMEM - Documentation error in EGR FMEM

logic.

2308 91-285 SYSTEM COMMUNICATION - Correct interface

issue with 9.1 cal con update.

NONE 91-287A ISC - Assist in calibrating ISC.

2205 91-288 ISC - DASPOT airmass is clipped under

utilizing feature.

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

EVOLUTION SOURCE

FILE FILE EMR NO. DESCRIPTION/REMARKS

LHAP0 LHAN0 90-326 FUEL - CRANK - Software error in FCA file

(06/01/89) for FN023. ERD 1768.

90-345 TRANSMISSION - OTHER - Compensate torque

calculation for SAF. ERD 1856.

90-345A TRANSMISSION - OTHER - Compensate torque

calculation for SAF. No ERD.

90-347 TRANSMISSION - SHIFT CONTROL - Improve

downshift quality. ERD 1911.

90-351 ISC - DESIRED RPM - Unable to get hicam

kick down. ERD 2068.

91-149 OTHER - Correct documentation to Keep

Alive Memory chapter. ERD 1806.

91-154A TRANSMISSION - EPC - Possible damage to

electronic transmission. No ERD.

91-165 MISCELLANEOUS - Lack of MPG mode. ERD 1807.

91-172 ISC - BYPASS - Multiple versions of ISC

MODE\_SELECT documentation. ERD 1873.

91-172A ISC - BYPASS - Correct documentation error

shown in 91-172. ERD 1873.

91-174 FUEL - Correct timer reset(s) logic upon a

LAMBSE reset. ERD 1934.

91-174A FUEL - Correct timer reset(s) logic upon a

LAMBSE reset. No ERD.

91-177 ISC - BYPASS - Multiple versions of ISC

dashpot documentation. ERD 1886.

91-179 FUEL - CLOSED LOOP - Errors in closed loop

LAMBSE documentation. ERD 1932.

91-197 FUEL - Change vector clips on function

FN023. ERD 2037.

91-205 ISC - DASHPOT - Improve ability to handle

tip-in/tip-out clunk. ERD 1390.

91-222 FUEL - CLSD LOOP ENABL - Allow closed loop

fuel control when in MPG mode. ERD 1951.

92-065 MISCELLANEOUS - OTHER - The codes

transmitted to the SBDS on the DCL could

be incomplete. ERD 1661.

1-14

STRATEGY EVOLUTION - LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

LHAN0 LHMA 89-552 FMEM - TRAN OIL TEMP - Correct FMEM INIT\_TOT

(02/24/89) Calculation. ERD 1778.

90-271B VIP - Correct implementation of 90-271: the

vector range maximum value of V\_VSS\_NMIN

should be 16,383.75 RPM, not 10,000 RPM.

URD 1708.

90-308A S/W - The software documentation for all

current & future S/W version prereleases

needs to be upgraded to a 1989 copyright

date beginning 01/01/89. URD 1639.

90-317 FMEM - Revise ISC FMEM to exclude ACT and

ECT effects. URD 1709.

90-325 TRANS - Some engagements may be preformed

with inappropriate EPC pressure. URD 1734.

90-325A TRANS - ENGAG/STALL TV - Correct error in

original EMR. ERD 1734.

90-332 TRANSMISSION - TQ\_IALFA CALC - Correct clip

check for TQ\_IALFA CALC. ERD 1814.

91-063D MISC - DCL - Revise BITMAP\_0 and BITMAP\_1

documentation. URD 861,985,1205.

91-130A SELF TEST - Continuous code 49 changed to 79

to make common. ERD 1821.

91-130B SELF TEST - Change of service code not

desired from year to year. ERD 1851.

91-130C SELF TEST - Add change pages that should

have been on 91-130B. No ERD.

91-135A VIP - S.M.A.C. recommendation to improve

diagnostics. URD 1606,1694.

LHMA LHM1 89-550 TRANS - Insufficient EPC pressure if vehicle

(02/09/89) speed sensor is questionable. URD 1754.

89-551 TRANS - Shift error flags can be set

erroneously if PDL\_ERROR is set. URD 1753.

90-323 TRANS - Incorrect clipping of EPC pressure.

URD 1745.

90-324 VIP - DASPOT function revisions required

before signoff. URD 1715.

90-324A VIP - Documentation changes required to

implement EMR 90-324. URD 1715.

LHM1 LHM0 0V-271A VIP - Correct implementation of 0V-271

(01/12/89) to refresh VSFMFLG in continuous VIP

as well as in the VIP executive.

URD 1352.

0V-314 FMEM- EPT sensor (open/short) will not

turn on MIL light, doees not set failure

flag (codes 31/35 are set). URD 1674.

LHM0 LHL0 9-541 FUEL - Reset TSLEGO and ACCUM

(12/21/88) upon a lambse reset to 1.0.

URD 1561.

9-542 TRANS - Neutral to manual 1 lever

movement results in 1st gear at all

speeds. URD 1583.

0V-301 MISC - DCL to VIP interface. URD 1500.

0V-302 FUEL - VIP requires idle fuel

modulation to stabilize engine during

the throttle adjust mode. URD 931.

0V-302A FUEL - Documentation pages included

1-15

STRATEGY EVOLUTION - LHBH1

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

in EMR 0V-302 were incorrect. URD

931.

0V-302B MISC - Documentation pages included

in EMR 0V-302 were incorrect. URD

931.

0-311 MISC - Set communication flags every

background loop. URD 1655.

1-106A MISC - DCL - Processor resets

occasionally when DCL is enabled.

URD 1600.

LHL0 LHK1 9-454 TRANS - Incorrect shift logic

(22/11/88) documentation. URD 799.

9-511E MISC - CANP - Modify canister purge

strategy to handle high vapor production.

commonize canister purge logic with the

final version developed for the 1989

running changes. URD 1272.

9-519A FUEL - LAMBSE will be clipped to the

minimum value (0.01) instead of the

maximum value (1.99) if LMBJMP

calculation on tip-in results in a

LAMBSE greater than 1.99. URD 1282.

9-520 SPARK - Allow more flexible octane

adjustment which accounts for all

combinations of ECT and ACT. URD 1296.

9-520A SPARK - The table specification was

shown as a 7 x 7 instead of a 6 x 6.

URD 1296.

9-520B SPARK - EMR 9-520 was written

primarily for running change LU and

LH. In order to incorporate the ECT, ACT

spark table in the mainline LL and LH,

it is necessary to make changes for

BRDRLN\_SPK which is used in Generic

ISC. URD 1296.

0V-117F VIP - Evaluation of TP adjust mode

requires modifications of test

conditions. URD 931.

0V-117G VIP - EMR 0V-117F requires modification.

URD 931.

0V-117I VIP - EMR 0V-117F requires modification.

Cancel EMR 0V-117G. URD 931.

0V-117J VIP - Base strategy KAM qualification

test must be revised in order that fuel

cells are not reset on exit from the VIP

throttle adjust mode. URD 931.

0V-117K VIP - Clean up EMR is required to

implement all previous associated EMRs.

URD 931.

0V-117L VIP - Byte thrift and clarification of

EMR 0V-117K. Cancel KAM changes from

EMRs 0V-117E and 0V-117F. Cancel EMR

0V-117J. URD 931.

0V-118 VIP - Improvements to Engine Running

Goose Test for robustness. URD 328,996.

0V-118B VIP - Strategy documentation updates

required to implement 0V-118. URD 996.

0V-118D VIP - Final updates required to

1-16

STRATEGY EVOLUTION - LHBH1

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implement EMRs 0V-118 and 0V-118B into

Speed Density strategies. URD 996.

0V-118F VIP - Revise Goose Test documentation

for added clarity. URD 1581.

0-144B TRANS - Attachment 9 of EMR 0-144A

contains an error. URD 1092.

0V-190D VIP - Allow EGO Full Time to switch

before indicating a failure. URD 904.

0V-195 VIP - Review of EMR 9V-399 for release

of 'TT' strategy required changes to

the documentation of the KAM Code Erase

logic. URD 945.

0-197A MISC - Cleanup EMR. URD 1444.

0-210 TRANS - RPM flare when converter unlocks

in first gear due to slight reduction

in throttle position. URD 1175.

0-219 TRANS - Compensation of EPC is required

for transmission oil temperature and

4x4 Low operation. Engagement TV pressure

needs to be a fraction of engine RPM and

time since engagement began.

URD 1176,1194,1204,1249,1281.

0-219A TRANS - Change dynamic EPC from engine

RPM to throttle position. Correct

specifications of EPC parameters

introduced by EMR 0-219. URD 1326,1381.

0-219B TRANS - Correct errors in original EMR

0-219. URD not required.

0-219C TRANS - Correct errors in original EMR

0-219. URD not required.

0-221 TRANS - The optimum speed ratio delta

to unlock/relock the torque converter

during upshifts varies with throttle

position, but current logic uses scalar

value independent of TP. URD 1178.

0-226 SPARK - KNOCK - The 4.9L engine is

knock limited above a certain RPM. To

allow maximum use of the knock sensor,

spark is advanced beyond SAF which

causes detonation when the engine enters

then knock limited speed range. URD 1294.

0-226A SPARK - KNOCK - FN146B is listed in

strategy book and FN146A is in the code.

FN146A is a word function and is correct

for the code. URD 1294.

0-232 FUEL - INJECTOR TIMING - If the INJCNT

register becomes corrupted, the

recovery code will not set IBETA and

INJCNT to zero as desired since the

foreground temporary register that is

stored as IBETA and INJCNT will not

contain a zero value. This could prevent

correct injecor timing. URD 1148.

0-235 TRANS - It is difficult to detect shift

errors on 1 -> 2 shift because of a

single minimum vehicle speed criteria to

validate a shift. Dividing the vehicle

speed paraemter by RT\_NOVS prior to

comparing to VSBART is extensively used

1-17

STRATEGY EVOLUTION - LHBH1

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in transmission control. Time/byte

thrift is possible. URD 1123,1250.

0V-252 VIP - Code used only for GS strategy is

done for all strategies. URD 1344.

0-255 TRANS - VEHICLE SPEED - Electronic

transmissions require a rapidly

responding rationality test of vehicle

speed to avoid unwanted shifts if the

vehicle sensor input is providing

incorrect data. Vehicle speed calculation

needs bullet-proofing modifications.

URD 1177.

0-255B TRANS - Correction/cleanup of EMR 0-255.

Original EMR incorrectly specified

"VSCNT" instead of "VSCTR" in "GR\_DR\_AUTO"

module for selecting shift logic. URD N/A.

0-256 SYSEQUAT - VSBART - Calibrating the time

constant for VSBART to a large value

results in a significant deadband. The

Rolling Average remainder is not currently

saved, and VSBART will not continue to

update when within the deadband. URD 1347.

0V-271 VIP - Changes in E-TRANS FMEM require that

VSFMFLG be able to set when in 4x4 mode.

URD 1352.

0-272 FMEM - All DIS logic should have been

removed including FMEM logic. DIS\_FMEM is

still included in the MILTMR logic and

should have been removed with the DIS logic.

URD 1405.

1-070 MISC - Add clock in engineering unit,

CLOCK\_SEC. Add capability to gather real

time in engineering units when data logging.

URD 1318.

1-084 MISC - MPGTMR - To enable fuel economy mode

during dynamometer certification of "over

8500" truck applications, where the vehicle

speed sensor input is non-functional.

URD 1125.

1-085 FUEL - INJECTOR OUTPUT IN CRANK - No fuel

output on 1st pip down edge. When down

edge fueling for crank is selected, and

the first edge processing is a PIP down

edge, no fuel is output because the

foreground fuel routine is called from the

PIP up edge and FUELPW is still zero.

URD 1362.

1-085A FUEL - INJECTOR OUTPUT IN CRANK - No fuel

output on 1st pip down edge. When down

edge fueling for crank is selected, and

the first edge processing is a PIP down

edge, no fuel is output because the

foreground fuel routine is called from the

PIP up edge and FUELPW is still zero.

Cancel EMR 1-085. URD 1362.

1-091 MISC - DCL - The 184 byte block of RAM,

which was previously reserved for SBDS

use, is now needed for engine control

strategy. This reduces the RAM available

1-18

STRATEGY EVOLUTION - LHBH1

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to the SBDS for downloaded programs from

600 to 416 bytes. URD 376.

LHK1 LHK0 1-043D MISC - Permit use of V8.2 cal console.

(10/13/88) Floating SMP data prohibits the use of

V8.2 cal consoles. LHK0 does not exceed

8K of SMP data, so V8.2 cal consoles

would be able to access all parameters.

URD 1340.

LHK0 LHJ0 9-511 MISC - PURGE/THERMACTOR - Thermactor

(09/28/88) and/or purge inducted Open Loop Fuel on

high rpm extended idles is undesirable.

URD 454,568,1151.

9-511A MISC - Clean up existing EMR (9-511).

Byte savings can be realized and revisions

to start book documentation to reflect

actual paragraph names. URD 454,568,1151.

9-511B FUEL - Fuel goes lean when PRGTMR is

reset to zero because LAMBSE is close

to the upper clip. URD 1272.

9-511C FUEL - EMR 9-511B did not include proper

"new" attachment 2 for LUVF strategy.

Some applications don't want to clip

LAMBSE when PRGTMR is reset. URD 1272.

9-519 CLOSED LOOP - If the LAMBSE jumpback

calculates a requested value which is

greater than 2.0, LAMBSE will be set

to 0.01 instead of 1.99 prior to the

LAMMIN/LAMMMAX clips. Therefore, the

clipped LAMBSE value will be LAMMIN

when it should have been LAMMAX.

URD 1282.

0V-035 VIP - Engine running: evaluate new

approach to testing the spout circuit.

URD 310.

0V-035A VIP - Strategy change and documentation

update required for clarification.

URD 310.

0V-117 VIP - Evaluate proposed throttle setting

mode in Engine Running test. This EMR

cancels EMR 0V-097, which was created for

EAO strategy (CE). URD 777,778,931.

0V-117A VIP - Changes of original EMR required for

implementation of EMR 0V-117. URD 931.

0V-117C VIP - Changes of original EMR required for

implementation of EMR 0V-117,0V-117A.

URD 931.

0-141 TRANS - To correct errors in the

strategy book documentation for E4OD.

URD 802,836,837.

0-146 SPARK - TRANSIENT SPARK - TLOFLG can

change state each pass once started.

this can cause spark errors in delivery

with resultant driveability complaints.

URD 1067.

0-161 FUEL - Incorrect FUEL\_A calculation.

URD 1132.

0-163 ISC - Commonize RPMERR documentation

1-19

STRATEGY EVOLUTION - LHBH1

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for Generic ISC. Multiple documentation

versions exist for the Generic ISC

RPMERR strategy modules, even though

all describe identical logic. URD 1137.

0-163D ISC - Correct parameter definitions in

0-163. Certain parameter definitions

were left out of list in EMR 0-163.

URD 1137.

0-172 ISC - FHEM strategy for Generic Idle

Speed. URD 223.

0-172A ISC - FHEM for Generic ISC. Revisions

to 0-172. HCAMFG was accidentally

shown as HCAMFLG in 0-172. Page 4 of

0-172 shows a logical AND which should

be an OR. URD 223.

0-174 MISC - Landsdale tester is not

compatible with 56K EPROM EEC-IV.

URD 1005.

0-180 MISC - Add RAM initialization pages to

strategy books. URD 324.

0V-190 VIP - More robust continuous EGO

switching test. URD 904.

0V-190A VIP - Cleanup of EGO switching test.

URD 904.

0V-190B VIP - Provide more explicit continuous

EGO test initialization logic. Modify

logic to reflect actual implememtation.

URD 904.

0-197 MISC - Supply flags for continuous EGO

VIP test. URD 1227.

0V-204 VIP - Prevent high TV pressure when in

Engine Running Self Test. Commonize

all electronic trans. control during

Engine Running. URD 1122.

0V-205 VIP - Software error when coding TOT

testing. Multiple failure (ECT and TOT

concurrently) cannot be detected in

KOEO VIP. URD 1197.

0-212A ISC - Commonize overview documentation

for Generic ISC. Multiple documentation

versions exist for the Generic ISC

OVERVIEW strategy. URD 1137.

0-212B ISC - Generic ISC OVERVIEW software is

incorrect. While doing commonization

of the Generic ISC OVERVIEW documentation,

it was discovered that certain software

implementations were incorrect. URD 1137.

0-246 SPARK - OUTPUT SCHEDULING - Missing

SPOUT signal with ICCD and ECHO PIP.

Transitions from ECHO PIP mode to

normal spark mode, and from falling

edge dwell to ECHO PIP mode, fail to

put out SPOUT signals URD 1333.

0-246A SPARK - OUTPUT SCHEDULING - Wrong

parameter set to DATA\_TIME. URD 1333.

0V-264 VIP - More efficient code and increased

robustness. Provide a single exit point

for common housekeeping whenever

continuous VIP is exited early due to

1-20

STRATEGY EVOLUTION - LHBH1

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being in crank mode or being in the

first four seconds since power up.

URD 1376.

1-043 MISC - Change S/W calling sequence to

support new 48K cal console. URD 1102.

1-043A MISC - Correct 48K cal console calling

routine. An EEC-IV system reset is

required before the cal console will

enter the CS mode. URD 1325.

1-043C OTHER - SMP data is still being truncated

with version 9 cal console. URD 1340.

LHJ0 LHI0 0-144 TRANS - improve execution time and

(06/02/88) create common strategy modules.

URD 1092.

0-144A TRANS - Clarify documentation.

0-145 SPARK - avoid premature TFI failure.

URD 715.

0-145A SPARK - revise 0-145. URD 715.

0-162 FUEL - Increase calibration

resolution. URD 970.

0-164 TRANS - avoid engine RPM flare on

subsequent tip-in before transmission

upshifts correctly when VSS fails.

URD 1113.

LHI0 LHH0 9-092 OTHER/SW - New macro. URD 127.

(05/13/88) 9-294 MISC - Common CRKTMR. URD 556.

9-497 ISC/SW - Add generic idle.

9-500 TRANS - Revise converter unlock.

URD 1022.

9-501 FUEL - Premature VS limiting in

4x4 low mode. URD 1032.

0-071 FUEL - Revise CRANK fuel to be a

function of PIPS (not time) in CRANK.

URD 854.

0V-072 VIP - Define KAM bits associated with

continuous error codes. URD 135.

0-099 DCL - Add DCL.

0-099A DCL - Revise PID table/Bit Map. URD 376.

0-102 DCL - modifications. URD 701.

0-102A DCL - modifications. URD 701.

0-106 ISC - Revert to former IPSIBR calculation.

URD 923.

0-131 AE - Revise AEFUEL enable/disable logic.

URD 978.

0-137 MISC - Revise A0 Base value; too large.

URD 1045.

0-166 DCL - Reset RAM/CART when changing modes.

URD 1121.

0-168 E40D/SW - Correct Gear Selection logic.

URD 1140.

LHH0 LHG1 9V-489 VIP-OCIL operates normally during

(03/14/88) ENGINE-RUNNING S/T. URD 967.

9-491 OTHER - Add proprietary messages.

URD 974

0V-046C VIP - Rename FMEM\_MONITR1 to 2.

0-092 ISC - Add Generic Idle. URD 017

1-21

STRATEGY EVOLUTION - LHBH1

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0-092A ISC - Revisions to 0-092. URD 017

0V-098 VIP - Delete unused calibration

constants, VTOT3, VTOT5. URD 966.

0V-101 VIP/ISC - Update to coincide with

Generic Idle Speed. URD 017.

LHG1 LHG0 9-486 SW/FMEM - Correct erroneous OFMFLG

(02/25/88) definition. URD 955.

9-487 FUEL - Do Open loop fuel control

during speed limiting. URD 956.

LHG0 LHF0 9-456A TRANS - Move ETVOCM conversion

(02/19/88) logic from System Equations to

ATOD CNVRT. URD 914.

9-470 TRANS - Create Calibration switch to

inc/exclude "shift errors" from

transmission fault(s) causing OCIL

flash. Refer to URD 887.

9V-476 VIP/SW - Revise EPC Solenoid Test

in KOEO Self Test. URD 903.

9V-476A Revisions to 9V-476. URD 903.

9-477 TRANS - Avoid harsh WOT upshifts.

Refer to URD 929.

9-480 MISC - Reduce memory. (No URD #)

9-481 TRANS - Insure correct entry to

Torque Truncation at high throttle

angles when EPC circuit open. URD 939.

9-482 TRANS - Insure EPC on high engine RPM

engagements and on first auto shift.

Refer to URD 938.

0-047 MISC - Redefine registers containing

flag bits. Refer to URD 748.

LHF0 LHE0 9V-032E VIP/KOEO - Fix sw error in ETV solenoid

(1/27/88) test performance. URD 816

9-154B MISC - Correct documentation of

original EMR. URD 729.

9-155B TRANS - Correct documentation of original

EMR. URD 729.

9-267B TRANS/SW - Correct Shift validation

software error. URD 877

9-268A TRANS - Byte thrift.

9-268B TRANS - Cancel 9-268A.

9-387 MISC - Add copyrights.

9-389C FMEM/TRANS - Correct software error in

ETV current monitor test. URD 828.

9-393A TRANS/SW - Update FLG\_PWR determination

flip-flops every BG Loop.

Refer to URD 692.

9-394 TRANS - Revise Coast Boost logic

to use FN3CB if GEAR\_CUR >OR= 3.

Refer to URD 757.

9-406 TRANS - Modify Shift logic to enable

downshift while upshift in progress.

Refer to URD 758.

9-411 TRANS - Avoid long delays for manual

downshifts. URD 759.

9-415 MISC/THERMACTOR - Replace AWOTMR with

WOTTMR in the Thermactor Air Control

1-22

STRATEGY EVOLUTION - LHBH1

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Bypass logic. URD 771.

9-416 MISC - Thrift, remove DPLGHP. URD 446.

9-417 SPARK - Respecify FN1128 to signed

table, resolution: 0.0156, range -2.00

to 1.98. URD 792.

9-417A SPARK - Correct calculation of

FN1127\*FN1128. Refer to URD 849.

9-434 FUEL - TORQUE Trunction, improve

function of torque limiting strategy.

Refer to URDs 630, 631, 825.

9-435 TRANS - delay transmission shifts

during torque limiting to improve drive.

Refer to URD 831.

9-437 SYSEQUA/FMEM - ECT & TOT start rolling

averages routines revised. URD 606.

9V-440 VIP - Avoid shift val. & converter

clutch monitoring errors during running

Wiggle mode. URD 848.

9-442 MISC - Revise POWSFG definition.

Refer to URD 668.

9-443 SW/TRANS - Revise Base Calibration.

URDs 679,718.

9-445 MISC - Incorrect FLG\_NO\_TV\_UP.

Refer to URD 725.

9-446 MISC - Correct VBAT computation

documentation. URD 739.

9-450 MISC - Incorrect BIHP documentation.

9-452 TRANS - Revise shift logic

documentation. Refer to URD 782.

9V-455 VIP - Fix fault filter subroutine so

error-detect flag is always = 0 before

subroutine returns. URD 851.

9-456 TRANS - compensate ETVOCM for VREF

variability. Refer to URD 731.

9-457 TRANS - Avoid harsh transmission

engagements after a very cold start.

Refer to URD 844.

9-461 TRANS - Modify NOV\_ACT calculation

pacing. Refer to URD 866.

0-048 SYMB - Add hexidecimal explanation.

LHE0 LHD0 9-001H TRANS - Documentation corrections.

(11/28/87) URDs 520, 582, 588, 591.

9V-032A VIP - Addition of ETV solenoid test to

KOEO. URD 285.

9V-032B VIP - Revise KOEO ETV solenoid eror code.

9V-032C VIP - Scaling revisions for ETV parameters.

9V-032D VIP - Revise ETV test.

9-038C TRANS - Documentation corrections. URD 638.

9V-102D VIP - Corrections to 9V-102C.

9V-170 VIP - Insure correct RPM if engine in

FMEM mode, upon entry to Self Test. URD 266.

9V-170A VIP - Modify 9V-170 implementation.

9V-244B VIP/SW - Avoid false indications of EGR

failure. URD 698.

9V-246 VIP -Prevent execution Engine Running Test

if vehicle moving. URD 396.

9V-261 VIP - Correct erratic TP sensor operation.

URD 471.

1-23

STRATEGY EVOLUTION - LHBH1

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9V-261A VIP - Cancel 9V-261.

9V-265 VIP - Software thrift. URD 477

9V-292 VIP - KOEO MAF test revision; ECT, ACT

Test documentation correction. URD 462.

9-341 TRANS - Add TP requirement to unlock

the converter clutch when brake applied.

Refer to URD 602.

9-341A TRANS - Update 9-341, replace TP\_REL

and FIPL\_REL with DD\_UN\_UNL. URD 602.

9-344 VIP compatibility. Cancel 9-145, 9-145A

9-300. Refer to URDs 612, 614, 623, 628.

9-345 TRANS - Cleanup: delete TM\_LK\_RATE.

Refer to URD 527.

9V-359 VIP - Reduce potential storage of erroneous

VSS error code. URD 664.

9-361 TRANS - Avoid unwanted downshifts. URD 558.

9-364 FMEM - S/W - force full h/w reset if

BG\_POINT range check fails. URD 661.

9-375 FUEL - Modify DFSO/FMEM interaction.

URD 425.

9V-375B VIP - Clarify VSS Test documentation.

9V-375C VIP - Correct logic error in Attachment #2

of 9V-375B. URD 425

9-381 ISC - Clear FFMTMR each time BGCNT is

clearedn in FAM. Refer to URD 708.

9V-382A VIP - General cleanup: documentation.

9-385 FMEM - modify with RPM/RP sensor failures.

9-387 S/W - Copyright paragraphs. NO URD.

9-389 TRANS - Modify TV Guide. Add test for

open/short if failure indicated. URD 731.

9-389A TRANS - Deletes 9-389; Modify TV Guide and

OFMFLG logic. URD 731.

9-389B TRANS - Modify register use.

9-391 TRANS - Improve shift error detection.

URDs 716, 738.

9-399 S/W - Modify VIP KAM code. URD 742.

9V-400 VIP - Correct warmup counter logic. URD 479.

9-401 TRANS - thrift/delete unused scheduled

1st gear converter clutch lock-up.

0-019 FMEM - Delete immobile TP test in FMEM.

Refer to URD 625

0V-019A VIP - Modify 0-019.

LHD0 LHC0 8V-165E VIP - Clutch switch failure.

(10/2/87) 9-003B ISC - Correct Bypass Air Idle speed

documentation.

9-029D S/W - Correct Closed loop fuel ramp rates.

9-105 FUEL - Update of fuel computation.

9-105A Cancel 9-105.

9-145 BACKGROUND - BG\_MANAGER, load register

Watchdog\_BG. Refer URD 140

9-145A BACKGROUND - Refine 9-145. Refer to URD 140.

9-146 FUEL - provide more consistent CRANK fuel.

9V-158 VIP - Correct code in VIP\_KAMOUT\_O.AST.

9V-166 VIP - Minimize Vectorfile compare effort.

9V-200 VIP - enhance continuous EGO.

9V-200A VIP - revisions to strategy.

9V-200B VIP - Correct documentation error.

9-226 TRANS - Commonize Converter Clutch Routines.

1-24

STRATEGY EVOLUTION - LHBH1

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9-235 FUEL - INJ timing. CIBETA - TOTAL DELAY\_<0

set TOTAL DELAY = 0.

9-239 TRANS - Flash OCIL light if failure occurs.

Refer to URD 419

9-239A TRANS - FLASH OCIL if ETV and shift failure

occurs. URD 419.

9-243 FUEL - FN071(MAP) current load input

FN1343, 1354, 1355.

9-251A S/W - TRANS - byte thrift.

9V-259A VIP - S/W thrift. Apply 9-259 to LH.

Refer to URD 285.

9-267 TRANS - Correct shift validation logic.

URD 496.

9V-267A VIP - Continuous test for Conv. Clutch.

Refer to URD 442,478, 496.

9-268 TRANS - Correct convertor clutch validation.

Refer to URD 442.

9-269 TRANS - Delete VBAT Check in PRNDL convert.

Refer to URD 478.

9-274 TRANS - S/W bullet-proofing. Refer to

URD 529.

9-281 MISC/THRIFT - remove unused code. Refer

to URD 540.

9-282 S/W - MISC-Byte and Time thrift.

9-283 S/W - MISC-Notification of Memory Overrun.

9-290 EGR EGRDC calculated & stored before

corresponding values of EGRCNT & EGRPRF.

9V-290A VIP&S/W - eliminates EGRDC = 0 check.

9-297 DOCUMENTATION - $SW\_RELK --> $SW\_RLK.

9-314 S/W - SYSEQUAT - Temp at start routine uses

byte instructions.

9V-318 VIP & S/W - Replace allign stmts with

conditional assembly.

9V-319 VIP-S/W set VSFMFLG according to

C29 KAM BIT in procedure.

9V-320 VIP & S/W - thrift bytes.

9-321 TRANS - ETV overcurrent failure flag not

setting properly. Refer to URD 531.

9-324 TRANS - Move setting of GR\_DS\_TV from

Delay Shift Logic to PRNDL Based Desired

Gear Determination. Refer to URD 559.

9V-327 VIP & S/W - fuel pump circuit monitor

check function. URD 597.

LHC0 LHB1 8V-165 VIP - Provide Continuous clutch switch test.

(8/12/87) 8V-165A VIP - Modify clutch switch test.

8V-165B VIP - Remove MTXSW logic.

8V-165C VIP - Correct 8V-165B.

8V-165D VIP - Add new Continuous clutch test.

9V-010D VIP - Correct the SW implementation of

9V-010 - 9-010C.

9-029C S/W - Improve implementation of fox

functions. Refer to URD #113.

9V-032 VIP - Add VIP test logic to the E4OD

transmission strategy.

9-049C Modify Air Charge calculation.

9V-052A VIP - Split LU self test strategy into

LL, LH, and LD. Refer to URD #96.

1-25

STRATEGY EVOLUTION - LHBH1

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9V-052B VIP - Change from Dual EGR to Sonic.

9V-058 VIP - Free up service code 75 for other

use. Refer to URD #76.

9V-058A VIP - Delete service code 75 from IVSC

test.

9V-058B VIP - Revise flag names and sense of flags

used in KOER brake test.

9V-129 VIP - SW.

9V-130 VIP - Restructure Engine-running Self Test

Refer to URD #219.

9V-130A VIP - Clarify variable names.

9-131C S/W - Correct PPCTR initialization.

9V-132 VIP - Byte and time thrift in Continuous

VIP. Refer to URD #139.

9V-133 VIP - Revise fault filter call.

9V-147 VIP - Byte thrift.

9V-165 VIP - Clarify source code for VIP KOER.

Refer to URD #299.

9V-183 VIP - Provide for two types of IDM. Refer

to URD #518.

9-184 Revise CRKTMR logic to supply correct

cranking fuel. Refer to URD #323.

9-184A Clearly define the CRKTMR strategy.

9-187 S/W - Protect future assemblies. Refer to

URD #317.

9-197 SYSEQUA - Improve MAP average during large

pulsations in manifold. Refer to URD #209.

9-197A Cleanup EMR for original.

9V-199A VIP - Make VIP compatible with strategy EMR

9-199. Refer to URD #11.

9-205 SPARK - Revise OSCMOD to apply to decel as

well as off idle.

9-220 Add Transmission Oil Strategy. Refer to

URD #309.

9-220B Use ECT for TOT if ITOT is out of limits.

9V-223 VIP - Add TOT sensor tests. Refer to

URD #309.

9V-223A VIP - Revise parameter and register names.

9V-224 VIP - Byte thrift. Refer to URD #411.

9-227 Correct TSLAMU update. Refer to URD #421.

9V-240 VIP - Boo Test. Refer to URD #436.

9-251 Add a calibration parameter (TVPMIN) and

clip TV\_PRES to TVPMIN as a minimum.

URD #456.

9-258 Set FLG\_ENG\_TV to 0 on F/R and R/F manual

shifts. Refer to URD #461.

9-271 Correct documentation of DSTPBR.

9-273 Clip daspot to 1.99 or FN882 \* FN891,

whichever is less. Refer to URD #499.

9-276 Documentation - Delete reference to VSMFLG

and VSFAIL. Refer to URD #506.

9-278 S/W - Correct temperature \_@ start routine.

Refer to URD #532.

LHB1 LHB0 9-038B TRANS - Correct misspelling of

(6/30/87) FLG\_SF\_AUTO.

9-144A FUEL S/W - Correct KAMREF lookups.

Refer to URD #174.

1-26

STRATEGY EVOLUTION - LHBH1

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LHB0 LHA0 9-049 FUEL - Add torque limiting strategy

(6/12/87) for ETV overcurrent failure.

Refer to URD #98.

9-049B FUEL - Clarify 9-049.

9-087B TRANS - Cleanup ETVOCM logic.

9-152A TRANS - Update SPD\_RATIO once per BG

pass. Refer to URD #358.

9-155A TRANS - Do not delay shift logic for

manual shifts. Refer to URD #278.

9-189 TRANS - Revise TV Pressure logic for

Reverse engagements. Refer to URD #326.

9-198 TRANS S/W - Correctly scale parameters.

Refer to URD #355.

LHA0 LUX0 9-014 TRANS - Delete SIL.

(5/28/87) 9V-032 VIP - Add VIP for E4OD.

9-052 MISC - Split LH from LU. Refer

to URD #96.

9V-052A VIP - Split LU into LL, LH, and LD.

9V-052B VIP - Drop PFEEGR.

9-052C EGR - Remove PFE EGR from LH.

9-087 TRANS - Add ETV failure flags.

Split from LD. Refer to URD #98.

9-087A TRANS - Add OFMFLG logic.

9-112B TRANS - Add failsafe to Dynamic TV

logic. Refer to URD #186.

9-112C TRANS - Revise failsafe to Dynamic

TV logic.

9-131 FUEL - Add Generic Open Loop fuel.

Refer to URD #165.

9-131A FUEL - Clean-up for 9-131.

9-131B FUEL - Correct CL LAMBSE reset.

9-144 FUEL - Expend VOLEFF & Adaptive fuel

tables. Refer to URDs #174 & #253.

9-149 TRANS - Combine the tip-out and TV

shift delays. Refer to URD #279.

9-149A MISC - Correct documentation in

9-149.

9-150 TRANS - Reverse the sign of the speed

ratio check during manual downshifts.

Refer to URD #272

9-151 TRANS - Only delay the manual 1-2

upshifts during power-off mode.

Refer to URD #273.

9-152 TRANS - Modify Converter Clutch

routines. Refer to URD #274.

9-153 TRANS - Revise the back-out upshift

logic. Refer to URD #276.

9-154 TRANS - Revise TV strategy to provide

coast boost TV when coast clutch is on.

Refer to URD #271.

9-154A TRANS - Clear FLG\_DEL\_MDN when shift

is complete.

9-155 TRANS - Recognize a 4-2/2-4 shift.

Refer to URD #278.

9-156 TRANS - Revise the "Infer Coast Clutch

Engaged Logic." Refer to URD #291.

9-164 TRANS - S/W clean-up. Implement

9-119. Refer to URD #307.

1-27

STRATEGY EVOLUTION - LHBH1

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9-164A TRANS S/W - Clarify 9-164.

9-164B TRANS S/W - Correct flag code.

9-172 MISC - Clean-up TP-RATCH vs TP\_REL

substitution. Refer to URD #314.

9-172A MISC - Clean-up TP-RATCH vs TP\_REL

substitution. Refer to URD #314.

1-28

CHAPTER 2

SYMBOLOGY

2-1

SYMBOLOGY - LHBH0

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SYMBOLOGY

DEFINED PARAMETERS

A defined parameter is a variable or a constant that is defined in EEC-IV

source code according to its definition in the strategy parameter dictionary.

Defined parameters are represented in the strategy description by identifiers

whose alphabetic characters are in the upper case.

STRATEGY SPECIFICATION PARAMETERS

A strategy specification parameter is a variable or a constant that is not

defined in the strategy parameter dictionary. Strategy specification

parameters are represented in the strategy description by identifiers whose

alphabetic characters are in the lower case. These parameters are used only

to facilitate the description of strategy function. A strategy specification

parameter need not be defined in the EEC-IV source code if the implementation

structure does not require it.

The scope of the identifier representing a strategy specification parameter

may include more than one strategy module, but it is strictly local to one

strategy chapter. A strategy specification variable cannot be used to pass

information between strategy modules that execute asynchronously. The value

of a strategy specification variable does not persist between repeated

executions of any particular strategy module in which it is referenced.

INPUTS

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

form:

X > Y

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

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

represent a variable.

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

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

SYMBOL MEANING

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

= EQUAL TO

<> NOT EQUAL TO

> GREATER THAN

>= GREATER THAN OR EQUAL TO

< LESS THAN

<= LESS THAN OR EQUAL TO

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

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

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

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

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

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

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

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

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

'0'.

2-2

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LOGICAL OPERATIONS

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

gate is represented by the following symbol:

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

|AND -| C

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

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

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

INPUT STATES as shown in the following truth table:

AND GATE

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

INPUT STATE INPUT STATE OUTPUT STATE

A B C

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

0 0 0

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

0 1 0

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

1 0 0

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

1 1 1

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

Likewise, the 'OR' gate is represented by:

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

|OR --| C

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

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

table:

OR GATE

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

INPUT STATE INPUT STATE OUTPUT STATE

A B C

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

0 0 0

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

0 1 1

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

1 0 1

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

1 1 1

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

2-3

SYMBOLOGY - LHBH0

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OUTPUTS

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

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

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

|AND -- C --|

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

|

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

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

treated like any other conditional statement when determining the value

of the final OUTPUT STATE E.

2) ACTION is taken based upon the OUTPUT STATE.

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

|AND -- C --| Energize OUTPUT

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

| --- ELSE ---

|

| De-energize OUTPUT

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

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

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

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

will appear.

2-4

SYMBOLOGY - LHBH0

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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.

2-5

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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

ELSE

No change to flip-flop output flag

ENDIF

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

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

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

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

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

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

smaller (L) parameter.

Example:

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

|

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

1.0 |

|

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

| | clear region |

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

| | |

| | |

| | no change (hysteresis)

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

| | |

| | set region \|/

|

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

2-7

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HOW TO INTERPRET THE HEXADECIMAL REPRESENTATION

OF A REGISTER CONTAINING BIT FLAGS

1) Display the register on the calibration console.

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

in hexadecimal format.

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

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

HEXADECIMAL DIGIT DISPLAYED BINARY EQUIVALENT STRING

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

|

0 | 0000

1 | 0001

2 | 0010

3 | 0011

4 | 0100

5 | 0101

6 | 0110

7 | 0111

8 | 1000

9 | 1001

A | 1010

B | 1011

C | 1100

D | 1101

E | 1110

F | 1111

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

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

of bit flags in bit positions 3 through 0.

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

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

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

2-8

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EXAMPLE:

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

register which is at address B0.

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

2) Display the contents in hexadecimal format.

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

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

| HEXADECIMAL | 2 | F |

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

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

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

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

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

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

2-9

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THE "DO:" STATEMENT

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

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

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

smaller pieces so that the strategy can be easily represented without

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

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

series of sequential pieces of logic.

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

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

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

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

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

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

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

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

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

diagram.

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

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

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

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

syntax is:

BEGIN: DSDRD\_GR MODULE BEGIN: RPM LIMITER PROCESS

. .

. .

. .

CONTINUE: DSDRD\_GR MODULE CONTINUE: RPM LIMITER PROCESS

(if required) (if required)

. .

. .

. .

END: DSDRD\_GR MODULE END: RPM LIMITER PROCESS

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

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

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

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

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

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

the third page.

2-10

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

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

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

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

execution after returning to the originating point.

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

|AND -| ACTION 1

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

| --- ELSE ---

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

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

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

| --- ELSE --- | .

| | .

| ACTION 2 | END: XYZ PROCESS

|

| |

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

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

|

| --- ELSE ---

|

| ACTION 2

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

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

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

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

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

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

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

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

its execution.

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

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

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

flop flop output flags within the DO: statement.

2-11

SYMBOLOGY - LHBH0

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The "ROLAV" Statement

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

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

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

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

first order differential equation and takes the form:

- (FK\_TMR/TC)

f = 1 - e

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

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

Using the first two terms of the series expansion:

x x²

e = 1 + x + -- + · · ·

2!

Simplifying, the exponential "f" becomes:

- (FK\_TMR/TC) 1

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

(FK\_TMR/TC)

e

1 1

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

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

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

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

also introduces more time lag into the signal.

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

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

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

average routine. See the calling convention below.

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

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

using the following convention:

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

Where:

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

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

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

becomes the old\_average on the next filtering event.

- new\_value = Input value to be filtered.

- TC = Time constant.

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

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

loop time.

2-12

SYMBOLOGY - LHBH0

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The "ABS" Statement

The ABS function returns a value which is the absolute value of parameter x.

ABS has the following form:

ABS(x)

The parameter x cannot be of flag type.

The "CLIP" Statement

The CLIP function returns the value x clipped between the range low and high.

low is the lower limit and high is the upper limit. low and high MUST be

specified in the given order. CLIP has the following form:

CLIP( x, low, high)

EXAMPLE:

y = CLIP( x, low, high)

This is equivalent to the following logic chart.

x > high ---------------------| y = high

|

| --- ELSE ---

|

x < low ----------------------| y = low

|

| --- ELSE ---

|

| y = x

NOTE:

If the limits high and low are calibrated such that low >= high, then the

output will be high. The high limit ALWAYS take priority.

2-13

SYMBOLOGY - LHBH0

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The "MAX" Statement

The MAX function returns the maximum value of a list of parameters x1,...xn.

MAX has the following form:

MAX(x1,...,xn)

The parameters x1 through xn cannot be of flag type.

Example:

y = MAX(x, 10)

This is equivalent to the following logic chart.

x < 10 -----------------------| y = 10

|

| --- ELSE ---

|

| y = x

The "MIN" Statement

The MIN function returns the minimum value of a list of parameters x1,...xn.

MIN has the following form:

MIN(x1,...,xn)

The parameters x1 through xn cannot be of flag type.

Example:

y = MIN(x, 15)

This is equivalent to the following logic chart.

x > 15 -----------------------| y = 15

|

| --- ELSE ---

|

| y = x

2-14

SYMBOLOGY - LHBH0

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The "SQR" Statement

The SQR function returns a value which represents the square of the parameter

x. SQR has the following form:

SQR(x)

The parameter x cannot be a flag type.

The "SQRT" Statement

The SQRT function returns a value which represents the square root of the

parameter x. SQRT has the following form:

SQRT(x)

The parameter x cannot be a flag type, and MUST NOT be NEGATIVE.

2-15

SYMBOLOGY - LHBH0

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The "pid\_def()" Construct

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

protocol between the Powertrain Control Module and an outside requestor.

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

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

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

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

other systems capable of establish and sustaining communications using the

SCP.

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

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

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

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

in a PID request. That construct is the:

pid\_def(pid\_number, description)

Where:

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

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

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

for j2190 or SBDS specific PIDs.

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

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

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

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

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

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

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

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

b1: FLG\_2,

b2: 1,

b3: 0,

b4: FLG\_3,

b5: FLG\_4,

b6: 0,

b7: 0)

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

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

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

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

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

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

pid\_definitions contexts will therefore be distrubuted throughout the

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

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

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

as to how to implement the PID scheme.

2-16

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MODULE NAME

OVERVIEW

Put overview text here. . .

DEFINITIONS

Put definitions text here. . .

PROCESS

STRATEGY MODULE: STRATEGY\_MODULE\_COM1n

BEGIN: pid\_definitions

;comment describing that this section is defining PIDs.

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

|AND -| flag1 := 1

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

| --- ELSE ---

|

| flag1 := 0

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

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

pid\_def(j2190\_xx, parameter1)

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

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

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

b1: FLG\_1,

b2: 0,

b3: 1,

b4: FLG\_2,

b5: CAL\_SW\_1,

b6: 0,

b7: 0)

END: pid\_definitions

Continue with the control strategy logic here. . .

2-17

SYMBOLOGY - LHBH0

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The "send()" Construct

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

the Powertrain Control Module and the vehicle network databus.

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

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

the bus.

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

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

in an SCP message. That construct is the

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

Where:

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

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

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

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

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

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

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

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

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

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

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

j1979\_01\_011,

j1979\_01\_012,

j1979\_01\_013,

j1979\_01\_014)

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

over the network with the following defined values:

scp\_data\_1 = 41h

scp\_data\_2 = 01h

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

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

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

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

NOTES: SCP messages which contain no variable data bytes are to be sent

from the strategy without the "scp\_data\_[]" portion defined.

The priority/type and target specifier bytes are unique values

for each message, and thus are NOT defined in the "send()" construct.

As a result, all messages referenced by "send()" must also be defined

in the SCP interface strategy for the software designers' reference.

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

rather a means of communicating information to the software designer to

transmit over the SCP network.

2-18

CHAPTER 3

EEC OVERVIEW

3-1

EEC OVERVIEW - LHBH0

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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.

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). It also contains the utility

functions, filters, ratchets, and timers, and a parameter dictionary of

calibration constants, fox functions and tables.

HARDWARE CALIBRATION SWITCHES

The LH strategy is an EFI, speed density strategy designed to handle any

vehicle speed or non-vehicle speed engine application. Hardware complexity

is taken into account via a set of user accessible software calibration

switches. These switches are detailed below:

- BIHP - If a brake on/off switch is present, set BIHP = 1, otherwise set

BIHP = 0.

- CANPHP - If EEC controlled canister purge hardware is present, set CANPHP

= 1, otherwise set CANPHP = 0 to bypass the canister purge logic.

- DOLHP - If Data Output Link is being utilized, set DOLHP = 1, otherwise

set DOLHP = 0 to bypass the DOL fuel calculation.

3-2

EEC OVERVIEW - LHBH0

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- GOVHP - If output to stand-alone governor is present, set GOVHP = 1;

otherwise set = 0.

- PFEHP - If a Sonic EGR system is being used, set PFEHP = 0. Sonic EGR

systems utilize an EVR (Electronic Vacuum Regulator) output. In order to

conserve memory, registers and fox functions have been scaled such that

both the PFE and Sonic EGR logic can share calibration locations. For

example; both EGR strategies use FN219, FN221, and FN239. Also, the EVR

output routine, EGR enable/disable logic, and the desired EGR rate are

common software code segments. If PFEHP is set to 1 or 2, then the EGR

Strategy is always disabled.

- PSPSHP - If a power steering pressure switch is present, set PSPSHP = 1,

otherwise set PSPSHP = 0. PSPSHP is used in the Idle Speed Control

logic.

- THRMHP - If Thermactor air pump hardware is present, set THRMHP = 1,

otherwise set THRMHP = 0. Also, the following logic sets CHKAIR = 1 for

proper function of the Closed Loop/Open Loop fuel logic when Thermactor

Air is not used.

THRMHP = 0 ----------------------------| CHKAIR = 1

|

| --- ELSE ---

|

| Do NOT modify CHKAIR

(Set within Thermactor logic)

- TSTRAT = Transmission Strategy switch - 0 -> No Transmission Control; 1

-> Shift Indicator Light Control; 2 -> A4LD with Vehicle Speed Sensor; 4

-> C6E4 Electronic Transmission Control.

- TRLOAD = 0 Manual trans, no clutch or gear switch, forced neutral (NDSFLG

= 0); TRLOAD = 1 Manual trans, no clutch or gear switch; TRLOAD = 2

Manual trans, one clutch or gear switch; TRLOAD = 3 Manual trans; TRLOAD

= 4 Auto trans, non-electronic, Neutral Drive Switch; TRLOAD = 5 Auto

trans, non-electronic, Neutral Pressure Switch (AXOD); TRLOAD = 6 Auto

trans, electronic, PRNDL sensor Park, Reverse, Neutral, Overdrive,

Manual2, Manual1 configuration.

- IMS - If no IMS (Inferred Mileage Sensor) hardware is present, IMS

defaults to a value of 1 (1 -> no IMS hardware or high mileage). IMS is

referenced in the EGR and Thermactor Air logic.

- VSTYPE - If a Vehicle Speed Sensor is present, set VSTYPE = 1, otherwise

set VSTYPE = 0.

3-3

EEC OVERVIEW - LHBH0

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DCL HARDWARE PRESENT SWITCHES

Hardware present switches define the types of devices connected to the

EEC module through the wiring harness. (See also DCL Chapter)

LINK\_SW 00 -> UART MODE disabled / no DOL, no DCL

01 -> UART MODE disabled / DOL present, no DCL

02 -> UART MODE disabled / no DOL , DCL present

03 -> UART MODE disabled / DOL present, DCL present

04 -> UART MODE enabled / no DOL, no DCL

05 -> UART MODE enabled / DOL present, no DCL

06 -> UART MODE enabled / no DOL, DCL present

07 -> UART MODE enabled / DOL present, DCL present

NOTE: All applications, except FN-9, should have UART mode enabled.

3-4

EEC OVERVIEW - LHBH0

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INITIALIZATION ROUTINE

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

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

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

calculated value) as shown below. NOTE: The parameters are not necessarily

initialized in the order shown.

RAM/FLAG INITIAL VALUE

A3CTMR FFFF (63.99 SEC)

ACT 60.00 DEG F

AEMAP MAP

APT -1.0 (CLOSED THROTTLE)

BP\_INTR 1.0

CFIEPT 650.0 COUNTS

CONPR 370.0 COUNTS

CRKFLG 1.0 (CRANK MODE)

ECT 60.0 DEG F

EGRBAR 307.0 COUNTS

EOFF 307.0 COUNTS

EPTBAR 650.0 COUNTS

FIEPT 650.0 COUNTS

GEAR\_CUR 1.0

GEAR\_OLD 1.0

GR\_CM 1.0

GR\_CM\_LST 1.0

GR\_DS 1.0

GR\_DS\_LST 1.0

GR\_OLD 1.0

IEGR 307.0 COUNTS

INJ\_PIP\_CNT 1.0

IPDL 7.0

ISCMOD 1.0

LAM\_OLD 1.0

LAMAVE 1.0

LAMBSE 1.0

LAMMUL 0.996

LOACT 245.0 DEG F

MAP 27.0 IN. HG

MAPBAR 27.0 IN. HG

MAP\_FREQ 150.0 HZ

MAP\_WORD 27.0 IN. HG

MKAY 1.0

MULTMR 255.0 SEC

NOV\_ACT NVBASE

NOV\_ACT\_LST NVBASE

OLFLG 1.0 (OPEN LOOP)

PDL 7.0

PDL\_LST 4.0

PPCTR PIPNUM

PUMP 1.0

RANNUM 8193

RATCH RACHIV (250 COUNTS)

RLKCTR 1.0

RT\_GR\_CUR GRRAT1

RT\_GR\_OLD GRRAT1

RT\_NOVS 1.0

3-5

EEC OVERVIEW - LHBH0

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INITIALIZATION ROUTINE (CONTINUED)

RAM/FLAG INITIAL VALUE

SAF 10.0 DEG. BTDC

SYNCTR 1.0

TBART RACHIV (250 COUNTS)

TLSCTR FFFF (ALL BITS EQUAL ONE)

TPBAR RACHIV (250 COUNTS)

TPBART RATIV

TPBARTC RATIV

TPBARTV RATIV

TSLMPH 0.249 SEC

UNDSP 1.0 (UNDERSPEED)

VBAT 12.5 VOLTS

WINDOW\_BETA 0.95

3-6

CHAPTER 4

CRANK/UNDERSPEED/RUN MODE SELECTION

4-1

CRANK/UNDERSPEED/RUN MODE SELECTION - LHBH0

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CRANK/UNDERSPEED/RUN MODE SELECTION

The EEC-IV strategy operation is divided into three distinct strategy

segments. These are:

1) CRANK

2) UNDERSPEED

3) RUN

The CRANK mode is entered after a power-up initialization or after an

engine stall. CRANK employs a special strategy to aid engine starting. When

the CRANK logic first becomes false, the UNDERSPEED mode is entered. The

UNDERSPEED mode employs a special spark and fuel strategy in place of the

normal engine control strategy (RUN). After start, the RUN mode is entered

and the normal engine control strategy is executed. If the engine stumbles

during RUN mode, the UNDERSPEED mode can again be entered to help recover

from the stumble and prevent a stall.

The specific strategies are:

CRANK STRATEGY

Fuel Energize all injector ports simultaneously

every CRKPIP PIPS on PIP Falling Edges.

Injector Synchronization Logic is disabled.

See the BACKGROUND FUEL PULSEWIDTH CALCULATION

section of the FUEL Chapter for a description

of the FUELPW calculation.

Spark Advance 10 degrees BTDC (on PIP signal)

Thermactor Air bypass

EGR disabled

Purge disabled

ISC disabled (0% duty cycle if N = 0, 100%

duty cycle if N <> 0)

4-2

CRANK/UNDERSPEED/RUN MODE SELECTION - LHBH0

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UNDERSPEED STRATEGY

Fuel Energize all injector ports in the

same manner as in the RUN mode,

referenced to PIP Rising Edges.

See the FUEL Chapter for the FUELPW calculation.

Spark Advance 10 degrees BTDC (on PIP signal)

Other outputs are the same as the RUN mode.

RUN STRATEGY

Injector Synchronization Logic is enabled

if SIGNATURE PIP distributor is present.

(See the FUEL Section)

The normal engine control strategy is described in the remainder of this

book.

4-3

CRANK/UNDERSPEED/RUN MODE SELECTION - LHBH0

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CRANK/UNDERSPEED/RUN MODE SELECT

DEFINITIONS

INPUTS:

Registers:

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

- N = Engine RPM.

- PIPCNT = Number of PIPs which have occurred.

- TSLPIP = Time since last PIP occurred, msec.

Bit Flags:

- CRKFLG = Flag indicating engine mode. 1 -> cranking; 0 -> run or

underspeed mode.

- FIRST\_PIP = Bit Flag set to 1 if First PIP has been received.

Calibration Constants:

- CRKPIP = Number of PIPs between injector firing.

- IGN\_TYPE = Inidcator of ignition type (0 = TFI, 1 = TFI\_ICCD, 2 =

LDR-DIS).

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

- NRUN = Minimum Engine Speed to exit CRANK Mode.

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

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

value assume that there was a reinit.

- UNRPM = Underspeed Engine Speed.

- UNRPMH = Hysteresis term for UNDERSPEED Mode.

OUTPUTS

Registers:

- ECTCNT = See above.

- INIT\_TOT = Temperature of transmission oil at start-up, deg. F.

- N = See above.

- PIPCNT = See above.

- RUNUPTMR = Time since RUNUP\_FLG was set, sec.

4-4

CRANK/UNDERSPEED/RUN MODE SELECTION - LHBH0

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- TCSTRT = Temperature of Engine Coolant at Startup, deg F.

Bit Flags:

- CRKFLG = See above.

- FLG\_STALL = Flag indicating a stall has occurred; transition from

underspeed/run to crank.

- REFLG = Reinit flag: 1 -> reinit occurred; 0 -> no reinit.

- RUNUP\_FLG = Flag indicating that Runup is complete; 1 -> Runup complete.

- UNDSP = Flag indicating engine mode: 1 -> cranking or underspeed, 0 ->

run mode.

CRANK/UNDERSPEED/RUN MODE SELECTION LOGIC

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

(Crank mode) | | CRANK MODE

|AND -| CRKFLG = 1

N <= NRUN ----------| | | UNDSP = 1

| | | FLG\_STALL = 0

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

| | --- ELSE ---

PIPCNT < NCNT ------| |

| A Stall has occurred

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

(Run or Underspeed mode) |AND -| CRKFLG = 1

| | UNDSP = 1

N < NSTALL ---------------| | ECTCNT = 0

| TCSTRT = 0

| INIT\_TOT = 0

| FLG\_STALL = 1

| RUNUP\_FLG = 0

| RUNUPTMR = 0

|

| --- ELSE ---

|

CRKFLG = 1 ---------| | UNDERSPEED Mode

|OR --|S Q--| CRKFLG = 0

N < UNRPM ----------| | | UNDSP = 1

| | FLG\_STALL = 0

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

| --- ELSE ---

|

| RUN Mode

| CRKFLG = 0

| UNDSP = 0

| FLG\_STALL = 0

4-5

CRANK/UNDERSPEED/RUN MODE SELECTION - LHBH0

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PIP COUNTER AND ECT 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

NOTE: If the PIP period (time elapsed since the last PIP signal) becomes >=

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.

ENGINE RUNNING REINIT STRATEGY

The reinit strategy attempts to differentiate an engine running reinit

from a normal start engine run-up. 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.

"first RPM calculation" >= STALLN -------| REFLG = 1

(Set reinit flag)

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

| FIRST\_PIP = 0

| REFLG = 0

When the engine is not moving and a LDR-DIS ignition system is used, the

SPOUT output from the EEC computer to the ignition module should be held in

the HIGH state to prevent the coil from charging.

IGN\_TYPE = 2 ---------------------|

(LDR-DIS system) |

|AND -| SPOUT to high

TSLPIP > 800 msec ----------| |

(no PIPs in long time) |OR --|

|

FIRST\_PIP = 0 --------------|

(no PIPs yet)

4-6

CHAPTER 5

THROTTLE MODE SELECTION

5-1

THROTTLE MODE SELECTION - LHBH0

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THROTTLE MODE SELECTION

OVERVIEW

The throttle mode scheduler is used to determine what engine operating region

is currently extant. The variable APT (At Part Throttle flag) is used to

indicate throttle mode and is assigned the following values:

THROTTLE MODE APT

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

Closed Throttle -1

Part Throttle 0

Wide Open Throttle 1

The value of APT is determined by the logic shown on the following page.

Briefly, throttle angle breakpoints, in terms of counts, are used to define

the CLOSED/PART THROTTLE and PART/WIDE OPEN THROTTLE transitions. Hysteresis

is incorporated in both breakpoints to prevent jitter between modes.

TP\_REL is a parameter which indicates the amount of throttle movement beyond

the closed throttle/idle setting. TP\_REL is computed by subtracting RATCH

from TP. Larger values of TP\_REL indicate wide open throttle, smaller values

of TP indicate part throttle, and near zero TP\_REL indicates closed throttle.

The variable RATCH is the output of a ratchet algorithm which continuously

seeks the minimum throttle angle corresponding to a CLOSED THROTTLE position.

This alleviates the necessity to set the throttle position sensor at an

absolute position and compensates for system changes and differences between

vehicles. The ratchet algorithm uses filtered throttle position for the

determination of RATCH. RATCH is initialized to the non-calibratable value

RATIV, currently set to 250 counts.

A more detailed explanation of the throttle position ratchets and throttle

position filter is contained in the SYSTEM EQUATIONS section.

DEFINITIONS

INPUTS

Registers:

- APT = Throttle Mode Flag; -1 -> closed throttle, 0 -> part throttle, 1 ->

wide open throttle.

- TP\_REL = Relative Throttle Position.

Bit Flags:

- CRKFLG = Flag indicating engine mode; 1 -> cranking, 0 -> run or

underspeed mode.

Calibration Constants:

- DELTA = CT/PT Breakpoint Value above RATCH.

5-2

THROTTLE MODE SELECTION - LHBH0

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- HYST2 = Hysteresis term to enter WOT Mode.

- HYSTS = Hysteresis term to exit Closed Throttle Mode.

- THBP2 = PT/WOT Breakpoint Value above RATCH.

OUTPUTS

Registers:

- APT = Throttle Mode Flag; -1 -> closed throttle, 0 -> part throttle, 1 ->

wide open throttle.

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

- PTSCR = Part throttle mode since exiting CRANK flag.

PROCESS

The logic described below considers the current position of the throttle and

compares that 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.

TP\_REL <= DELTA ----------------|S Q--| CLOSED THROTTLE MODE

| | APT = -1

TP\_REL >= DELTA + HYSTS --------|C |

| --- ELSE ---

|

TP\_REL > THBP2 + HYST2 ---------|S Q--| WIDE OPEN THROTTLE MODE

| | APT = 1

TP\_REL <= THBP2 ----------------|C |

| --- ELSE ---

|

| PART THROTTLE MODE

| APT = 0

5-3

THROTTLE MODE SELECTION - LHBH0

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Previous APT = -1 -------------|

|

Current APT <> -1 -------------|AND -| CTPTFG = 1

| | (Closed Throttle to Part/WOT

CRKFLG = 0 --------------------| | transition)

| PTSCR = 1

| (Part Throttle since Crank)

|

| --- ELSE ---

|

| CTPTFG = 0

NOTE: PTSCR and CTPTFLG are initialized to zero.

5-4

CHAPTER 6

FUEL STRATEGY

6-1

FUEL STRATEGY, OVERVIEW - LHBH0

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OVERVIEW

The purpose of the Fuel Control Strategy is to provide fuel to the engine in

appropriate quantities to achieve the desired Air/Fuel ratio in the

combustion chambers. The desired A/F ratio is determined by the fuel control

strategy and calibration for all operating conditions. It can either be a

predetermined value that is calibration dependent and can vary with engine

operating conditions (Open Loop Control); or the EEC may ramp the value up

and down in a limit cycle to maintain an average stoichiometric mixture, as

determined by the EGO sensor (Closed Loop Control).

The fuel control actuators, or fuel injectors, consist of a solenoid and

metering needle or pintle which is moved off a seat by energizing the

solenoid, thus releasing fuel through a nozzle. Each cylinder has an

injector installed in the intake manifold to direct fuel toward the intake

valve. The length of time the solenoid is energized (pulsewidth) determines

the amount of fuel delivered.

Fuel is supplied to the injectors by a high pressure electric fuel pump,

controlled by the EEC. Fuel supply pressure is modulated by a regulator

sensing MAP to maintain the pressure differential across the injectors

constant.

A group of 2,3 or 4 injectors are energized simultaneously by a single output

port of the processor. If only one output port is used, all injectors are

energized every PIPOUT pips. If two output ports are used, they can be

energized individually in an alternating manner, with each port being

energized PIPOUT/NUMOUT pips after the other port, or simultaneously every

PIPOUT pips. The calibration parameter OUTINJ selects the injection scheme.

Except while in CRANK mode, until the #1 cylinder is identified from a

Signature Pip System, or if a Signature Pip System is not used, the injectors

are energized on the rising edge of PIP. If it is desired to optimize the

fuel delivery timing relative to intake valve opening, the injectors must be

grouped into banks with each bank containing cylinders in consecutive spark

firing order. Bank "A" must contain cylinder #1. This provides a time (or

window) during the engine cycle when all intake valves for a given injector

bank are closed. After synchronization, the injections can be delayed to

occur after the rising edge of the reference (signature) pip signal. CIBETA

(in pip periods) is the delay. CIBETA should be calibrated to cause the

injection during the closed valve window.

Except while in CRANK mode, the amount of air entering the engine is divided

by the desired A/F ratio to obtain the desired fuel flow. The desired A/F

ratio is expressed in terms of lambda, where lambda is the desired A/F ratio

divided by 14.64, the chemically correct ratio for complete combustion

(stoichiometry). This desired fuel flow is then converted to a pulsewidth

for the injectors, based on the engine RPM, number of cylinders, injector

flow characteristics, number of injectors and the desired injection

frequency.

In CRANK mode, since the airflow measurement is unreliable, the injector

pulsewidth is based on ECT, ACT, MAP and elapsed time in CRANK. Also, to

maximize the voltage available to activate the injectors, they are energized

on PIP Falling Edges.

6-2

FUEL STRATEGY, OVERVIEW - LHBH0

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The strategy has the ability to modify the fuel pulsewidth to account for

intake manifold wall wetting (TRANSIENT FUEL), injector flow reduction due to

high temperatures (HICOMP/A0COR), or while operating in UNDERSPEED mode. The

pulsewidth is also modulated during idle to stabilize idle RPM on Speed

Density systems (ISCMOD). The fuel can also be turned off during

decelerations (DFSO). Asynchronous with the main pulses, additional pulses

can be issued to account for the manifold filling effect during throttle

openings (AEFUEL).

The strategy also has the ability to adjust the fuel pulsewidth just prior to

energizing the injectors. The base pulsewidth is calculated in the

background sequence, using the then available MAP value. It may be a

significant time period before that pulsewidth is actually used, and MAP (and

airflow) may have changed. MAP is updated in the foreground on PIP up edges

prior to performing the fuel logic. For small changes in MAP, airflow can be

approximated as a linear function of MAP. Therefore, a more accurate fuel

pulsewidth can be obtained by adjusting the pulsewidth by the ratio of the

most current MAP value to the value used to calculate airflow. This

technique is called "Foreground Fuel".

6-3

FUEL STRATEGY, OVERVIEW - LHBH0

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FUEL MODE DESCRIPTION

The purpose of the FUEL\_MODE module is to determine the fuel control mode

(Open Loop/Closed Loop) and the value of LAMBSE. The fuel control strategy

consists of 3 mutually exclusive modes:

OPEN LOOP (OLFLG = 1)

CLOSED LOOP (OLFLG = 0)

SELF TEST OPEN LOOP (OLFLG = 1)

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 value (LAMBSE) can vary with engine operating

conditions and is calibration dependent.

CLOSED LOOP MODE

During closed loop operation, the computer ramps the desired lambda value

(LAMBSE) in a limit cycle manner about stoichiometry. Using the EGO

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

at a calculated rate of change. The rate at which LAMBSE changes is

calibration dependent.

SELF TEST OPEN LOOP MODE

During Self Test, the computer calculates lambda values (LAMBSEL,

LAMBSER) that will exercise the fuel, EGO, and thermactor systems. These

calculations are done in Self Test, outside of "Base Fuel Strategy" (See

the SELF TEST SECTION).

6-4

FUEL STRATEGY, ACCELERATION ENRICHMENT - LHBH0

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ACCELERATION ENRICHMENT

(Called from SOFTWARE TAR routine which is done in the CONVRT module)

OVERVIEW

Whenever the rate of change of throttle angle exceeds a certain value

additional injection pulses are delivered during throttle opening transients

until the manifold filling effect is completed (MAP stops increasing). These

pulses are added to the normal pulse train to provide Acceleration Enrichment

(AE).

AEFUEL = The acceleration enrichment desired fuel flow rate, lb/hr

The AE pulse period (AEPP) is controlled by FN332 which adds pulses at

a rate determined by the desired AE fuel flow (AEFUEL). The duration of

each AE pulse is given by AEPW.

AEPW is then used to update the DOL summer register FUEL\_SUM\_TKS.

NOTE: The "MINPW" minimum pulsewidth clip is only applied to FUELPW, the main

fuel pulsewidth. The clip does not apply to AEPW. Since AEPW is determined

by the AEFUEL and AE pulse period calibration, it is expected that the

developer will not request AE pulses in the non-linear injector range.

ADDITIONAL REQUIREMENTS

All injectors are energized together when delivering AE pulses.

AE pulses are asynchronous to normal fuel pulsewidths. If a fuel pulse is

not in progress when an AE pulse is required, the AE pulse is sent

immediately. In this case, the injector offset (FN367) is added to the AE

pulsewidth calculation (AEPW).

If a normal fuel pulsewidth is in progress when an AE pulse is required, the

AE pulse is added to the base pulse for that injector. In this case, the

injector offset (FN367) is not added to the AE pulsewidth calculation (AEPW)

(it is done once in the normal pulsewidth calculation).

For throttle angle rates of change below that of the first column of the TAE

table (AETAR), TAE is set to zero.

AE pulses are enabled during run and underspeed modes only.

The AE fuel is turned off by setting TAR equal to zero in the S/W TAR logic.

See SOFTWARE TAR CALCULATION in the System Equations Chapter.

6-5

FUEL STRATEGY, ACCELERATION ENRICHMENT - LHBH0

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DEFINITIONS

INPUTS

Registers:

- ACT = Air charge temperature, degrees F.

- A0COR = Corrected fuel flow rate of injectors, lb/sec (see Fuel chapter).

- BP = Barometric pressure, inches Hg.

- ECT = Engine coolant temperature, degrees F.

- FUEL\_SUM\_TKS = Register for DOL summer, ticks.

- MAP = Manifold absolute pressure, inches Hg.

- NBAR = Rolling average RPM.

- RATCH = Kicker off lowest filtered TP, counts.

- TAR = Throttle Angle Rate, deg/sec.

- TLSPAT = Torque limiting strategy injection pattern.

- TP = Throttle position, counts.

- VBAT = Battery voltage, volts.

Bit Flags:

- CRKFLG = Flag indicating status of engine mode.

Calibration Constants:

- AEM = ECT/ACT weighting factor, unitless.

- AETAR = TAR above which AE may be enabled.

- FN019A(TAR) = x-axis input to FN1303.

- FN020(FRCTAE \* ACT + (1-FRCTAE) \* ECT) = y-axis input to FN1303.

- FN1303(TAR,TEMP) = Desired AE fuel flow, lbm/hr.

- FN324(MAP) = Accel enrichment fuel flow multiplier, unitless.

- FN331A(TP-RATCH) = Accel enrichment fuel flow multiplier, unitless.

- FN332(AEFUEL) = Accel enrichment pulse period, seconds.

- FN378(BP) = Accel enrichment fuel flow multiplier, unitless.

- FN379(NBAR) = Accel enrichment fuel flow multiplier, unitless.

- FN367(VBAT) = Injector offset, millisec.

6-6

FUEL STRATEGY, ACCELERATION ENRICHMENT - LHBH0

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- FRCTAE = ACT to ECT proportioning factor, unitless.

- INJOUT = Number oof injectors fired by each output port.

- NUMOUT = Number of injector output ports, unitless.

- stcf = Seconds to clock ticks conversion factor, ticks/second.

OUTPUTS

Registers:

- AEFUEL = The acceleration enrichment desired fuel flow rate, lb/hr.

- AEPP = The AE pulse period as defined by FN332, sec.

- AEPW = Acceleration Enrichment Pulsewidth, ticks.

- FUEL\_SUM\_TKS = Register for DOL summer, ticks.

6-7

FUEL STRATEGY, ACCELERATION ENRICHMENT - LHBH0

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PROCESS

STRATEGY MODULE: FUEL\_AE\_COM5

AE ENABLE LOGIC

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

(RUN/UNDERSPEED) |

|AND -| Enable AE

TAR > AETAR ------------| | AEFUEL = AEM \* FN1303 \* FN331A \* FN378

| | \* FN379 \* FN324

TLSPAT = 65535 ---------| | AEPP = FN332(AEFUEL)

| AEPW = [ AEFUEL \* FN332 / ( NUMOUT

| \* INJOUT \* 3600 \* A0COR )

| + FN367 / 1000 ] \* stcf

| FUEL\_SUM\_TKS = FUEL\_SUM\_TKS + AEPW

|

| --- ELSE ---

|

| Disable AE

| AEFUEL = 0

| AEPW = 0

| AEPP = 0

| FUEL\_SUM\_TKS = 0

6-8

FUEL STRATEGY, WARM EGO LOGIC - LHBH0

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WARM EGO LOGIC

OVERVIEW

The Warm EGO Logic determines if the EGO sensor is warm enough to enter

Closed Loop control. Time since start-up and coolant temperature at start-up

are used to determine if the sensor is warm. The output from the logic is

the flag, 'WRMEGO'.

DEFINITIONS

INPUTS

Registers:

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

- ATMR2 = Time since ECT became greater than TEMPFB, sec.

- ECT = Engine Coolant Temperature, degrees F.

- EGOSSS = Number of EGO switches since start-up.

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

Bit Flags:

- CRKFLG = Flag indicating engine mode; 1 -> cranking, 0 -> run or

underspeed mode.

- FLG\_ECTSTABLQ = ECT stabilized flag; 1 -> ECT stabilized, use FN1360.

- MPGFLG = Flag that indicates whether in Fuel Economy mode; 1 -> In Fuel

Economy mode, 0 -> Not in Fuel Economy mode.

- SWTFL = EGO switch flag; 0 -> no EGO switch, 1 -> EGO switch this

background loop.

Calibration Constants:

- CTHIGH = Hot start engine coolant temperature, deg F.

- CTLOW = Cold start engine coolant temperature, deg F.

- ECTSTABL = Minimum ECT to use stabilized engine open loop fuel table

FN1360.

- ECTSTHYS = Hysteresis for ECTSTABL. This value should be larger than the

drop in ECT when the thermostat opens on a 0 degree cold warm-up.

- MFARMP = MFAMUL ramp increment when ramping into MPG table. MFARMP is

added every background loop.

- OPCLT1 = Cold start closed loop delay, seconds.

6-9

FUEL STRATEGY, WARM EGO LOGIC - LHBH0

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- OPCLT2 = Mid-ambient start closed loop delay, seconds.

- OPCLT3 = Hot start closed loop delay time, seconds.

- TCSTRT = ECT at start-up.

OUTPUTS

Registers:

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

Bit Flags:

- FFULFG = Foreground fuel flag; 1 -> Compute fuel pulsewidth in foreground

using latest computed manifold absolute pressure, 0 -> otherwise use

background fuel pulsewidth.

- WRMEGO = Flag that is set equal to 1 if the EGO sensor is warm and reset

to zero if the sensor has cooled off.

PROCESS

STRATEGY MODULE: FUEL\_WRMEGO\_COM3

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

| FFULFG = 0

| Exit FUEL\_MODE

|

| --- ELSE ---

|

| Continue with FUEL\_MODE

| and LAMBSE DETERMINATION

EGOSSS LOGIC

SWTFL = 1 ------------------------------| Increment EGOSSS

(EGO switch) | Clip at 255

|

| --- ELSE ---

|

| Freeze EGOSSS

6-10

FUEL STRATEGY, WARM EGO LOGIC - LHBH0

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WRMEGO LOGIC

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

|AND -|

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

|

CTLOW < TCSTRT < CTHIGH ----| |

|AND -|OR --| WRMEGO = 1

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

| | --- ELSE ---

TCSTRT <= CTLOW ------------| | |

|AND -| | WRMEGO = 0

ATMR2 >= OPCLT1 ------------|

STABILIZED ECT FLIP/FLOP LOGIC

(FLG\_ECTSTABLQ)

ECT >= ECTSTABL ------------------|S Q--| FLG\_ECTSTABLQ = 1

| | (ECT stabilized)

ECT < ECTSTABL - ECTSTHYS --------|C |

| --- ELSE ---

|

| FLG\_ECTSTABLQ = 0

| (cold engine)

MFAMUL LOGIC

(MFAMUL ramps LAMBSE to the MPG mode table FN1328)

MPGFLG = 0 -----------------------------| MFAMUL = 0

|

| --- ELSE ---

|

| MFAMUL = MFAMUL + MFARMP

| Clip MFAMUL to 1.0 as a maximum

6-11

FUEL STRATEGY, LAMMUL RESET LOGIC - LHBH0

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LAMMUL RESET LOGIC

OVERVIEW

LAMMUL provides a means to adjust LAMBSE (rich or lean) momentarily on

transmission engagements while in Open Loop. LAMMUL and FN371 have a range

of 0 through 1.99. The LAMMUL RESET and RAMP BACK logic are done both in

Open Loop and Closed Loop fuel. LAMMUL, however is only applies in Open Loop

fuel.

DEFINITIONS

INPUTS

Registers:

- LAMMUL = Fuel multiplier for Neutral-to-Drive transitions used to prevent

cold engine stalls following transmission engagement.

- MULTMR = Time since incrementing LAMMUL, sec.

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

- DNDSUP = Delayed Neutral/Drive flag; 0 -> neutral, 1 -> drive.

- NEUFLG = Neutral/Drive transition occurred.

Calibration Constants:

- FN371 = Initial LAMMUL as a function of ECT.

- FN371\_ALT = Alternative FN371.

- MULTM = Minimum time interval incrementing LAMMUL.

- TRLOAD = Transmission load switch.

OUTPUTS

Registers:

- LAMMUL = Fuel multiplier for Neutral-to-Drive transitions used to prevent

cold engine stalls following transmission engagement.

6-12

FUEL STRATEGY, LAMMUL RESET LOGIC - LHBH0

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PROCESS

STRATEGY MODULE: FUEL\_LAMMUL\_COM3

ALT\_CAL\_FLG = 1 ------------------------| fn371 = FN371\_ALT(ECT)

|

| --- ELSE ---

|

| fn371 = FN371(ECT)

TRLOAD <= 3 ----------------------------| No LAMMUL RESET

(manual transmission) | No change to LAMMUL

| No change to NEUFLG

|

| --- ELSE ---

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

(transmission in gear) | |

|AND -| LAMMUL = fn371(ECT)

NEUFLG = 1 -----------------------| | (LAMMUL reset)

(transition from neutral) | NEUFLG = 0

| (N/D fuel enrichment)

|

| --- ELSE ---

|

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

(transmission in neutral)

LAMMUL RAMP BACK LOGIC

MULTMR >= MULTM ------------------------| LAMMUL = LAMMUL + .0039

(free running timer) | Clip at .996 maximum

| MULTMR = 0

6-13

FUEL STRATEGY, OPEN LOOP FLAG DETERMINATION - LHBH0

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OPEN LOOP FLAG DETERMINATION

OVERVIEW

This module determines the state of the Open Loop Flag, FLG\_OPEN\_LOOP.

DEFINITIONS

INPUTS

Registers:

- APT = At Part Throttle; -1 -> Closed throttle, 0 -> Part throttle, 1 ->

Wide Open throttle.

- APTMR = Timer to limit time in close loop fuel control when at Wide Open

Throttle.

- BIAS = A/F biasing term: FN1355(N,MAP). Units are lambdas.

- EGO\_CNT\_IDLE = Number of EGO switches which have occurred since entering

Idle Fuel Modulation.

- IDLTMR = Time since entering Idle mode, seconds. IDLTMR is defined in

the TIMER Chapter.

- LAMAVE = Average LAMBSE between EGO switches.

- MAP = Manifold Absolute Pressure, inches Hg.

- N = RPM.

- TP\_REL = Relative TP (TP - RATCH).

- XAPT = Time elapse afterwhich you leave Closed Loop at Wide Open

Throttle, to return to Open Loop.

Bit Flags:

- CHKAIR = Thermactor forced open loop flag; 0 -> thermactor logic forcing

open loop, 1 -> closed loop permitted.

- DFSFLG = Indicates decel fuel shut off.

- MPGFLG = Flag that indicates whether in Fuel Economy mode; 1 -> In Fuel

Economy mode, 0 -> Not in Fuel Economy mode.

- OFMFLG = ETV over-current monitor failure flag: 0 -> ETV O.K.; 1 -> ETV

failure mode.

- TLS\_NV\_FLG = Engine speed/Vehicle speed limiting flag; 0 -> not limiting

speed, 1 -> limiting speed.

6-14

FUEL STRATEGY, OPEN LOOP FLAG DETERMINATION - LHBH0

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Calibration Constants:

- EGO\_IDLE = Number of EGO switches required to enter Open Loop Fuel at

extended idles.

- FN311 = Minimum TP\_REL required to force open loop.

- FN1360 = Stabilized open loop fuel table, an 8 x 10 table of lambda

values as a function of engine speed N, and load, MAPPA. FN070B is the

normalizing function for N. FN072C is the normalizing function for

MAPPA.

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

- LAMDLT = LAMAVE delta to allow open loop fuel.

- LAMRHYS = Hysteresis for LAMRICH.

- LAMRICH = FN1360 Lambda value below which enrichment is requested.

- LMAP = Minimum MAP for open loop decels, inches Hg.

- LOMAPH = Hysteresis for LMAP, inches Hg.

- MPG\_CL\_SW = MPG mode closed loop switch; 1 -> operate in closed loop, 0

-> operate in open loop.

- OLITD1 = Time delay to go open loop at idle, seconds.

- T70LSW = 7.0L thermactor application switch.

- TP\_HYS\_OL = TP\_REL hysteresis for operation in open loop.

OUTPUTS

Bit Flags:

- FLG\_OPEN\_LOOP = Open Loop Fuel flag; 1 -> Open Loop fuel, 0 -> Closed

Loop fuel may be permitted.

- MPGTFG = MPG transition mode flag; 1 -> MPG mode exit into Closed Loop

fuel.

6-15

FUEL STRATEGY, OPEN LOOP FLAG DETERMINATION - LHBH0

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PROCESS

STRATEGY MODULE: FUEL\_OLFLG\_COM7

FN1360 <= LAMRICH -------------|S Q -|

(enrichment required) | |

| |

FN1360 > LAMRICH + LAMRHYS ----|C |AND -|

(return to closed loop) | |

| |

HLTMR >= HLDTIM ---------------------| |

(high load delay time) | |

| |

OPEN\_TMR <= TIME\_OL -----------------| |

(O.K. to remain in open loop; not time |

to adaptive or force purge control) |

|

MAP < LMAP - LOMAPH -----------------|S Q -|

(decel load) | |

| |

MAP >= LMAP -------------------------|C |

|

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

|AND -|OR --| FLG\_OPEN\_LOOP = 1

APTMR >= XAPT -----------------------| | | (open loop conditions

| | met)

MPG\_CL\_SW = 0 -----------------------| | | MPGTFG = 0

|AND -| | Stop MPG mode fuel ramp

MPGFLG = 1 --------------------------| | |

(MPG mode) | | --- ELSE ---

| |

DFSFLG = 1 --------------------------------| | Check to see if EGO sensor

(decel fuel shutoff) | | ready or fuel ramp in

| | progress

IDLTMR > OLITD1 ---------------------| | | FLG\_OPEN\_LOOP = 0

(idle) | | | (closed loop operation

| | | possible)

EGO\_CNT\_IDLE >= EGO\_IDLE ------------|AND -|

| |

|1.0 + BIAS - LAMAVE| <= LAMDLT -----| |

|

CHKAIR = 0 --------------------------| |

(thermactor forced open loop) | |

|AND -|

T70LSW = 0 --------------------------| |

(1 = 7.0L application; no thermactor |

forced open loop) |

|

OFMFLG = 1 --------------------------------|

(ETV sol. shorted to ground) |

|

TLS\_NV\_FLG = 1 ----------------------------|

(vehicle/engine speed limiting) |

|

TP\_REL > FN311(N) -------------------|S Q -|

|

TP\_REL <= FN311(N) - TP\_HYS\_OL ------|C

Where: BIAS = FN1355(N,MAP).

6-16

FUEL STRATEGY, CALCULATION OF LAMAVE - LHBH0

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CALCULATION OF LAMAVE

OVERVIEW

This module calculates the LAMBSE average to be used in Self Test to

determine if the adaptive tables have reached their clip.

The LAMBSE average, LAMAVE, is only calculated in Closed Loop. Also, it

requires at least two EGO switches after entering Closed Loop to calculate an

average.

DEFINITIONS

Registers:

- LAMBSE = Desired Air/Fuel ratio. LAMBSE(N) = New LAMBSE. LAMBSE(O) =

previously calculated LAMBSE.

- LAM\_OLD = Value of LAMBSE at previous EGO switch.

Bit Flags:

- OLFLG = Open Loop Fuel flag; 1 -> open loop, 0 -> closed loop possible.

OUTPUTS

Registers:

- LAMAVE = Average LAMBSE between EGO switches.

- LAM\_OLD = See above.

6-17

FUEL STRATEGY, CALCULATION OF LAMAVE - LHBH0

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PROCESS

STRATEGY MODULE: FUEL\_LAMAVE\_COM2

OLFLG = 1 -----------------------------| LAM\_OLD = 0

| LAMAVE = 1.0

|

| Exit FUEL\_LAMAVE\_COM1 module

EGO switch ----------------------|

|

OLFLG = 0 -----------------------|AND -| LAM\_OLD = LAMBSE

| | (not enough EGO switches

LAM\_OLD = 0 ---------------------| | since going Closed Loop

| to calculate LAMAVE)

|

| --- ELSE ---

|

EGO switch ----------------------| |

|AND -| LAMAVE = (LAM\_OLD + LAMBSE) / 2

OLFLG = 0 -----------------------| | LAM\_OLD = LAMBSE

| (update LAM\_OLD for next time)

NOTE: LAMAVE and LAM\_OLD are initialized to 1.0.

6-18

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - LHBH0

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OPEN LOOP LAMBSE CALCULATION

OVERVIEW

Due to the current design of the EGO sensor, Closed Loop operation about

stoichiometry only can be utilized. In the future, Universal EGOs will be

able to provide feedback at points either rich or lean of stoich. Closed

loop operation is also required for adaptive fuel to "learn" the

variabilities associated with production tolerances of airflow measuring and

fuel metering devices. Given, however, that closed loop fuel is not always

the appropriate mode of operation, the FUEL\_MODE logic performs two

functions:

- determine whether open loop fuel is appropriate, and

- schedule the optimum equivalence ratio (LAMBSE).

Optimum Air/Fuel (A/F) ratio at any given engine speed-load is that which

will develop the required torque with the lowest fuel consumption consistent

with smooth reliable operation. This optimum A/F ratio is not constant but

depends on many factors. The proper A/F ratio for each particular set of

operating conditions is most conveniently viewed under the two headings,

Stabilized and Cold Engine/Startup. Stabilized is taken to mean continuous

operation with normal engine temperatures. Cold engine/startup includes

starting and warming up or when the EGO sensor is not ready to switch.

COLD/START-UP OPEN LOOP FUEL

ENTRY CONDITIONS

- WRMEGO = 0, EGO sensor may not be ready to switch or,

- ECT < ECTSTABL, engine coolant temperature too cold and FLG\_OPEN\_LOOP =

1, standard open loop conditions met. (see Stabilized Open Loop entry

condition below.)

FUEL SCHEDULING

- Fuel may be scheduled as a function of load, temperature and time since

start.

6-19

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - LHBH0

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STABILIZED ENGINE OPEN LOOP FUEL

Mixture requirements for lowest fuel consumption can generally be adequately

described as a function of engine load.

Idle, extremely light loads or deceleration:

- No useful work is being done at idle other than driving accessory loads,

i.e. brake torque is zero. The lowest fuel consumption is that A/F

which provides steady, reliable cylinder firing. Extremely light loads

or decels at high RPMs may require A/F scheduling. This is because the

mass of residual gas tends to be constant, therefore, at closed

throttle/slight part throttle decels, the percentage of residual diluting

the fresh charge increases, hence the need to enrichen the incoming

charge.

- During Closed Throttle, High RPM Decels, the fuel can be completely

turned off to improve fuel economy and/or limit catalyst temperatures.

See Decel Fuel Shut-off logic in this chapter.

Medium loads, typical part throttle operation at road load:

- Best economy is around 18:1 A/F ratio, however, this may lead to

excessive highway NOx levels. Also, current catalyst technology makes

use of the closed loop fuel limit cycle to maximize conversion

efficiency. This, closed loop fuel operation is desirable from both an

adaptive fuel and catalyst efficiency standpoint. Provisions are in

place to schedule lean open loop operation during steady state cruise

modes (MPG mode).

Full load, typical W.O.T operation:

- A rich A/F ratio is required to maximize the torque output of the engine

during periods of high driver demand. Maximum torque output is about

13:1 A/F ratio (LBT). Best fuel economy is sacrificed in return for

higher torque output.

- Best economy at a given load is independent of RPM at least down to idle

type loads, under conditions at which fuel distribution is good.

Departures from best fuel economy may be required due to the following:

- Poor distribution (usually a function of TP and RPM).

- To reduce temperature of hot spots such as exhaust valves, spark plug

points or piston crowns - that is, to assist cooling.

6-20

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - LHBH0

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STABILIZED OPEN LOOP FUEL

ENTRY CONDITIONS

- WRMEGO = 1 - engine coolant hot and engine is stabilized, EGO sensor is

ready to switch.

- High Load enrichment required - scheduled as a function of speed/load.

An open loop delay time is provided to prevent unnecessary enrichment

during high load spikes such as during shifts. A second enrichment timer

provides the ability to schedule fuel as a function of time in the

enrichment mode to enhance durability in heavy truck applications.

- Decel loads - either enrichment or enleanment can be scheduled as a

function of speed/load.

- Extended idle - the ability to go open loop for idle stability is

provided as a function of time at idle.

- Lean cruise mode uses a unique speed/load table to schedule open loop

lambdas.

- W.O.T. mode - open loop is automatically scheduled as a function of wide

open throttle mode.

- CHKAIR = 0 - thermactor air control can put upstream air into the exhaust

manifold ahead of the EGO sensor causing the EGO to always read lean.

Open loop is therefore required.

- Lack of EGO switching requires the scheduling of open loop operation.

- Decel Fuel Shutoff is an open loop state.

FUEL SCHEDULING

- Fuel may be scheduled as a function of load, RPM, temperature and time at

high load.

SPECIAL EXIT CONDITIONS

- If MPG mode or Decel Fuel Shut-Off logic had previously dictated Open

Loop control, and that mode is no longer desired, special logic maintains

Open Loop control and decrements LAMBSE to 1.0 before allowing closed

loop control.

6-21

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - LHBH0

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DEFINITIONS

INPUTS

Registers:

- APT = At Part Throttle; -1 -> Closed throttle, 0 -> Part throttle, 1 ->

Wide Open throttle.

- APTMR = Timer to limit time in close loop fuel control when at Wide Open

Throttle.

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

- BIAS = A/F biasing term: FN1355(N,MAP). Units are LAMBDAS.

- ECT = Engine coolant temperature.

- EGOSSS = Number of EGO switches since start-up.

- EGOSW\_OL\_CTR = Number of EGO switches in closed loop; used to determine

when o.k. to return to open loop.

- LAMAVE = Average of last two LAMBSE values.

- LAMBSE = Desired ratiometric air/fuel ratio.

- LAMMUL = Fuel multiplier for Neutral-to-Drive transitions used to prevent

cold engine stalls following transmission engagement.

- MAPPA = MAP/BP, inches of Hg.

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

- N = Engine speed, rpm.

- PPCTR = PIP counter; updated at PIP rising edge before injector

pulsewidth is calculated and output.

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

- DNDSUP = Delayed Neutral/Drive flag; 0 -> neutral, 1 -> drive.

- CLFLG = Closed Loop Flag; 0 -> open loop, 1 -> closed loop.

- FLG\_ECTSTABLQ = ECT stabilized flag; 1 -> ECT stabilized, use FN1360.

- FLG\_NOT\_ADP = Adaptive enabled within an act and ect range.

- FLG\_OPEN\_LOOP = Open Loop Fuel flag; 1 -> Open Loop fuel, 0 -> Closed

Loop fuel may be permitted.

- ISCFLG = ISC mode flag; 1 -> RPM control mode.

- LESFLG = Lack of EGO switching flag; 0 -> EGO switching, 1 -> EGO did not

switch for LESTIM seconds.

6-22

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - LHBH0

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- MPGFLG = Flag that indicates whether in Fuel Economy mode; 1 -> In Fuel

Economy mode, 0 -> Not in Fuel Economy mode.

- MPGTFG = MPG transition mode flag; 1 -> MPG mode exit into Closed Loop

fuel.

- OLFLG = Open Loop fuel flag; 1 -> open loop fuel, 0 -> closed loop fuel.

- SWTFL = EGO switched flag.

- WOTTMR = Time of WOT.

- WRMEGO = Flag that is set equal to 1 if the EGO sensor is warm and reset

to zero if the sensor has cooled off.

6-23

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - LHBH0

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Calibration Constants:

- EGOCL1 = Number of EGO switches required to enter Closed Loop.

- DFSLAM = Relative LAMBSE value to exit decel fuel shut-off.

- EGO\_CNT\_OL = Number of EGO switches required in closed loop to return to

open loop control.

- FN301(N) = Multiplier for closed throttle as a function of engine speed

N.

- FN303(N) = Multiplier for WOT as a function of engine speed N.

- FN310(WOTTMR) = WOT fuel multiplier as a function of time in WOT mode.

WOTTMR is a count up/count down timer to prevent resets during normal

shifts. FN310 is used only within a WOTRPL and WOTRPH RPM range.

- FN325(ECT) = Multiplier as a function of ECT for FN1360.

- FN1325L = LTMTBL learning/use control table.

- FN1328 = MPG fuel table, lambdas. It is a 10 x 8 table of fuel economy

open loop lambda values as a function of N and MAPPA.

- FN1360 = Stabilized open loop fuel table, an 8 x 10 table of lambda

values as a function of engine speed N, and load, MAPPA. FN070B is the

normalizing function for N. FN072C is the normalizing function for

MAPPA.

- FN1361 = Start-up fuel table = an 8 x 10 table of lambda values as a

function of [FRCSFT \* ACT + (1 - FRCSFT) \* ECT] and MAPPA. FN022A is the

temperature normalizing function. FN018A is the time normalizing

function.

- FN1362 = Base fuel table = an 8 x 10 table of lambda values as a function

of [FRCBFT 8 ACT + (1 - FRCBFT) \* ECT] and MAPPA. FN022A is the

temperature normalizing function.

- FN1362 = Alternatice FN1362.

- LAMDLT\_OL = LAMAVE DELTA to allow return to open loop fuel control.

- LAMRICH = FN1360 Lambda value below which enrichment is requested.

- MPG\_CL\_SW = MPG mode closed loop switch; 1 -> operate in closed loop, 0

-> operate in open loop.

- MPGDEC = Lambse decrement when exiting MPG mode.

- OLIDRV = Drive Open Loop Idle Fuel Multiplier.

- OLINEUT = Neutral Open Loop Idle Fuel Multiplier.

- OLMCL = Open loop fuel multiplier for development only.

- PIPNUM = Number of PIPs for DFSO exit fuel ramp.

6-24

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - LHBH0

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- TRLOAD = Transmission load switch.

- WOTRPH = Maximum RPM to use FN310 for WOT enleanment.

- WOTRPL = Minimum RPM to use FN310 for WOT enleanment. Set to WOTRPL to

10,000 RPM to disable use of FN310.

- XAPT = Time elapse afterwhich you leave Closed Loop at Wide Open

Throttle, to return to Open Loop.

- XMAPPA = Calibratable MAPPA value above which APTMR is enabled.

OUTPUTS

Registers:

- APTMR = See above.

- EGOSW\_OL\_CTR = See above.

- LAMBSE = Desired air/fuel ratio.

- OPEN\_TMR = TIME IN OPEN LOOP, SECONDS.

Bit Flags:

- ACCUM = Accumulator for closed loop LAMBSE ramp increments. Used for

jumpback when TSLEGO <= transport lag.

- CLFLG = See above.

- OLFLG = See above.

- MPGTFG = MPG transition mode flag; 1 -> MPG mode exit into Closed Loop

fuel.

6-25

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_OL\_LAMBSE\_COM3

FINAL FUEL MODE DETERMINATION (OLFLG/CLFLG)

AND OPEN LOOP LAMBSE CALCULATION

ALT\_CAL\_FLG = 1 ---------------------| fn1362 = FN1362\_ALT(TEMP,MAPPA)

|

| --- ELSE ---

|

| fn1362 = FN1362(TEMP,MAPPA)

MPGFLG = 1 --------------------|

|AND -| LAMBSE = 1 + [FN1328(N,MAPPA) \*

MPG\_CL\_SW = 0 -----------------| | (MFAMUL)]

| OLFLG = 1

| CLFLG = 0

| ACCUM = 0

| (lean cruise mode)

|

| --- ELSE ---

MPGTFG = 1 --------------------| |

(exiting MPG mode) | |

|AND -| LAMBSE = LAMBSE - MPGDEC

MPG\_CL\_SW = 0 -----------------| | Do: MPGTFG RESET LOGIC

| OLFLG = 1

| CLFLG = 0

| ACCUM = 0

| (lean cruise mode exit into

| closed loop fuel (ramp fuel))

|

| --- ELSE ---

PPCTR < PIPNUM ----------------| |

(decel fuel shut-off) | |

|AND -| LAMBSE = 1 + DFSLAM -

FLG\_OPEN\_LOOP = 0 -------------| | [(PPCTR / PIPNUM)

(closed loop conditions met) | \* DFSLAM]

| OLFLG = 1

| CLFLG = 0

| ACCUM = 0

| (decel fuel shut-off exit into

| closed loop fuel (ramp fuel))

|

| --- ELSE ---

(continued on next page)

6-26

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

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

(cold EGO) | |

| |

FLG\_OPEN\_LOOP = 1 -| | |

(open loop req'd) | |OR --| Do: 'C' MULTIPLIER LOGIC

| | | LAMBSE = [fn1362(TEMP,MAPPA) -

EGOSSS < EGOCL1 ---|OR --| | | FN1361(TEMP,ATMR1)] \* C \*

(not enough EGO | | | | LAMMUL \* OLMCL

switches) | | | | OLFLG = 1

| |AND -| | CLFLG = 0

LESFLG = 1 --------| | | ACCUM = 0

(lack of EGO | | (cold engine/start-up fuel tables)

switching) | |

| |

FLG\_ECTSTABLO = 0 -------| |

(ECT cold) |

| --- ELSE ---

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

(warm EGO) | |

|AND -| Do: 'C' MULTIPLIER LOGIC

FLG\_OPEN\_LOOP = 1 -------| | | LAMBSE = FN1360(N,MAPPA) \*

(open Loop required) | | | FN325(ECT) \* C \*

| | | LAMMUL \* OLMCL

EGOSSS < EGOCL1 ---------|OR --| | OLFLG = 1

(not enough EGO | | CLFLG = 0

switches) | | ACCUM = 0

| | (stabilized engine fuel table)

LESFLG = 1 --------------| |

(lack of EGO switching) |

| --- ELSE ---

|

| Do: CLOSED LOOP LAMBSE CALCULATION

| OLFLG = 0

| CLFLG = 1

| (closed loop fuel)

6-27

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Compute OPEN\_TMR to determine if conditions exist to return to open loop:

FN1360 <= LAMRICH -------------------|

|

CLFLG = 1 ---------------------------|

|

EGOSW\_OL\_CTR >= EGO\_CNT\_OL ----------|AND -|

| |

|1.0 + BIAS - LAMAVE| <= LAMDLT\_OL --| |

|

FN1325L < 0 -------------------------------|

(not in an adaptable area; forced |OR --| OPEN\_TMR = 0

adaptive not required) | |

| |

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

(at idle; forced adaptive not required) | |

| |

APTMR >= XAPT -----------------------------| |

| |

FLG\_NOT\_ADP = 0 ---------------------------| |

| --- ELSE ---

|

CLFLG = 0 ---------------------------------------| Increment OPEN\_TMR.

|

| --- ELSE ---

|

| Freeze OPEN\_TMR.

ACT > AFACT1 ------------------------------|

|

ACT < AFACT2 ------------------------------|

|AND -| FLG\_NOT\_ADP = 1

ECT <= AFECT2 -----------------------------| |

| |

ECT >= AFECT1 -----------------------------| |

| --- ELSE ---

|

| FLG\_NOT\_ADP = 0

6-28

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Increment EGOSW\_OL\_CTR when EGO switches during closed loop:

CLFLG = 1 ---------------------------------|

|AND -| Increment EGOSW\_OL\_CTR.

SWTFL = 1 ---------------------------------| |

(EGO switched) |

| --- ELSE ---

|

CLFLG = 0 ---------------------------------------| EGOSW\_OL\_CTR = 0

Increment APTMR to limit time in close loop when at Wide Open Throttle.

MAPPA >= XMAPPA ---------------------------|

|AND -| increment APTMR

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

(closed loop) | --- ELSE ---

|

| APTMR = 0

GLOBAL LAMBSE CLIP

always ------------------------------------------| Clip LAMBSE to 1.999969 as

| a maximum and 0.0000305

| as a minimum

6-29

FUEL STRATEGY, OPEN LOOP LAMBSE CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

"C" MULTIPLIER LOGIC

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

(in drive) |

|OR --|

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

(manual trans) |

|

APT = -1 ----------------------|AND -| "C" = FN301(N)

| | (closed throttle decel/idle, FN1360

WRMEGO = 0 --------------| | | not available)

(cold EGO) | | |

|OR --| |

FLG\_ECTSTABLQ = 0 -------| |

(ECT cold) |

| --- ELSE ---

DNDSUP = 0 --------------------| |

(in neutral) | |

|AND -| "C" = OLINEUT

APT = -1 ----------------------| | (neutral idle)

(closed throttle) |

| --- ELSE ---

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

(in drive) | |

|AND -| "C" = OLIDRV

APT = -1 ----------------------| | (drive idle)

|

| --- ELSE ---

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

|AND -| "C" = FN303(N) \* FN310(WOTTMR)

WOTRPL <= N <= WOTRPH ---------| | (wide open throttle)

|

| --- ELSE ---

|

APT = 1 -----------------------------| "C" = FN303(N)

| (wide open throttle)

|

| --- ELSE ---

|

| "C" = 1

MPGTFG RESET LOGIC

MPGTFG = 1 --------------------|

|AND -| MPGTFG = 0

LAMBSE <= 1.0 -----------------| | (fuel ramp to stoic. is done)

6-30

FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - LHBH0

PED-PTE, FomoCo, PROPRIETARY & CONFIDENTIAL

CLOSED LOOP LAMBSE CALCULATION

(Background software module CLFUEL, called from FUEL\_MODE)

OVERVIEW

The goals of the closed loop strategy are:

- add the capability of introducing A/F ratio biasing,

- maximize the feedback limit cycle frequency for all bias values, and

- maintain a simple calibration procedure to describe the closed loop limit

cycle.

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.

When an EGO switch occurs, an instantaneous change (or "jumpback") is made in

the A/F ratio back towards stoichiometry. The jump is made relative to the

A/F ratio (LAMBSE) 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 on the next page.

6-31

FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - LHBH0

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LIMIT CYCLE DESCRIPTION

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

| \*\* \*\* |

| \* \* \* \* |

| \* \* \* \* |

| \* \* \* \* |

| \* \* \* \* |

FN1354(N,MAP) \* \* RF \* \* (RF\*T) OR (ACCUM)

(PTPAMP) \* \* \* \* |

- - - | - | - - - \* - - - \* - - - - - \* - - - \* | - - - - - - mean A/F

| BIAS \* \* \* \* |

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

| | | \* \* \* \* |

| | | \* \* \* \* |

| | | \* \* RS \* \* (RS\*T) OR (ACCUM)

| | | \* \* \* \* |

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

|<TSLEGO->|<-TSLEGO>|

\*\*\*\*\* 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.

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

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

\*\*\*\*\* WARNING \*\*\*\*\*

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

It is imperative that an accurate value for the system transport delay 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 \*\*\*\*\*

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

6-32

FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - LHBH0

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Prior to calculating a new Closed Loop LAMBSE value, LAMBSE may be clipped to

1.0 maximum and/or multiplied by JMPMUL under the conditions listed below.

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

follows:

- when entering or exiting the filtered idle air mass region (FAM),

- when changing load states within the filtered idle air mass region (FAM),

and

- 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

driveability concerns.

CALIBRATION PHILOSOPHY

Although appearing somewhat complicated, this closed loop algorithm has been

designed to be easy to use.

There are 3 tables which must be calibrated. They are:

1) limit cycle peak to peak amplitude; FN1354(N,MAP); a typical value is

0.034 lambdas (0.034 \* 14.64 = 0.49776 A/F ratio) = PTPAMP

2) fuel system transport delay; FN1343(N,MAP); typical values have been 5 -

10 engine revolutions, but note earlier WARNING.

3) BIAS; FN1355(N,MAP) for closed throttle mode:

a) a positive bias value is lean; a negative bias value is rich

b) any calculated absolute value of BIAS/PTPAMP exceeding .2 is clipped

to .2. This is done to avoid extremely long limit cycle periods.

6-33

FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - LHBH0

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DEFINITIONS

INPUTS

Registers:

- ACCUM = Accumulator for closed loop LAMBSE ramp increments. Used for

jumpback when TSLEGO <= transport lag.

- APT = Throttle mode flag; -1 -> Closed throttle, 0 -> Part throttle, 1 ->

Wide-Open throttle.

- BIAS = A/F biasing term: FN1355(N,MAP). Units are lambdas.

- ISFLAG = Indication of engine load state at idle (See IDLE SPEED CONTROL

Chapter); 0 -> Drive, 1 -> Drive and A/C clutch engaged, 2 -> Neutral, 3

-> Neutral and A/C clutch engaged.

- ISLAST = Register which tracks the state of engine load from the previous

background pass. Used in determining when it is necessary to increment

the filtered air mass (FAM) and clip the C/L idle speed integrator to a

minimum value.

- JUMP = Amount of jumpback after an EGO switch, either ACCUM or based on

table FN1343.

- LAMBSE = Desired Air/Fuel ratio. LAMBSE(N) = New LAMBSE. LAMBSE(O) =

previously calculated LAMBSE.

- PTPAMP = Limit cycle peak to peak amplitude.

- R = Ramp rate; can be set to either RF or RS.

- RF = Fast ramp rate used on the side of stoichiometry that bias is

desired: RF = FN1354(N,MAP) \* FN372(|BIAS/PTPAMP|) \* N/FN1343(N,MAP).

Units are lambdas/second.

- RS = Slow ramp rate used on the side of stoichiometry that bias is not

desired: RS = FN1354(N,MAP) \* (0.01660 - FN372(|BIAS/PTPAMP|)) \*

N/FN1343(N,MAP). Units are lambdas/second.

- TDSEC = 60 \* FN1343/N (temporary register).

- TSLAMU = Time since the last LAMBSE update (1 background loop).

- TSLEGO = Time since last EGO switch occurred, seconds.

Bit Flags:

- JMPFLG = LAMBSE reset flag.

- OLFLG = Open Loop fuel flag; 1 -> Open Loop fuel, 0 -> Closed Loop fuel.

- REFFLG = Indication of Idle Air Flow; 1 -> Idle Air Flow.

6-34

FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - LHBH0

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Calibration Constants:

- FN025 = MAP normalizing function for Bias, Peak-to-Peak and Transport

Delay Tables. Input = MAP, Output = Table Entry Point.

- FN372(|BIAS/PTPAMP|) = Ramp rate multiplier (not a calibration item) -

provides correct multiplier to produce desired waveform; function of

|BIAS/PTPAMP|. Units are minutes/sec.

- FN1343(N,MAP) = 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 = FN025

normalized manifold absolute pressure, MAP; output = transport delay,

REVS.

- FN1354(N,MAP) = Closed loop Peak-to-Peak amplitude: units are lambdas.

X-input = FN039 normalized engine speed, RPM; Y-input = FN025 normalized

manifold absolute pressure, MAP; output = Peak-to-Peak amplitude, PTPAMP.

- FN1355(N,MAP) = Amount of BIAS from stoichiometry: X-input = FN039

normalized engine speed, RPM; Y-input = FN025 normalized manifold

absolute pressure, MAP; output = BIAS from stoichiometry.

- JMPMUL = FAM exit LAMBSE reset multipler.

- LAMMAX = Maximum closed loop LAMBSE clip.

- LAMMIN = Minimum closed loop LAMBSE clip.

OUTPUTS

Registers:

- ACCUM = See above.

- BIAS = See above.

- JUMP = See above.

- LAMBSE = See above.

- R = See above.

- TDSEC = See above.

- TSLEGO = See above.

Bit Flags:

- JMPFLG = See above.

- V\_LAMJMP = Flag when 1 indcates base strategy caused a LAMBSE jump since

last EGO switch.

6-35

FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - LHBH0

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PROCESS

STRATEGY MODULE: FUEL\_CL\_LAMBSE\_COM3

LAMBSE RESET - LOAD STATE CHANGE

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

(closed throttle) |

|

ISFLAG <> ISLAST ------------------|AND -| Clip LAMBSE to 1.0 as a

(load state change) | | maximum

| | TSLEGO = 0

LAMBSE > 1.0 ----------------------| | ACCUM = 0

| V\_LAMJMP = 1

OPEN LOOP/CLOSED LOOP LAMBSE RESET

Previous OLFLG = 1 ----------------|

(last pass was open loop) |

|

Current OLFLG = 0 -----------------|AND -| Clip LAMBSE to 1.0 as a

(current pass is closed loop) | | maximum

| | TSLEGO = 0

LAMBSE > 1.0 ----------------------| | ACCUM = 0

| V\_LAMJMP = 1

FAM ENTRY/EXIT LAMBSE RESET

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

|

JMPFLG = 0 ------------------------|AND -| JMPFLG = 1

| | Clip LAMBSE to 1.0 as a

LAMBSE > 1.0 ----------------------| | maximum

| TSLEGO = 0

| ACCUM = 0

| (entering idle region)

| V\_LAMJMP = 1

|

| --- ELSE ---

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

|AND -| JMPFLG = 1

JMPFLG = 0 ------------------------| |

| --- ELSE ---

REFFLG = 0 ------------------------| |

|AND -| JMPFLG = 0

JMPFLG = 1 ------------------------| | LAMBSE = LAMBSE \* JMPMUL

| (exiting idle region)

| V\_LAMJMP = 1

|

| --- ELSE ---

|

| No change

6-36

FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - LHBH0

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CALCULATE PTPAMP, RF AND RS

always ------------------------------| PTPAMP = FN1354(N,MAP)

| RF = PTPAMP \* FN372(|BIAS/PTPAMP|) \*

| N / FN1343(N,MAP)

| RS = PTPAMP \* (0.01660 -

| FN372(|BIAS/PTPAMP|)) \*

| N / FN1343(N,MAP)

RAMP RATE CALCULATIONS BASED ON BIAS AND EGO STATE

BIAS = 0 ----------------------|

(no bias) |AND -| LAMBSE(N) = LAMBSE(O) -

| | RF \* TSLAMU

EGO IS LEAN -------------------| | ACCUM = ACCUM + RF \* TSLAMU

| (ramp in rich direction)

|

| --- ELSE ---

BIAS = 0 ----------------------| |

(no bias) |AND -| LAMBSE(N) = LAMBSE(O) +

| | RF \* TSLAMU

EGO IS RICH -------------------| | ACCUM = ACCUM + RF \* TSLAMU

| (ramp in lean direction)

|

| --- ELSE ---

BIAS > 0 ----------------------| |

(lean bias) |AND -| LAMBSE(N) = LAMBSE(O) -

| | RS \* TSLAMU

EGO IS LEAN -------------------| | ACCUM = ACCUM + RS \* TSLAMU

| (ramp in rich direction)

|

| --- ELSE ---

BIAS > 0 ----------------------| |

(lean bias) |AND -| LAMBSE(N) = LAMBSE(O) +

| | RF \* TSLAMU

EGO IS RICH -------------------| | ACCUM = ACCUM + RF \* TSLAMU

| (ramp in lean direction)

|

| --- ELSE ---

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

(rich bias) |AND -| LAMBSE(N) = LAMBSE(O) -

| | RF \* TSLAMU

EGO IS LEAN -------------------| | ACCUM = ACCUM + RF \* TSLAMU

| (ramp in rich direction)

|

| --- ELSE ---

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

(rich bias) |AND -| LAMBSE(N) = LAMBSE(O) +

| | RS \* TSLAMU

EGO IS RICH -------------------| | ACCUM = ACCUM + RS \* TSLAMU

| (ramp in lean direction)

NOTE: TSLAMU is time since the last LAMBSE update (1 background loop).

6-37

FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - LHBH0

PED-PTE, FomoCo, PROPRIETARY & CONFIDENTIAL

JUMPBACK CALCULATIONS BASED ON BIAS AND EGO STATE

BIAS = 0 ------------------------|

(no bias) |AND -| LAMBSE(N) = LAMBSE(O) + JUMP

| | R = RF

EGO SWITCHED FROM LEAN TO RICH --| | ACCUM = 0

| (jumpback in lean direction)

| TSLEGO = 0

|

| --- ELSE ---

BIAS = 0 ------------------------| |

(no bias) |AND -| LAMBSE(N) = LAMBSE(O) - JUMP

| | R = RF

EGO SWITCHED FROM RICH TO LEAN --| | ACCUM = 0

| (jumpback in rich direction)

| TSLEGO = 0

|

| --- ELSE ---

BIAS > 0 ------------------------| |

(lean bias) |AND -| LAMBSE(N) = LAMBSE(O) + JUMP

| | R = RS

EGO SWITCHED FROM LEAN TO RICH --| | ACCUM = 0

| (jumpback in lean direction)

| TSLEGO = 0

|

| --- ELSE ---

BIAS > 0 ------------------------| |

(lean bias) |AND -| LAMBSE(N) = LAMBSE(O) - JUMP

| | R = RF

EGO SWITCHED FROM RICH TO LEAN --| | ACCUM = 0

| (jumpback in rich direction)

| TSLEGO = 0

|

| --- ELSE ---

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

(rich bias) |AND -| LAMBSE(N) = LAMBSE(O) + JUMP

| | R = RF

EGO SWITCHED FROM LEAN TO RICH --| | ACCUM = 0

| (jumpback in lean direction)

| TSLEGO = 0

|

| --- ELSE ---

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

(rich bias) |AND -| LAMBSE(N) = LAMBSE(O) - JUMP

| | R = RS

EGO SWITCHED FROM RICH TO LEAN --| | ACCUM = 0

| (jumpback in rich direction)

| TSLEGO = 0

TSLEGO <= TDSEC -----------------------| JUMP = ACCUM

(time since last EGO <= |

transport lag) | --- ELSE ---

|

| JUMP = R \* TDSEC

6-38

FUEL STRATEGY, CLOSED LOOP LAMBSE CALCULATION - LHBH0

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

|AND -| Clip LAMBSE to 1.0 as a maximum

ISFLAG <> ISLAST ----------------| |

| --- ELSE ---

|

| Clip LAMBSE to LAMMAX as a maximum

always --------------------------------| Clip LAMBSE to LAMMIN as a

| minimum

6-39

FUEL STRATEGY, DAC REGISTER CALCULATION - LHBH0

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DAC REGISTER CALCULATION

(software module DACEQN, called from FUEL\_MODE)

OVERVIEW

A special register, DSLMBS, has been added to assist in calibration

development by increasing the resolution of LAMBSE for display purposes.

DSLMBS is updated every time LAMBSE is updated, both Open & Closed Loop.

DEFINITIONS

INPUTS

Registers:

- LAMBSE = Desired ratiometric air/fuel ratio.

OUTPUTS

Registers:

- DSLMBS = Special display version of LAMBSE.

PROCESS

STRATEGY MODULE: FUEL\_DAC\_REG\_COM2

The value of DSLMBS is calculated as shown:

DSLMBS = LAMBSE - 1.0

Because DSLMBS is a signed word quantity, a value of zero will be output as 5

volts.

6-40

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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ADAPTIVE FUEL LOGIC

(Background software module ADAPT)

OVERVIEW

Fuel injected systems may exhibit vehicle to vehicle steady state A/F ratio

errors due to normal variability in fuel system components.

The adaptive fuel strategy attacks this problem by memorizing the

characteristics of the individual fuel system being used. This memorized

information is used to predict what the system will do based on past

experience.

The ability to predict fuel system behavior improves both open loop and

closed loop fuel control. As an example, the memorized information can be

used on cold starts to achieve better open loop fuel control before the 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.

6-41

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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ADAPTIVE FUEL TABLE

The adaptive fuel table, LTMTBL, is a 2-dimensional array of learned fuel

system corrections. Ideally, if LAMBSE = 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 10 (rows) x 10 (columns) plus 6 special idle adaptive

cells, for a total of 106 cells.

The total learned fuel system correction is called KAMREF where KAMREF = 0.5

+ LTMTBLrc.

During adaptive learning, only the LTMTBL cells are modified. Therefore, the

range of the KAMREF multiplier is (0.5 + 0.0) to (0.5 + 1.0) or 0.5 to 1.5.

The range of the LTMTBL cells can be further restricted by use of the

calibration parameter clips, MINADP and MAXADP.

The precise location where KAMREF is used is shown in the FUELPW equation.

If KAM fails the KAM validation test (described later), all LTMTBL cells are

initialized to 0.5 or 80 (HEX) resulting in a value of KAMREF = 0.5 + 0.5 =

1.0.

When allowed, updates to LTMTBL 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 FN1325L description. Note that idle cells do

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

LTMTBL and FN1325L share the same normalizing functions. FN031 is the MAPOPE

normalizing function. FN070L is the engine speed N normalizing function.

The adaptive fuel table, LTMTBL, is shown on the next page.

6-42

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

PED-PTE, FomoCo, PROPRIETARY & CONFIDENTIAL

ADAPTIVE FUEL TABLE (LTMTBL)

LTMTBLrc CELLS

special idle

adaptive cells -----> |100 101 102 103 104 105

|

9 |90 91 92 93 94 95 96 97 98 99

|

8 |80 81 82 83 84 85 86 87 88 89

|

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

|

FN031 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 |

(MAPOPE) 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

FN070L NORMALIZED

ENGINE SPEED

(N)

6-43

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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FN1325L DESCRIPTION

FN1325L is an 11 (row) x 10 (column) table containing 1 cell corresponding to

each cell in the adaptive fuel table LTMTBL. (The 11th row is used to

reference the idle cells and is not accessible from FN031 which only goes

from 0 to 9)

The normalizing functions for FN1325L and LTMTBL are shared. FN031 is the

MAPOPE normalizing function. FN070L is the engine speed N normalizing

function.

FN1325L is designed to do the following:

- Identify LTMTBL cells where learning is allowed to occur.

- Learning is allowed in any LTMTBLrc cell whose corresponding

FN1325Lrc cell contains a value >= 0. Negative FN1325L cell values

disallow learning in the corresponding LTMTBL cell.

- 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 FN1325L cell.

The negative number serves as an offset to LTMTB00. If 1 of the 4

cells used by the 4 point linear interpolation LTMTBL 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 LTMTBL cell located at the intersection of row 4 and column 2.

In the extreme, if -42 was entered into every cell of FN1325Lrc

except for the cell corresponding to LTMTB42, learning would be

allowed only in cell LTMTB42 and the learned correction in LTMTB42

would be applied to all speed-load points (every cell referenced by

the 4 point linear interpolation routine during the LTMTBL table

lookup would point to cell LTMTB42). This calibration for FN1325L is

shown on the next page.

- Specify the values of LOPCT1 and LOPCT2 required to update an individual

LTMTBL cell.

- This is done by entering a value into FN1325L that is >= 0. The

value entered represents 1/2 the required update value. A value of

20 entered would require LOPCT1 and/or LOPCT2 to be greater than 40

for an update to occur.

6-44

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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LTMTBL LEARNING/USE CONTROL TABLE (FN1325L)

FN1325L CELLS

special idle

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

|

9 |-42 -42 -42 -42 -42 -42 -42 -42 -42 -42

|

8 |-42 -42 -42 -42 -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

|

FN031 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 |

(MAPOPE) 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

FN070L NORMALIZED

ENGINE SPEED

(N)

6-45

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

PED-PTE, FomoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- ACT = Air Charge Temperature, deg F.

- ADPTMR = Adaptive Learning Enable Timer (see TIMER section).

- AEFUEL = Acceleration enrichment fuel flow, lb/hr.

- BIAS = A/F biasing term: FN1355(N,MAP). Units are lambdas.

- CHKSUM = KAM word containing the sum of the LTMTBL contents.

- ECT = Engine Coolant Temperature.

- EFTR = EQUIL fuel transfer rate BIN 16 LBM/SEC.

- EGOCNT = Number of EGO switches required before allowing updates to the

Adaptive Fuel cell.

- FUELPW = Fuel Pulsewidth.

- KWUCTR = KAM Warm Up counter. Stores number of warm ups in KAM. Reset

to zero if KAM is corrupted (battery disconnect, etc.).

- LAMBSE = Desired air/fuel ratio.

- LAMWIN = LAMBSE window outside which adaptive is enabled.

- LSTROW = Last pass normalized row.

- LTMTBL = Adaptive Fuel Table.

- MAPOPE = MAP/ABS exhaust pressure.

- N = Engine speed RPM.

- PTPAMP = Limit cycle peak\_to\_peak amplitude

- PURGDC = Canister Purge Duty Cycle.

- RANNUM = Random numbers used to statistically distribute the corrections

to the Adaptive Fuel Table among four adjacent cells.

- TCSTRT = ECT at start-up.

- UPRATE = KAM update rate.

6-46

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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Bit Flags:

- AFMFLG = ACT Failure flag set to 1 if the ACT fails range check.

- CFMFLG = ECT Failure flag set to 1 if the ECT fails range check.

- DFSFLG = Indicates decel fuel shut off.

- DISABLE\_ADAPT = Adaptive fuel disable flag; 1 -> disable adaptive fuel.

- HCAMFG = Flag indicating the completion of Hi-Cam; 0 -> no desired engine

speed adder exists, 1 -> an rpm adder above base idle is present. Flag

is used in the ISC adaptive update routine to disable updates when HCAMFG

= 1.

- ISCFLG = ISC MODE Flag; 1 -> rpm control mode.

- ISFLAG = Indication of engine load state at Idle (See ISC Chapter).

- LIMIT\_PURGE = Flag which indicates Purge Duty Cycle is being limited due

to LAMBSE being clipped; 1 -> limited Purge.

- MFMFLG = MAP Failure flag set to 1 if MAP sensor fails.

- REFFLG = Indication of Idle Air Flow; 1 -> Idle Air Flow.

- SWTFL = EGO switch flag; 0 -> no EGO switch, 1 -> EGO switch this

background loop.

- TFMFLG = TP Failure flag set to 1 if TP sensor fails range check.

- WARM\_UP = Engine Warm-up flag; 1 -> engine warmed-up.

Calibration Constants:

- ADAPTM = Adaptive learning enable time delay (seconds).

- ADEFTR = Transient fuel threshold to update adaptive fuel.

- ADEGCT = Number of EGO switches required to permit Adaptive Learning

within the cell boundaries.

- AELIM = Maximum acceleration enrichment fuel flow to allow adaptive

learning, lb/hr.

- AFACT1 = Minimum ACT to Update Adaptive Fuel Table, deg F.

- AFACT2 = Maximum ACT to Update Adaptive Fuel Table, deg F.

- AMPMUL = Multiplier to determine LAMWIN from PTPAMP.

- DELAMB = Deadband (around LAMBSE = 1.0) within which loop counter values

are not altered.

- 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.

6-47

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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- DELROW = Same function as DELCOL but for normalized load MAPOPE.

- 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.

- FN031 = MAPOPE normalizing function used with both FN1325L and LTMTBL.

- FN025 = MAP normalizing function for Bias, Peak-to-Peak and Transport

Delay Tables. Input = MAP, Output = Table Entry Point.

- FN039 = Engine Speed (N) normalizing function for FN1355.

- FN070L = Normalizing function for N, used with FN1325L as well as LTMTBL.

- FN1325Lrc = LTMTBL learning/use control table.

- FN1355 (N,MAP) = Amount of BIAS from stoichiometry, units are lambdas.

X-input = FN039 (Normalized engine speed, rpm). Y-input = FN025

(Normalized Manifold Absolute pressure, Inches Hg), Output = BIAS from

stoichiometry, lambdas.

- HCAMSW = Calibration switch which allows 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, FN826, and BZZRPM.

- KWUCNT = Maximum number of warm-up cycles to use fast adaptive EGO count.

Should be set to approximately 3 to 5 warm-ups.

- MAXADP = Maximum adaptive correction.

- MINADP = Minimum adaptive correction.

- MINPW = Minimum pulsewidth clip value.

- RANMUL = Multiplier for random number generation.

- VECT3 = Minimum coolant temperature, engine on.

- VECT5 = Starting coolant temperature for warm-up counter.

OUTPUTS

Registers:

- COLTBU = Column address of Adaptive cell to be updated, integer = FN070L

+ 0.5 + upper byte of RANNUM (where the upper byte of RANNUM is a random

number ranging from -0.5 to 0.496).

6-48

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

PED-PTE, FomoCo, PROPRIETARY & CONFIDENTIAL

- EGOCNT = See above.

- FUELPW = See above.

- KWUCTR = See above.

- LAMWIN = See above.

- LOPCT1 = See above.

- LOPCT2 = See above.

NOTE: A background loop occurs when the computer reaches the same point

in the program after executing all other necessary instructions.

- LSTCOL = Last pass normalized column.

- LSTROW = See above.

- LTMTBL = Adaptive Fuel Table.

- RANNUM = See above.

- ROWTBU = Row address of adaptive cell to be updated, integer = FN031 +

0.5 + lower byte of RANNUM (where the lower byte of RANNUM is a random

number ranging from -0.5 to 0.496).

- UPRATE = See above.

Bit Flags:

- DISABLE\_ADAPT = Adaptive fuel disable flag; 1 -> disable adaptive fuel.

- WARM\_UP = Engine Warm-up flag; 1 -> engine warmed-up.

6-49

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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PROCESS

STRATEGY MODULE: FUEL\_ADAPT\_COM4

Calculate the random number to be used this background pass:

always ------------------------------------| RANNUM = RANNUM \* RANMUL +

| RANMUL/4

| rancol = rannum\_hi

| = the high byte of the

| low word of RANNUM

| ranrow = rannum\_lo

| = the low byte of the low

| word of RANNUM

| RANNUM = the low word of RANNUM

| (save for next pass)

Calculate the cell to be updated this background pass:

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

|

ISCFLG = 1 --------------------------|AND -| kamcol = ISFLAG

| | COLTBU = ISFLAG

HCAMFG = 0 --------------------| | | kamrow = 10

|OR --| | ROWTBU = 10

HCAMSW = 0 --------------------| | (special idle cells)

|

| --- ELSE ---

|

| kamcol = FN070L(N)

| COLTBU = kamcol + 0.5 + rancol

| kamrow = FN031(MAPOPE)

| ROWTBU = kamrow + 0.5 + ranrow

Calculate the DISABLE\_ADAPT value:

DFSFLG = 1 --------------------------------| DISABLE\_ADAPT = 1

|

| --- ELSE ---

|

FUELPW < MINPW ----------------------------| DISABLE\_ADAPT = 1

| FUELPW = MINPW

|

| --- ELSE ---

|

| DISABLE\_ADAPT = 0

Calculate EGO switch logic:

SWTFL = 1 ---------------------------------| Increment EGOCNT

(EGO switch)

6-50

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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Determine if adaptive is enabled/disabled of if adaptive area has changed:

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

|

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

|

TFMFLG = 1 --------------------------|

|

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

|

ACT <= AFACT1 -----------------------|

|

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

|OR --| LOPCT1 = 0

DISABLE\_ADAPT = 1 -------------------| | LOPCT2 = 0

| | EGOCNT = 0

OPEN LOOP FUEL CONTROL --------------| | LSTCOL = kamcol

| | LSTROW = kamrow

ADPTMR < ADAPTM ---------------------| |

| | Do: NEW\_UPRATE\_CALC

|kamrow - LSTROW| > DELROW ----------| |

| | Exit FUEL\_ADAPT\_COM4

|kamcol - LSTCOL| > DELCOL ----------| |

| |

AEFUEL > AELIM ----------------------| |

| |

|EFTR| >= ADEFTR --------------------| |

| |

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

|AND -| |

ISCFLG <> 1 -------------------| |

| --- ELSE ---

|

| Continue with FUEL\_ADAPT\_COM4

6-51

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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Calculate the LAMBSE window, LAMWIN:

always ------------------------------------| LAMWIN = DELAMB + (PTPAMP \*

| AMPMUL)

Calculate the EGO based learning rate:

(This logic gives the system the capability to learn faster during 'green

engine conditions').

WARM\_UP = 0 -------------------------|

|

TCSTRT < VECT5 ----------------------|

|AND -| WARM\_UP = 1

ECT > VECT3 -------------------------| | KWUCTR = KWUCTR + 1

| | Clip KWUCTR to 255

RUN mode ----------------------------|

KWUCTR < KWUCNT ---------------------------| egolearn\_rat = FAEGCT

(first few warm-up cycles) | (use fast learning rate)

|

| --- ELSE ---

|

KWUCTR >= KWUCNT --------------------------| egolearn\_rat = ADEGCT

| (use normal learning rate)

Calculate loop counters:

(LOPCT1 and LOPCT2)

EGO IS RICH -------------------------|

|

LAMBSE >= (1 + BIAS + LAMWIN) -------|

|AND -| Increment LOPCT1 (max 255)

EGOCNT >= egolearn\_rat --------------| |

| |

LIMIT\_PURGE = 0 ---------------| | |

|OR --| |

PURGDC = 0 --------------------| |

| --- ELSE ---

EGO IS LEAN -------------------------| |

| |

LAMBSE <= (1 + BIAS - LAMWIN) -------|AND -| Increment LOPCT2 (max 255)

| |

EGOCNT >= egolearn\_rat --------------| |

| --- ELSE ---

|

| No change to LOPCT1 or LOPCT2

6-52

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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Determine if adaptive cells should be incremented/decremented:

LTMTBL cells are updated when the following conditions are satisfied:

Note that r = ROWTBU and c = COLTBU in the following charts.

FN1325Lrc >= 0 ---------------------|

|

LOPCT1 > 2 \* UPRATE ----------------|AND -| LTMTBLrc = LTMBLrc - 0.0039

| | Decrement CHKSUM

LTMTBLrc > MINADP ------------------| | LOPCT1 = 0

| EGOCNT = 0

|

| --- ELSE ---

|

LOPCT1 > 2 \* UPRATE ----------------------| LOPCT1 = 0

| EGOCNT = 0

|

| --- ELSE ---

LOPCT2 > 2 \* UPRATE ----------------| |

| |

LTMTBLrc < MAXADP ------------------|AND -| LTMTBLrc = LTMTBLrc + 0.0039

| | Increment CHKSUM

FN1325Lrc >= 0 ---------------------| | LOPCT2 = 0

| EGOCNT = 0

|

| --- ELSE ---

|

LOPCT2 > 2 \* UPRATE ----------------------| LOPCT2 = 0

| EGOCNT = 0

6-53

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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BEGIN: NEW\_UPRATE\_CALC

This algorithm calculates the average loop counter value to be used during

the adaptive algorithm. The standard four point interpolation routine is

used. If, however, one or more of the cells in the four points is a

reference cell, then the average of the values in the positive cells is used

in place of the negative values.

If the system is in the special idle cells, the UPRATE value is equal to the

value in FN1325L specified by kamcol.

Note: kamrow\_max = maximum number of table rows (excluding the Special Idle

Cells row).

kamrow\_spec = row number for the Special Idle Adaptive Cells.

kamcol\_max = maximum number of table columns.

kamrow = kamrow\_spec ------------| Read the value in FN1325L specified

| by kamcol.

| Load this value in UPRATE.

|

| Exit the subroutine NEW\_UPRATE\_CALC

|

| --- ELSE ---

|

| Continue with subroutine NEW\_UPRATE\_CALC

Separate kamcol and kamrow into an integer and remainder.

always --------------------------| kamcol\_rem = kamcol - int(kamcol)

| kamcol = int(kamcol)

| kamrow\_rem = kamrow - int(kamrow)

| kamrow = int(kamrow)

Check for row and column boundary conditions:

kamcol < kamcol\_max -------| | adapt1\_uprat = FN1325L(kamcol,kamrow)

|AND -| adapt2\_uprat = FN1325L(kamcol + 1,kamrow)

kamrow < kamrow\_max -------| | adapt3\_uprat = FN1325L(kamcol,kamrow + 1)

| adapt4\_uprat =

| FN1325L(kamcol + 1,kamrow + 1)

|

| --- ELSE ---

kamcol = kamcol\_max -------| |

|AND -| adapt1\_uprat = FN1325L(kamcol,kamrow)

kamrow = kamrow\_max -------| | adapt2\_uprat = adapt1\_uprat

| adapt3\_uprat = adapt1\_uprat

| adapt4\_uprat = adapt1\_uprat

| (use FN1325L 4 times so not to wrap

| around table or use special idle cells)

|

| --- ELSE ---

(continued on next page)

6-54

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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(continued from previous page)

|

kamcol = kamcol\_max -------------| adapt1\_uprat = FN1325L(kamcol,kamrow)

| adapt2\_uprat = adapt1\_uprat

| adapt3\_uprat = FN1325L(kamcol,kamrow + 1)

| adapt4\_uprat = adapt3\_uprat

| (use kamcol\_max values twice so not to

| wrap around table)

|

| --- ELSE ---

|

kamrow = kamrow\_max -------------| adapt1\_uprat = FN1325L(kamcol,kamrow)

| adapt2\_uprat = FN1325L(kamcol + 1,kamrow)

| adapt3\_uprat = adapt1\_uprat

| adapt4\_uprat = adapt2\_uprat

| (use kamrow\_max values twice so not to

| wrap around table or use special

| idle cells)

always --------------------------| uprat\_cnt = 0

Check for reference cells:

adapt1\_uprat >= 0 ---------------| uprat\_cnt = uprat\_cnt + 1

| adapt1\_uprat\_ref = 0

|

| --- ELSE ---

|

| adapt1\_uprat = 0

| adapt1\_uprat\_ref = 1

adapt2\_uprat >= 0 ---------------| uprat\_cnt = uprat\_cnt + 1

| adapt1\_uprat\_ref = 0

|

| --- ELSE ---

|

| adapt2\_uprat = 0

| adapt2\_uprat\_ref = 1

adapt3\_uprat >= 0 ---------------| uprat\_cnt = uprat\_cnt + 1

| adapt3\_uprat\_ref = 0

|

| --- ELSE ---

|

| adapt3\_uprat = 0

| adapt3\_uprat\_ref = 1

6-55

FUEL STRATEGY, ADAPTIVE FUEL LOGIC - LHBH0

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adapt4\_uprat >= 0 ---------------| uprat\_cnt = uprat\_cnt + 1

| adapt4\_uprat\_ref = 0

|

| --- ELSE ---

|

| adapt4\_uprat = 0

| adapt4\_uprat\_ref = 1

If all cells are referenced cells, set UPRATE to a maximum value. Else,

find UPRATE average.

uprat\_cnt = 0 -------------------| UPRATE = 127 (maximum value)

|

| --- ELSE ---

|

| uprat\_avg = (adapt1\_uprat +

| adapt2\_uprat + adapt3\_uprat +

| adapt4\_uprat) / uprat\_cnt

|

| Truncate UPRATE to an integer

adapt1\_uprat\_ref = 1 ------------| adapt1\_uprat = uprate\_avg

adapt2\_uprat\_ref = 1 ------------| adapt2\_uprat = uprate\_avg

adapt3\_uprat\_ref = 1 ------------| adapt3\_uprat = uprate\_avg

adapt4\_uprat\_ref = 1 ------------| adapt4\_uprat = uprate\_avg

always --------------------------| Make kamcol and kamrow real numbers

| kamcol = kamcol + kamcol\_rem

| kamrow = kamrow + kamrow\_rem

|

| Do four point interpolation using

| kamrow and kamcol, and the four

| adaptn\_uprat values calculated

| above. Store this value in UPRATE.

END: NEW\_UPRATE\_CALC

6-56

FUEL STRATEGY, KAM ADAPTIVE FUEL LOGIC - LHBH0

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KAM ADAPTIVE FUEL LOGIC

(Background software module KAMREF, called from BG\_FUELPW)

OVERVIEW

The adaptive fuel table stored in KAM is used as a reference for both open

and closed loop fuel control. The use of KAMREF is shown in the pulsewidth

equation section of this chapter.

NOTE: The following Adaptive Fuel Logic is not executed during ENGINE

RUNNING Self Test MODE.

DEFINITIONS

INPUTS

Registers:

- ISFLAG = Indication of engine load state at idle (See IDLE SPEED CONTROL

Chapter); 0 -> Drive, 1 -> Drive and A/C clutch engaged, 2 -> Neutral, 3

-> Neutral and A/C clutch engaged.

- LTMTBL = Adaptive fuel table.

Bit Flags:

- CRKFLG = Flag indicating engine mode; 1 -> Cranking, 0 -> Run or

Underspeed mode.

- HCAMFG = Flag indicating the completion of Hi-Cam; 0 -> no desired engine

speed adder exists, 1 -> an rpm adder above base idle is present. Flag

is used in the ISC adaptive update routine to disable updates when HCAMFG

= 1.

- REFFLG = Indication of Idle Air Flow; 1 -> Idle Air Flow.

Calibration Constants:

- HCAMSW = Calibration switch which allows 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, FN826, and BZZRPM.

OUTPUTS

Registers:

6-57

FUEL STRATEGY, KAM ADAPTIVE FUEL LOGIC - LHBH0

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- KAMREF = Adaptive fuel strategy correction factor.

PROCESS

STRATEGY MODULE: FUEL\_KAM\_ADAPT\_COM3

CRKFLG = 1 ----------------------------------| KAMREF = 1.0

(crank mode) | (use no interpolation)

|

| --- ELSE ---

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

|AND -| KAMREF = 0.5 + LTMTBLrc

HCAMFG = 0 ----------------------| | | (where r = 10 and

(no rpm adder) |OR --| | c = ISFLAG)

| | (use no interpolation)

HCAMSW = 0 ----------------------| |

(ignore HCAMFG) | --- ELSE ---

|

| KAMREF = 0.5 + LTMTBLrc

| (use 4-point

| interpolation)

NOTE: For purposes of interpolation, the LTMTBL100 to LMTBL105 cells are not

included. These cells should correspond to the special idle cells.

6-58

FUEL STRATEGY, TRANSIENT FUEL COMPENSATION - LHBH0

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TRANSIENT FUEL COMPENSATION

(Background software module TFCOMP, called from BG\_FUELPW)

OVERVIEW

Transient Fuel is variously referred to as manifold wall wetting, puddling,

filling, and 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:

- eliminate lean air/fuel excursions during accelerations, and

- eliminate rich air/fuel excursions during decelerations.

NOTE: Transient Fuel Compensation is not run in Self Test.

6-59

FUEL STRATEGY, TRANSIENT FUEL COMPENSATION - LHBH0

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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 MAP 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 |

\ /

6-60

FUEL STRATEGY, TRANSIENT FUEL COMPENSATION - LHBH0

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DEFINITIONS

INPUTS

Registers:

- AISF = Actual Intake Surface Fuel Calculation, lb.

- ATMR1 = Time since Start-up, sec.

- DELTIM = Time since last AISF update, sec.

- EFTR = Equilibrium fuel transfer rate, fuel flow to and from the manifold

puddle.

Bit Flags:

- DFSFLG = Indicates decel fuel shut off.

- EFFLG1 = Equilibrium Fuel Transfer flag.

- ISCFLG = ISC Mode Flag. 1 -> RPM control; 2 -> RPM lockout

- MPGFLG = Manage fuel air state flag.

- REFFLG = Indicates idle fuel modulation enabled.

Calibration Constants:

- AISFM = Multiplier on AISF when in DFSO (0 - 2). Determines Fuel Puddle

size upon re-entering Normal Fuel.

- ALPHA = Multiplier proportioning the dependency of ACT to ECT.

- EFTC = TEFTC(FN1322) = an 8 X 10 table of equilibrium fuel transfer time

constants as a function of ALPHA \* ACT + (1 - ALPHA) \* ECT and MAP.

- EISF = TEISF(FN1321) = an 8 X 10 table of fuel mass values as a function

of ALPHA \* ACT + (1 - ALPHA) \* ECT and MAP.

- FN307(N\_BYTE) = MTEFTC Multiplier as a function of N\_BYTE.

- FN1321(TEISF) = Equlibrium intake surface fuel function.

- KFT = Multiplier (if set = 0, disables TFC) when not in MPG mode.

- KFTMPG = Transient Fuel multiplier in MPG mode.

- MEFTRA = Transient fuel PW multiplier during accels.

- MEFTRD = Transient fuel PW multiplier during decels.

- MTEISF = Multiplier for FN1321.

- TFCBITS = Minimum difference in Equilibrium Intake Surface Fuel to

trigger transient fuel. 1 bit = 0.000015259, therefore to have a

deadband of 5 bits, set TFCBITS = 0.000076295.

NOTE: To see how many bits are contained in the desired fuel puddle,

6-61

FUEL STRATEGY, TRANSIENT FUEL COMPENSATION - LHBH0

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calculate FN1321 \* MTEISF/0.000015259. For example, if FN1321 =

0.0014648, MTEISF = 0.0625, then the number of bits in the puddle is 6.

Thus even a 1 bit change would require an 18% TFCDED to eliminate it.

TFCBITS resolves this issue when puddle values are extremely small.

- TFCDED = Percentage deadband around Equilibrium Intake Surface Fuel to

turn off Transient Fuel.

- TFCISW = Switch for Transient Fuel Control.

- TFCTM = Time since entering Transient Fuel, sec.

- TFRFSW = Trans fuel REFFLG enable switch; 0 = disable REFFLG logic.

OUTPUTS

Registers:

- AISF = Actual Intake Surface Fuel Calculation, lb.

- EFTR = Equilibrium fuel transfer rate, fuel flow to and from the manifold

puddle.

- EFTRFF = Equilibrium fuel flow.

Bit Flags:

- EFFLG1 = Equilibrium Fuel Transfer flag.

6-62

FUEL STRATEGY, TRANSIENT FUEL COMPENSATION - LHBH0

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PROCESS

STRATEGY MODULE: FUEL\_TRANS\_COM5

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

(CRKFLG = 1) |

|

UNDERSPEED mode ---------------|OR --| EFFLG1 = 0

(UNDSP = 1) | | EFTR = 0

| | EFTRFF = 0

ATMR1 < TFCTM -----------------| | (do not run transient

| fuel compensation)

|

| --- ELSE ---

EFFLG1 = 0 --------------------| |

| |

RUN mode ----------------------|AND -| AISF = MTEISF \* FN1321(TEISF)

(CRKFLG = 0, UNDSP = 0) | | EFFLG1 = 1

| | (do not run transient

TFCISW = 1 --------------------| | fuel compensation)

(assume wet manifold at start-up) |

| --- ELSE ---

EFFLG1 = 0 --------------------| |

| |

RUN mode ----------------------|AND -| AISF = 0

| | EFFLG1 = 1

TFCISW = 0 --------------------| | (do not run transient)

(assume dry manifold at start-up) |

| --- ELSE ---

RUN mode ----------------------| |

| |

DFSFLG = 1 --------------------| |

(in DFSO) |AND -| AISF = MTEISF \* FN1321(TEISF) \* AISFM

| | EFFLG1 = 1

EFFLG1 = 1 --------------------| | EFTR = 0

| (do not run transient)

|

| --- ELSE ---

EFFLG1 = 1 --------------------| |

|AND -| Do ACTUAL INTAKE SURFACE

RUN mode ----------------------| | FUEL CALCULATIONS

(CRKFLG = 0, UNDSP = 0) | Do EQUILIBRIUM FUEL

| TRANSFER CALCULATIONS

| (run transient fuel

| compensation)

NOTE: During ENGINE RUNNING Self Test MODE, the above logic is not executed;

the Self Test software prevents Transient Fuel Compensation.

6-63

FUEL STRATEGY, TRANSIENT FUEL COMPENSATION - LHBH0

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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 = A \* [(EISF \* MTEISF - AISF) / (EFTC \* FN307(N\_BYTE))]

MPGFLG = 0 ------------------------------------| A = KFT

(not in MPG mode) |

| --- ELSE ---

|

MPGFLG = 1 ------------------------------------| A = KFTMPG

(in MPG mode)

ACTUAL INTAKE SURFACE FUEL CALCULATION (AISF)

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. Clip AISF to 0 as a minimum.

AISF = AISF + (EFTR \* DELTIM)

6-64

FUEL STRATEGY, TRANSIENT FUEL COMPENSATION - LHBH0

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TRANSIENT FUEL FLOW MULTIPLIER

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

|AND -|

TFRFSW = 1 ------------------------| |

(enable REFFLG logic) |

|

ISCFLG > 0 ------------------------| |

(in RPM control) | |

|AND -|OR --| EFTRFF = 0

TFISCW = 1 ------------------------| | | (stop adding

(enable ISCFLG logic) | | transient fuel to

| | pulsewidth continue

|MTEISF \* FN1321 - AISF| <= TFCBITS -----| | AISF update)

(difference is less than a few bits) | |

| |

|(MTEISF \* FN1321 - AISF) / | |

(MTEISF \* FN1321)| <= TFCDED --------| |

(percentage difference is small) |

| --- ELSE ---

|

MTEISF \* FN1321 < AISF ------------------------| EFTRFF = MEFTRD \* 60

| EFTR

| (use decel multiplier)

|

| --- ELSE ---

|

| EFTRFF = MEFTRA \* 60

| \* EFTR

| (use accel multiplier)

6-65

FUEL STRATEGY, HOT INJECTOR COMPENSATION - LHBH0

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HOT INJECTOR COMPENSATION

(Done in background software module CNVRT)

OVERVIEW

Under conditions of high injector tip temperatures, injector fuel delivery

decreases as a function of increasing injector tip temperature. The amount

of vaporized fuel delivered by the injector increases as hot soak time

increases, or as conducted heat (from cylinder head) and/or radiated heat

(from intake/exhaust manifold) increases. Higher fuel pressure or lower fuel

volatility helps the situation, but fuel volatility is beyond the developers

control. Hot Injector compensation has therefore been applied to the fuel

delivery slope A0. Tip temperature has been characterized to be a function

of ECT/ACT, ACSTRT, ATMR3 and AM as follows:

- ECT/ACT for conducted or radiated heat.

- ACSTRT for soak time.

- ATMR3 for fuel mass to cool the injector.

- AM for fuel mass to cool the injector.

Hot injector compensation, as a percent above base A0 is, HICOMP =

FN1349(TEMP,ACSTRT) \* FN1348(ATMR3,AM).

A0 corrected = A0/(1 + HICOMP) = A0COR

Thus when HICOMP goes to 0, no enrichment is desired. FN1350 has been added

for crank fuel enrichment as a function of ACT and CRKPIP\_CTR. ACT is the

input - in case of a stall and no key off, you will get a better enrichment

factor as opposed to ACSTRT.

6-66

FUEL STRATEGY, HOT INJECTOR COMPENSATION - LHBH0

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DEFINITIONS

INPUTS

Registers:

- ACSTRT = ACT at start-up; arithmetic average of the first 8 ACT readings.

- ACT = Air Charge Temperature, degrees F.

- AM = Air mass flow, lb/min.

- ATMR3 = Time since entering RUN mode, secs.

- CRKPIP\_CTR = Foreground PIP counter for crank fuel.

- ECT = Coolant temp, degree F.

Calibration Constants:

- FN1349 = Fuel enrichment factor. X = FN005(TEMP) Y = FN005(ACSTRT)

- FN1348 = Time multiplier. X = FN008(ATMR3) Y = FN007(AM)

- FN1350 = CRANK fuel enrichment multiplier as a function of "number of

PIPs" in CRANK and ACT. X = FN023(CRKPIP\_CTR) Y = FN024(ACT)

- FRCHIC = Fraction of ECT or ACT to use in FN1349. If FRCHIC = 1.0, all

ACT is used, if FRCHIC = 0, all ECT is used.

OUTPUTS

Registers:

- HICOMP = Hot injector compensation enrichment factor.

PROCESS

STRATEGY MODULE: FUEL\_HOT\_INJ\_COMP\_COM2

HICOMP = FN1349(TEMP,ACSTRT) \* FN1348(ATMR3,AM)

6-67

FUEL STRATEGY, INJECTOR DELAY LOGIC - LHBH0

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INJECTOR DELAY LOGIC

OVERVIEW

UNSYNCHRONIZED (SYNFLG = 0 or FUEL\_SYNC = 0) The injector timing routine is

disabled (IBETA = 0). All injector output ports are fired on the rising edge

of their respective reference PIPs.

SYNCHRONIZED (SYNFLG = 1 and FUEL\_SYNC = 1) All injector output port firings

are delayed CIBETA PIP periods from their respective reference PIPs.

NOTE: A Signature PIP distributor is required in order to delay injector

firing by CIBETA PIP periods. If a Signature PIP distributor is not used,

SYNFLG will always be 0.

CALIBRATION PHILOSOPHY

CIBETA should be calibrated so that the injector firings occur within the

optimum window determined by camshaft geometry.

DESIRED INJECTOR DELAY IN CRANK DEGREES - 10 DEG

CIBETA = ------------------------------------------------

CRANK DEGREES BETWEEN PIPS

The range of CIBETA is 0 to 6.5 PIP periods.

DEFINITIONS

INPUTS

Registers:

- TOTAL\_DELAY = Register which is equivalent to CIBETA. TOTAL\_DELAY

changes during synchronization until the requested CIBETA is obtained.

Bit Flags:

- FUEL\_SYNC = Flag which indicates that PIP and fuel are in synch.

- NEW\_DELAY = Flag to indicate that new TOTAL\_DELAY is being requested by

the FUEL SERVICE module.

- SYNFLG = Signature PIP correctly identified flag: 1 -> Signature PIP in

correct place; 0 -> not Signature PIP or in wrong place.

Calibration Constants:

- CIBETA = Number of PIPs to delay Bank A from rising edge of Signature

PIP.

6-68

FUEL STRATEGY, INJECTOR DELAY LOGIC - LHBH0

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- PIPOUT = Number of PIP periods between injector outputs on each injector

port.

OUTPUTS

Registers:

- NEW\_DELAY = See above.

- TOTAL\_DELAY = See above.

6-69

FUEL STRATEGY, INJECTOR DELAY LOGIC - LHBH0

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PROCESS

STRATEGY MODULE: FUEL\_INJDLY\_COM4

SYNFLG = 0 ----------------------|

|

FUEL\_SYNC = 0 -------------------|

(fuel not sync'd) |

|

SYNFLG = 1 ----------------| |

| |

FUEL\_SYNC = 1 -------------| |

| |

NEW\_DELAY = 1 -------------| |

(requesting new delay) |AND -|OR --| TOTAL\_DELAY = 0

| | | NEW\_DELAY = 0

CIBETA > PIPOUT -----------| | | Exit FUELPW ROUTINE

(requested delay too long) | |

| |

SYNFLG = 1 ----------------| | |

| | |

FUEL\_SYNC = 1 -------------| | |

|AND -| |

NEW\_DELAY = 1 -------------| |

| |

CIBETA < TOTAL\_DELAY ------| |

(requested delay less than |

present delay) |

| --- ELSE ---

SYNFLG = 1 ----------------------| |

| |

FUEL\_SYNC = 1 -------------------|AND -| Exit FUELPW ROUTINE

| |

NEW\_DELAY = 0 -------------------| |

| --- ELSE ---

|

CIBETA - TOTAL\_DELAY > 0.5 ------------| TOTAL\_DELAY =

(requested delay more than 1/2 PIP | TOTAL\_DELAY + 0.5

away) | NEW\_DELAY = 0

| Exit FUELPW ROUTINE

|

| --- ELSE ---

|

| TOTAL\_DELAY = CIBETA

| NEW\_DELAY = 0

| Exit FUELPW ROUTINE

NOTE: TOTAL\_DELAY is used by the FUEL SERVICE routine to compute IBETA.

6-70

FUEL STRATEGY, IDLE FUEL MODULATION - LHBH0

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IDLE FUEL MODULATION

OVERVIEW

Idle fuel modulation is used to enhance the idle stability of speed density

systems. The strategy achieves A/F modulation by multiplying the FUELPW

equation by the parameter ISCMOD, which has a nominal value of 1.0. ISCMOD

is inversely proportional to rate of change of rpm. If rpm is increasing,

the value of ISCMOD becomes less than 1.0, which leans the A/F and tends to

stop the increase. The opposite happens if rpm is decreasing. To prevent

the A/F modulation from being excessive, ISCMOD is clipped between maximum

and minimum values.

Idle speed modulation is enabled when TP is near RATCH, and rpm is near

DSDRPM. The flag REFFLG indicates that idle speed modulation is enabled.

DEFINITIONS

INPUTS

Registers:

- DNDT\_ISC = Rate of change of rpm. From the rpm calculation.

- DSDRPM = Desired rpm. Calculated in Idle Speed Control.

- N\_BYTE = Byte value of rpm. From the rpm calculation.

- RATCH = Lowest filtered throttle position (see System Equations Chapter).

- TP\_REL = Throttle Position relative to RATCH; TP\_REL = TP - RATCH.

Bit Flags:

- DISABLE\_ISC = Flag set in Running VIP to disable ISCMOD; 1-> disable

ISCMOD.

- REFFLG = Idle fuel modulation flag; 1 -> idle fuel modulation enabled.

- RUNUP\_FLG = Flag indicating that a stall has occurred; 1 -> Runup rpm

exceeded.

- VRUN\_ISCFLG = 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:

- DELRAT = Throttle position adder to RATCH. Used to describe a throttle

position below which idle fuel modulation is enabled.

- DLHYST = Hysteresis for DELRAT.

- ISCMOD\_MAX = Maximum clip on ISCMOD. Limits the maximum rich excursion

that will result from the idle fuel modulation strategy.

6-71

FUEL STRATEGY, IDLE FUEL MODULATION - LHBH0

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- ISCMOD\_MIN = Minimum clip on ISCMOD. Limits the maximum lean excursion

that will result from the idle fuel modulation strategy.

- ISCMOD\_RPM = Incremental adder to DSDRPM; total defines an engine speed

below which idle fuel modulation can occur. Should be kept to a minimum

to avoid unnecessary activation of the fuel modulation routine.

- KDNDT = Gain term for idle fuel modulation. Larger values result in more

fuel being added when engine speed falls and more fuel being taken away

when engine speed rises. Too small a value results in unstable idle and

too large a value results in unnecessary A/F excursions at idle.

- V\_ISCMOD\_MAX = VIP maximum clip on ISCMOD when in VIP throttle adjust

mode.

- V\_ISCMOD\_MIN = VIP minimum clip on ISCMOD when in VIP throttle adjust

mode.

- V\_KDNDT = gain term for idle fuel modulation when in VIP Throttle Adjust

mode.

OUTPUTS

Registers:

- EGO\_CNT\_IDLE = Number of EGO switches which have occurred since entering

Idle Fuel Modulation.

- ISCMOD = FUELPW equation multiplier for idle fuel modulation.

- LAM\_OLD = Value of LAMBSE at previous EGO switch.

- LAMAVE = Average LAMBSE between EGO switches.

Bit Flags:

- REFFLG = See above.

CALIBRATION INFORMATION

Typical Values:

- DELRAT = 15 counts.

- DLHYST = 10 counts.

- ISCMOD\_MAX = 1.2 (allows up to 20\_% rich A/F to correct for decreasing

rpm).

- ISCMOD\_MIN = 0.9 (allows up to 10\_% lean A/F to correct for increasing

rpm).

- ISCMOD\_RPM = 75 to 150 rpm.

- KDNDT = 0.0003 sec/rpm.

6-72

FUEL STRATEGY, IDLE FUEL MODULATION - LHBH0

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PROCESS

STRATEGY MODULE: FUEL\_IDLE\_MOD\_COM3

DISABLE\_ISC = 1 ---------------------------------| REFFLG = 1

(freeze ISCDTY for VIP) | ISCMOD = 1.0

| (disable idle fuel

| modulation for

| VIP)

|

| --- ELSE ---

|

VRUN\_ISCFLG = 1 ---------------------------------| REFFLG = 1

(throttle adjust mode) | ISCMOD = (1 -

| V\_KDNDT \*

| DNDT\_ISC)

| Clip ISCMOD between

| V\_ISCMOD\_MIN and

| V\_ISCMOD\_MAX

| (enable VIP Idle Fuel

| Modulation)

|

| --- ELSE ---

TP\_REL <= DELRAT + DLHYST -----------------| |

| |

RUNUP\_FLG = 1 -----------------------------| |

(initial runup complete) |AND -| REFFLG = 1

| | ISCMOD = (1 -

TP\_REL <= DELRAT --------------| | | KDNDT \*

|AND -| | | DNDT\_ISC)

N\_BYTE <= DSDRPM + ISCMOD\_RPM -| |OR --| | Clip ISCMOD between

| | ISCMOD\_MIN and

previous value of REFFLG = 1 --------| | ISCMOD\_MAX

| (enable idle fuel

| modulation)

|

| --- ELSE ---

|

| REFFLG = 0

| ISCMOD = 1.0

| (disable idle fuel

| modulation)

Previous value of REFFLG = 0 --------------|

|AND -| EGO\_CNT\_IDLE = 0

Current value of REFFLG = 1 ---------------|

EGO switch --------------------------------------| Increment EGO\_CNT\_IDLE

6-73

FUEL STRATEGY, IDLE FUEL MODULATION - LHBH0

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NOTE:

- REFFLG = 1 indicates idle fuel modulation is enabled.

- ISCMOD is a multiplier on the FUELPW equation.

- DNDT\_ISC is a filtered dn/dt (see rpm calculation)

- ISCMOD\_RPM = Delta rpm above DSDRPM to enable idle fuel modulation.

- Most MAF systems should not use Idle Fuel Modulation (set KDNDT = 0).

6-74

FUEL STRATEGY, DECEL FUEL SHUT-OFF LOGIC - LHBH0

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DECEL FUEL SHUT-OFF LOGIC

(Software module DECEL\_FUEL\_SHUTOFF, called by BG\_FUELPW)

OVERVIEW

This logic turns off the fuel on a deceleration condition.

DEFINITIONS

INPUTS

Registers:

- BG\_TMR = Background loop time, sec.

- CTTMR = Time at closed throttle, sec.

- DSDRPM = Desired engine speed. See the IDLE SPEED CONTROL Chapter

Overview section for definition of the various uses of this register.

- D\_TP\_DT = Time derivitive of TP (ticks/sec).

- DFSO\_A\_TMR = Free running, down counting, TP based thermactor air shut

off timer.

- DFSO\_F\_TMR = Free running, down counting, TP based DFSO timer.

- ECT = Engine Coolant Temperature.

- MAP = Manifold Absolute Pressure, " Hg (byte value).

- N = Engine speed, rpm.

- NACTMR = Time since leaving Closed Throttle mode. NACTMR is defined in

the TIMERS Chapter.

- NOVS = The ratio of engine speed (NBAR) over vehicle speed (VSBAR).

- OLD\_TP\_DFSO = Previous value of TP used in DFSO logic.

- TP = Throttle position, counts.

- VSBAR = Time dependent rolling average of instantaneous vehicle speed,

VS.

Bit Flags:

- DFSVS\_HYS\_FG = Decel fuel vehicle speed flip-flop.

- FLG\_DFSO\_NOVS = Flip flop state flag using transmission gear to engage

DFSO.

- FPWQ2 = Fuel pulsewidth flip-flop 2.

6-75

FUEL STRATEGY, DECEL FUEL SHUT-OFF LOGIC - LHBH0

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- FPWQ3 = Fuel pulsewidth flip-flop 3.

- MFMFLG = MAP failure flag; 1 -> MAP sensor has failed.

- NDSFLG = Flag that indicates Neutral/Drive switch position; 0 -> neutral,

1 -> drive.

- 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.

- TFMFLG = Flag indicating that the TP sensor is in/out of range; 1 ->

failed range check.

- VSFMFLG = Flag indicating the Vehicle Speed Sensor has failed; 1 ->

failed sensor.

Calibration Constants:

- CTDSFO = Time at closed throttle for DFSO, sec.

- CTEDSO = Time at extended decel for DFSO, sec.

- DFNOVH = Hysteresis for DENOVS, rpm/mph.

- DFNOVS = NOVS value below which DFSO is permitted. Used to disable DFSO

in lower transmission gears to prevent large torque changes.

- DFSECT = Minimum ECT to do DFSO, degrees F.

- DFSMAP = Minimum MAP for DFSO. Should be calibrated to not allow DFSO

when the engine is making power so as to minimize torque change at fuel

shut off point, Hg.

- DFSO\_ECT = Ect above which TP based DFSO is allowed.

- DFSO\_OUT = Switch to disable DFSO under a throttle position faliure; 1 ->

DFSO disabled.

- DFSMPH = Hysteresis for DFSMAP, Hg.

- DFSRPH = Hysteresis value for DFSRPM.

- DFSRPM = Minimum value of (N - DSDRPM) for DFSO, rpm.

- DFSTM = Time delay before DFSO, sec.

- DFSVS = Minimum vehicle speed to allow Decel Fuel Shut-Off. Used to

limit DFSO when in a high gear, low speed decel. Also prevents use of

DFSO in parking lots, etc, mph.

- DFSVSH = Hysteresis value for DFSVS, mph.

- D\_TP\_DT\_F = TP tip out rate needed to trigger TP based DFSO (should never

be greater that zero). TP tip out can be turned off by setting this

scalar to its maximum negative value.

6-76

FUEL STRATEGY, DECEL FUEL SHUT-OFF LOGIC - LHBH0

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- FND\_TP\_DT\_A = TP rate at which to activate air bypass.

- TRLOAD = Transmission load switch.

- FN222A(n) = The amount of time which thermactor air is shut off, sec.

- FN222F(n) = The amount of time which DFSO is active, sec.

OUTPUTS

Registers:

- D = Decel fuel shut-off multiplier.

- D\_TP\_DT = See above.

- DFSO\_A\_TMR = See above.

- DFSO\_F\_TMR = See above.

- OLD\_TP\_DFSO = See above.

Bit Flags:

- DFSFLG = Decel Fuel Shut-Off flag; 1 -> the decel fuel multiplier is not

one.

- FLG\_DFSO\_NOVS = See above.

- DFSVS\_HYS\_FG = See above.

- FPWQ2 = See above.

- FPWQ3 = See above.

6-77

FUEL STRATEGY, DECEL FUEL SHUT-OFF LOGIC - LHBH0

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PROCESS

STRATEGY MODULE: FUEL\_DFSO\_COM2

always ------------------------------------------| D\_TP\_DT = (TP -

| OLD\_TP\_DFSO) / BG\_TMR

| OLD\_TP\_DFSO = TP

ECT > DFSO\_ECT ----------------------------|

(ECT high enough) |

|AND -| [dfso\_condition] = 1

| |

TFMFLG = 0 --------------------------------| |

(TP sensor OK) |

| --- ELSE ---

|

| [dfso\_condition] = 0

[dfso\_condition] = 1 ----------------------|

(condition right) |

|

DFSO\_F\_TMR = 0 ----------------------------|AND -| DFSO\_F\_TMR = FN222F(N)

(initialize once) | |

| |

D\_TP\_DT < D\_TP\_DT\_F -----------------------| |

(tipping out) |

| --- ELSE ---

|

| decrement DFSO\_F\_TMR

| (clip at zero)

[dfso\_condition] = 1 ----------------------|

(condition right) |

|

DFSO\_A\_TMR = 0 ----------------------------|AND -| DFSO\_A\_TMR = FN222A(N)

(initialize once) | |

| |

D\_TP\_DT < FND\_TP\_DT\_A(N) ------------------| |

(tipping out) |

| --- ELSE ---

|

| decrement DFSO\_A\_TMR

| (clip at zero)

6-78

FUEL STRATEGY, DECEL FUEL SHUT-OFF LOGIC - LHBH0

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Evaluate each flip flop each background pass:

NACTMR > DFSTM ----------------------------|S Q -| FPWQ3

(long tip-in) |

|

NACTMR > 0 --------------------------------|C

VSBAR >= DFSVS ----------------------------|S Q -| DFSVS\_HYS\_FG

|

VSBAR < DFSVS - DFSVSH --------------------|C

NOVS <= DFNOVS ----------------------------|S Q -| FLG\_DFSO\_NOVS

(in higher gear) |

|

NOVS > DFNOVS + DFNOVH --------------------|C

N - DSDRPM >= DFSRPM ----------------|

(rpm high enough) |

|AND -|S Q -| FPWQ2

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

|OR --| |

MAP <= DFSMAP -----------------| |

(not making power) |

|

N - DSDRPM < DFSRPM - DFSRPH --------| |

|OR --|C

MAP > DFSMAP + DFSMPH ---------| |

|AND -|

MFMFLG = 0 --------------------|

6-79

FUEL STRATEGY, DECEL FUEL SHUT-OFF LOGIC - LHBH0

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FPWQ2 = 1 ---------------------------------|

|

RUNNING = 0 -------------------------------|

(not in KOER VIP) |

|

TRLOAD < 2 --------------------------| |

(ignore N/D input) |OR --|

| |

NDSFLG = 1 --------------------------| |

(in gear) |

|

ECT > DFSECT ------------------------------|

(engine warm enough) |

|

TFMFLG = 0 --------------------| |

|AND -| |

DFSO\_OUT = 0 ------------------| | |

| |

MFMFLG = 0 --------------------| | |

|AND -|OR --|AND -| "A" = 1

DFSO\_OUT = 0 ------------------| | | |

| | |

TFMFLG = 0 --------------------| | | |

|AND -| | |

MFMFLG = 0 --------------------| | |

| |

TFMFLG = 1 --------------------------| | |

|OR --| |

CTTMR > CTDSFO ----------------| | | |

(closed throttle long enough) | | | |

|AND -| | |

CTTMR > CTEDSO ----------| | | |

(extended closed throt.)| | | |

|OR --| | |

FPWQ3 = 1 ---------| | | |

|AND -| | |

FLG\_DFSO\_NOVS = 1 -| | |

| |

VSFMFLG = 1 -------------------------| | |

(VS sensor bad) |OR --| |

| |

DFSVS\_HYS\_FG = 1 --------------------| |

| --- ELSE ---

|

| "A" = 0

DFSO\_F\_TMR <> 0 ---------------------------|

|OR --| FUEL OFF

"A" = 1 -----------------------------------| | D = 0

| DFSFLG = 1

|

| --- ELSE ---

|

| FUEL ON

| D = 1

| DFSFLG = 0

6-80

FUEL STRATEGY, BACKGROUND PULSEWIDTH DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FUEL PULSEWIDTH CALCULATION (BGFUEL)

(Background Module BG\_FUELPW)

OVERVIEW

Except for crank mode and Asynchronous Acceleration Enrichment, fuel

pulsewidths are calculated from the following equation:

[ AM \* KAMREF ]

BGFUEL = FUEL\_A \* [ -------------- + EFTRFF ]

[ 14.64 \* LAMBSE ]

1 PIPOUT

\* ------------------ \* --------------- + FN367

N \* ENGCYL \* A0COR INJOUT \* NUMOUT

DEFINITIONS

INPUTS

Registers:

- A0COR = Corrected fuel injector slope.

- ACT = Air Charge Temperature.

- AM = Air Mass flow as defined in the SYSTEM EQUATIONS Chapter, lb/min.

- BASE\_EM = Fuel requirement based on EGR flow (non-displayable).

- BASEFF = Fuel amount to provide stoichiometric operation based on

inducted air mass (AM) = (KAMREF \* AM)/(14.64 \* LAMBSE).

- CRKPIP\_CTR = Foreground PIP counter for crank fuel.

- CRKPIP\_CTR\_BG = Background equivalent of CRKPIP\_CTR.

- D = Decel fuel shutoff multiplier.

- ECT = Engine Coolant Temperature.

- EFTRFF = Equilibrium fuel transfer rate for transient fuel compensation

(lbf/min).

- EM = Actual EGR mass flow.

- FUEL\_A = Fuel pulsewidth multiplier for Idle Fuel Modulation / Decel /

Underspeed operation, unitless (non-displayable).

- FUELPW = Foreground/background calculated fuel pulsewidth.

- ISCMOD = Multiplier for idle speed fuel.

6-81

FUEL STRATEGY, BACKGROUND PULSEWIDTH DETERMINATION - LHBH0

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- KAMREF = Adaptive fuel strategy correction factor.

- LAMBSE = Desired ratiometric air/fuel ratio. Normalized to stoichiometry

(14.7 a/f).

- MAP = Manifold Absolute Pressure, "Hg (byte value).

- MAPWBG = MAP\_WORD updated once per background pass at calculation of

AMPEM. Used in fuel pulsewidth calculation.

- N = Engine speed in revolutions per minute.

- OFMFLG = ETV overcurrent monitor failure flag; 0 -> ETV O.K., 1 -> ETV

failure mode.

- PWCF = Pulsewidth Conversion Factor - converts total computed for engine

into amount per injector = [1/(N \* ENGCYL)]/[PIPOUT/(NUMOUT \* INJOUT)].

- RT\_NOVS\_KAM = Ratio of actual N-OVER-V to base N-OVER-V.

- TLS\_NV\_FLG = Torque limiting strategy - no fuel flag; 0 -> normal fuel, 1

-> no fuel.

- TLS\_24\_FLG = Torque limiting strategy - 1/2 fuel flag; 0 -> normal fuel,

1 -> 1/2 fuel.

- TLS\_34\_FLG = Torque limiting strategy - 3/4 fuel flag; 0 -> normal fuel,

1 -> 3/4 fuel.

- TP\_REL = TP - RATCH.

- VBAT = Battery voltage.

- VSBAR = Time dependent rolling average of instantaneous vehicle speed,

VS.

- VSBART\_FM = VS calculated based on NIBART, NOBART, or NOBART.

- VSFMFLG = Vehicle speed sensor FMEM flag.

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

- CRKFLG = Flag indicating engine mode; 1 -> cranking, 0 -> run or

underspeed mode.

- DSFFLG = Decel Fuel Shutoff flag; 1 -> the decel fuel multiplier is not

one.

- MFMFLG = MAP sensor failure flag.

- REFFLG = Idle air flow region flag; 1 -> in region.

- TFMFLG = TP sensor failure flag; 1 -> TP failure.

- UNDSP = Run/Underspeed Engine Mode flag; 1 -> Underspeed/Crank, 0 -> Run

mode.

6-82

FUEL STRATEGY, BACKGROUND PULSEWIDTH DETERMINATION - LHBH0

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Calibration Constants:

- BFULSW = Calibration switch to force use of background calculation of

fuel pulsewidth; 1 -> do all fuel calculations in background, 0 -> use

foreground fuel flag logic.

- ENGCYL = Number of cylinders per engine revolution.

- FN348(ECT) = Crank fuel pulsewidth as a function of ECT.

- FN367(VBAT) = Injector offset as a function of VBAT.

- FN387(ECT) = Fuel pulsewidth multiplier as a function of ECT.

- FN387\_ALT = Alternative FN387.

- FN1350(CRKPIP\_CTR\_BG,ACT) = Cranking fuel pulsewidth multiplier as a

function of number of PIPs in crank and air charge temperature.

- FREQ18 = Seconds to clock ticks conversion factor. 1 clock tick = 3 \*

10E-6 seconds.

- INJOUT = Number of injectors fired by each output port.

- MINPW = Minimum pulsewidth for repeatable fuel delivery.

- NLMT = Overspeed RPM.

- NLMTH = Hysteresis for overspeed RPM.

- NUMOUT = Number of injector output ports.

- OUTINJ = Injector scheme selection switch; 1 -> alternate injections, 2

-> simultaneous injections.

- PIPOUT = Number of PIP periods between injector outputs on each injector

port.

- TLSNV = Torque limiting pattern for engine RPM/vehicle speed, unitless.

- TLS24D = Torque limiting pattern for 1/2 fuel, double fire, unitless.

- TLS34D = Torque limiting pattern for 3/4 fuel, double fire, unitless.

- TLS24S = Torque limiting pattern for 1/2 fuel - single fire.

- TLS34S = Torque limiting pattern for 3/4 fuel - single fire.

- TP\_DECHOKE = TP value above which to de-choke.

- TQMAX1 = Maximum torque before 3/4 fuel.

- TQMAX2 = Maximum torque before 1/2 fuel.

- TQMAXH = Hysteresis for TQMAX1.

- VSLIM = Maximum vehicle speed, MPH.

6-83

FUEL STRATEGY, BACKGROUND PULSEWIDTH DETERMINATION - LHBH0

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- VSLIMH = Hysteresis for maximum vehicle speed, MPH.

OUTPUTS

Registers:

- BASE\_EM = See above.

- BASEFF = See above.

- BGFUEL = Background fuel pulsewidth, clock ticks.

- FFULC = The constant that is added in the foreground fuel pulsewidth

equation, lb/cyl.

- FFULM = The value that is multiplied by MAP\_WORD in the foreground fuel

pulsewidth equation (lb/cyl - "Hg).

- FUEL\_A = See above.

- FUEL\_PIPS = Number of PIPs between injections.

- LAMBSE = See above.

- TLS\_NV\_FLG = See above.

- PWCF = See above.

- TLS\_24\_FLG = See above.

- TLS\_34\_FLG = See above.

- TLSPAT = Torque limiting strategy injection pattern.

Bit Flags:

- DISABLE\_ADAPT = Adaptive fuel disable flag; 1 -> disable adaptive fuel.

- FFULFG = Foreground fuel flag; 1 -> Compute fuel pulsewidth in foreground

using latest computed manifold absolute pressure, 0 -> otherwise use

background fuel pulsewidth.

6-84

FUEL STRATEGY, BACKGROUND PULSEWIDTH DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_BG\_PW\_DET\_COM5

CRANK MODE FUEL PULSEWIDTH

ALT\_CAL\_FLG = 1 ---------------------| fn387 = FN387\_ALT(ECT)

|

| --- ELSE ---

|

| fn387 = FN387(ECT)

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

|AND -| BGFUEL = FN348(ECT) \*

TP\_REL <= TP\_DECHOKE ----------| | FN1350(CRKPIP\_CTR\_BG,ACT) \*

| | (MAP/29.875)

TFMFLG = 0 --------------------| | (clip to 0.249 sec as a max)

(tp sensor o.k.) | Goto "CONVERT PULSEWIDTH TO CLOCK

| TICKS"

| Exit FUELPW Routine

|

| --- ELSE ---

|

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

| (WOT de-choke mode)

| Goto "CONVERT PULSEWIDTH TO CLOCK

| TICKS"

| Exit FUELPW Routine

CALCULATE KAMREF

always ------------------------------| Do "KAMREF" Module

CALCULATE TRANSIENT FUEL

always ------------------------------| Do "TFCOMP" Module

DETERMINE BASE FUEL FLOW (BASEFF)

BASEFF is used in the foreground fuel calculation and contains base fuel

flow, unadjusted for transient fuel, AE fuel, or injector hardware.

AM \* KAMREF

BASEFF = --------------

14.64 \* LAMBSE

6-85

FUEL STRATEGY, BACKGROUND PULSEWIDTH DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DETERMINE BASE EM (BASE\_EM)

BASE\_EM is used in the foreground fuel calculation to adjust the base fuel

for EGR mass that may be present at the time.

EM \* KAMREF

BASE\_EM = --------------

14.64 \* LAMBSE

CALCULATE PULSEWIDTH CONVERSION FACTOR (PWCF)

PWCF converts total fuel required for the engine into an amount required per

injection.

PWCF = [1/(N \* ENGCYL \* A0COR)] \* [PIPOUT/(INJOUT \* NUMOUT)]

CALCULATE IDLE FUEL MODULATION/DECEL/UNDERSPEED MULTIPLIER (FUEL\_A)

always ------------------------------| Do "DECEL FUEL SHUTOFF" Logic

| (determine the value of D)

| Do "IDLE FUEL MODULATION" Logic

| (determine the value of "ISCMOD")

UNDSP = 1 ---------------------------| FUEL\_A = D \* ISCMOD \* fn387(ECT)

|

| --- ELSE ---

|

| FUEL\_A = D \* ISCMOD

APPLY MINIMUM FUELPW AND LAMBSE CLIPS

DFSFLG = 1 --------------------------| DISABLE\_ADAPT = 1

(decel fuel shutoff) | (disable adaptive fuel)

|

| --- ELSE ---

|

FUELPW < MINPW ----------------------| DISABLE\_ADAPT = 1

| (do not learn adaptive fuel

| at minimum clip)

| BGFUEL = MINPW

| LAMBSE = 1.0

|

| --- ELSE ---

|

| DISABLE\_ADAPT = 0

6-86

FUEL STRATEGY, BACKGROUND PULSEWIDTH DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE AND VEHICLE SPEED LIMITER LOGIC

VSFMFLG = 1 -------------------------| vsbar = VSBART\_FM

|

| --- ELSE ---

|

| vsbar = VSBAR

N > NLMT ----------------|S Q-|

| |

N <= NLMT - NLMTH -------|C |OR --| TLS\_NV\_FLG = 1

| |

vsbar > VSLIM / | |

RT\_NOVS\_KAM ------|S Q-| |

| |

vsbar <= (VSLIM / | |

RT\_NOVS\_KAM) - | |

VSLIMH -------|C |

| --- ELSE ---

|

| TLS\_NV\_FLG = 0

NOTE: This strategy does not limit based on vehicle speed. It limits based

on propshaft speed as a result of dividing VSLIM by RT\_NOVS\_KAM, and assumes

that with a change in axle ratio, the equivalent change is made to the VSS

drive gear.

ENGINE TORQUE LIMITING STRATEGY

OFMFLG = 0 --------------------|

(TV solenoid OK) | (Full Fuel)

|OR --| TLS\_24\_FLG = 0

TQ\_OFM < TQMAX1 - | | TLS\_34\_FLG = 0

TQMAXH --------|S Q-| |

| |

TQ\_OFM >= TQMAX1 --------|C |

| --- ELSE ---

|

| (1/2 Fuel)

TQ\_OFM >= TQMAX2 --------------|S Q-| TLS\_24\_FLG = 1

| | TLS\_34\_FLG = 0

TQ\_OFM < TQMAX2 - TQMAXH ------|C |

| --- ELSE ---

|

| (3/4 Fuel)

| TLS\_24\_FLG = 0

| TLS\_34\_FLG = 1

6-87

FUEL STRATEGY, BACKGROUND PULSEWIDTH DETERMINATION - LHBH0

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TLS\_NV\_FLG = 1 ----------------------| TLSPAT = TLSNV

|

| --- ELSE ---

PIPOUT/ENGCYL = 2 -------------| |

(single fire) | |

|AND -| TLSPAT = TLS24S

TLS\_24\_FLG = 1 ----------------| |

| --- ELSE ---

PIPOUT/ENGCYL = 2 -------------| |

|AND -| TLSPAT = TLS34S

TLS\_34\_FLG = 1 ----------------| |

| --- ELSE ---

PIPOUT/ENGCYL = 1 -------------| |

(double fire) | |

|AND -| TLSPAT = TLS24D

TLS\_24\_FLG = 1 ----------------| |

| --- ELSE ---

PIPOUT/ENGCYL = 1 -------------| |

|AND -| TLSPAT = TLS34D

TLS\_34\_FLG = 1 ----------------| |

| --- ELSE ---

|

| TLSPAT = 65535

CONVERT PULSEWIDTH TO CLOCK TICKS

(can be entered from CRANK MODE FUEL PULSEWIDTH)

always ------------------------------| BGFUEL = [FUEL\_A \* (BASEFF +

| EFTRFF) \* PWCF] \* FREQ18

| (FREQ18 = 1/3 \* 10E-6 ticks per sec)

CALCULATE NUMBER OF PIPS BETWEEN INJECTIONS (FUEL\_PIPS)

(used in FUEL SERVICE FOREGROUND routine)

PIPOUT \* OUTINJ

always ------------------------------| FUEL\_PIPS = ---------------

NUMOUT

6-88

FUEL STRATEGY, BACKGROUND PULSEWIDTH DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DETERMINE STATE OF FOREGROUND FUEL FLAG (FFULFG)

BFULSW = 1 --------------------|

|

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

|OR --| FFULFG = 0

CRKFLG = 1 --------------------| | (do background fuel)

| |

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

| --- ELSE ---

|

| FFULFG = 1

| (do foreground fuel)

CALCULATE FOREGROUND PARTS OF THE FUEL EQUATION (FFULM, FFULC)

always ------------------------------| FFULM = FUEL\_A \* [(BASEFF +

| BASE\_EM) / MAPWBG] \*

| PWCF

| FFULC = FUEL\_A \* (EFTRFF -

| BASE\_EM) \* PWCF

CALCULATE INJECTOR DELAY (CIBETA)

always ------------------------------| Do "INJECTOR DELAY" Logic

VBAT INJECTOR OFFSET

FN367(VBAT) is compensation for low battery voltage. It is added to the fuel

pulsewidth in foreground as the pulse is sent out. The displayed pulsewidth

does not include FN367.

6-89

FUEL STRATEGY, FUEL PUMP CONTROL LOGIC - LHBH0

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FUEL PUMP CONTROL LOGIC

OVERVIEW

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.

DEFINITIONS

INPUTS

Registers:

- TSLPIP = Timer indicating time since last PIP low-to-high transition,

sec.

OUTPUTS

Registers:

- PUMP = Bit flag indicating fuel pump mode; 0 -> fuel pump disabled, 1 ->

fuel pump enabled.

PROCESS

STRATEGY MODULE: FUEL\_PUMP\_COM1

TSLPIP < 1 SECOND -----------------| PUMP = 1

|

| --- ELSE ---

|

| PUMP = 0

6-90

FUEL STRATEGY, PPCTR CONTROL - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PPCTR CONTROL

(Updated during PIP\_DATA foreground routine)

OVERVIEW

This counter counts PIPs when not in Decel Fuel Shut-Off. PPCTR is updated

at PIP rising edge before injector pulsewidth is calculated and output.

DEFINITIONS

INPUTS

Bit Flags:

- DFSFLG = Decel Fuel Shut-Off flag; 1 -> the decel fuel multiplier is not

one.

Calibration Constants:

- PIPNUM = Number of PIPs to remain in Open Loop fuel after DFSO. Prevents

LAMBSE from ramping off rich due to normal transport delay time. Set to

1 to calibrate out.

OUTPUTS

Registers:

- PPCTR = PIP counter; updated at PIP rising edge before injector

pulsewidth is calculated and output.

PROCESS

STRATEGY MODULE: FUEL\_PPCTR\_COM2

DFSFLG = 0 -----------------------------------| Increment PPCTR every PIP

| Clip at PIPNUM

|

| --- ELSE ---

|

| PPCTR = 1

6-91

FUEL STRATEGY, FUEL SERVICE ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FUEL SERVICE ROUTINE

(foreground module FUEL\_SERVICE executed on PIP falling edge in CRANK

and PIP rising edge in UNDSP & RUN)

OVERVIEW

The purpose of the Fuel Service module is to issue the on-off signals to the

injectors to attain the desired amount of fuel (FUELPW) at the desired time

in the engine cycle (TOTAL\_DELAY). This module also updates the background

calculated fuel pulsewidth to the most current MAP if so desired (Foreground

Fuel).

A software switch, OUTINJ, can be calibrated to yield the desired injection

scheme:

OUTINJ = 1 -----------------------------------| ALTERNATE INJECTIONS

|

| --- ELSE ---

|

OUTINJ = 2 -----------------------------------| SIMULTANEOUS INJECTIONS

6-92

FUEL STRATEGY, FUEL SERVICE ROUTINE - LHBH0

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DEFINITIONS

INPUTS

Registers:

- BGFUEL = Background fuel pulsewidth, clock ticks.

- CRKPIP = Number of PIPs between injector firing.

- ENGCYL = Number of PIPs (or injections) per revolution.

- FFULM = The valve which is multiplied by MAP\_WORD in the foreground fuel

pulsewidth equation, lb/cyl -- " Hg.

- FUEL\_PIPS = Number of PIPs which have occurred between injections.

- FUEL\_SUM\_TKS = Register for DOL summer, ticks.

- FUELPW = Fuel pulsewidth, displayed in clock ticks.

- IBETA = Fractional part of total injector delay, PIPs.

- INJ\_PIP\_CNT = Counter which counts the number of PIPs between injections.

- INJCNT = Injector portion of total delay.

- MAP\_WORD = Manifold absolute pressure, " Hg.

- N = Engine rpm.

- NUMOUT = Number of injector output ports.

- OUTINJ = Injector scheme selection switch; 1 -> alternate injections, 2

-> simultaneous injections.

- SYNCTR = Counter which counts PIP signals until its value equal NUMCYL;

always initialized to zero.

- TLSCTR = Torque limiting strategy injection counter.

- TLSPAT = Torque limiting strategy injection pattern.

6-93

FUEL STRATEGY, FUEL SERVICE ROUTINE - LHBH0

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Bit Flags:

- CRKFLG = Flag indicating engine mode; 1 -> crank mode, 0 -> run or

underspeed.

- DSFFLG = Decel fuel shutoff flag; 1 -> the decel fuel multiplier is not

one.

- FFULFG = Foreground fuel flag; 1 -> compute fuel pulsewidth in foreground

using latest computed manifold absolute pressure, 0 -> otherwise use

background fuel pulsewidth.

- FUEL\_FINISHED = Flag indicating status of fuel calculations; 1 -> fuel

calculations are complete.

- INJ\_BANK = Flag indicating which injector bank is being energized; 0 ->

Bank A, 1 -> Bank B.

- NO\_SYNC = 1 -> Fuel injectors are not sychronized with the Signature PIP.

- PIPOUT = Number of PIP periods betwen injector outputs on each injector

port.

- RUNNING = Engine running VIP enable flag.

- STALL = Flag which indicates Run to Crank transition.

- SYNFLG = Signature PIP correctly identified flag; 1 -> Signature PIP in

correct place, 0 -> not Signature PIP or in wrong place.

- TLS\_24\_FLG = Torque limiting strategy - 1/2 fuel flag; 0 -> normal fuel,

1 -> 1/2 fuel.

- TLS\_34\_FLG = Torque limiting strategy - 3/4 fuel flag; 0 -> normal fuel,

1 -> 3/4 fuel.

- TLS\_NV\_FLG = Engine RPM/Vehicle speed limiting flag.

- UNDSP = Engine mode flag; 1 -> cranking or underspeed, 0 -> run.

Calibration Constants:

- DT12S = The value, in clock ticks, of the current PIP period.

- FFULC = The constant which is added in the foreground fuel pulsewidth

equation, lb/cyl.

- FREQ18 = Seconds to clock ticks conversion factor. 1 clock tick = 3 \*

10E-6 seconds.

- MINPW = Minimum pulsewidth for repeatable fuel delivery.

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

value, then assume a reinit occurred, rpm.

6-94

FUEL STRATEGY, FUEL SERVICE ROUTINE - LHBH0

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OUTPUTS

Registers:

- FUELPW = See above.

- FUEL\_SUM\_TKS = See above.

- IBETA = See above.

- INJ\_PIP\_CNT = See above.

- INJCNT = See above.

- SYNCTR = See above.

- TLS\_SHFTR = Foreground scratch register for injection pattern.

- TLSCTR = See above.

Bit Flags:

- FUEL\_FINISHED = See above.

- FUEL\_SYNC = See above.

- INJ1\_PIP = Injector number one PIP occurred, if set to one.

- INJ2\_PIP = Injector number two PIP occurred, if set to one.

- NO\_SYNC = See above.

- STALL = See above.

- SYNFLG = See above.

6-95

FUEL STRATEGY, FUEL SERVICE ROUTINE - LHBH0

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PROCESS

STRATEGY MODULE: FUEL\_INJ\_OUT\_COM6

FUEL SERVICE START

STALL = 1 ---------------------------| STALL = 0

(N < STALLN) | SYNFLG = 0

| SYNCTR = 0

| FUEL\_SYNC = 0

| NO\_SYNC = 0

| INJ\_PIP\_CNT = 1

Divide TOTAL\_DELAY into an integer portion, INJCNT and a fraction

portion, IBETA.

TOTAL\_DELAY = 0 ---------------------| IBETA = 0

| INJCNT = 0

| SYNCH\_VALUE = 0

| Do: "FUEL FIRING PIP"

|

| --- ELSE ---

|

| IBETA = TOTAL\_DELAY - INJCNT

IBETA < 0 ---------------------------| IBETA = 0

| INJCNT = 0

| SYNCH\_VALUE = 0

| Do: "Fuel Firing PIP"

|

| --- ELSE ---

|

IBETA >= 1.0 ------------------------| IBETA = IBETA - 1

| INJCNT = INJCNT + 1

| INJ\_PIP\_CNT = INJ\_PIP\_CNT + 1

| (number of PIPs between injections)

always ------------------------------| SYNCH\_VALUE = (2 \* ENGCYL) - INJCNT

SYNCH\_VALUE <= 0 --------------------| IBETA = 0

| INJCNT = 0

| SYNCH\_VALUE = 0

| Do: "FUEL FIRING PIP"

SYNCH\_VALUE = 2 \* ENGCYL ------------| SYNCH\_VALUE = 0

6-96

FUEL STRATEGY, FUEL SERVICE ROUTINE - LHBH0

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FUEL FIRING PIP

Check to see if this is the correct PIP for firing fuel. SYNCH\_VALUE is the

integer portion of TOTAL\_DELAY.

SYNFLG = 1 --------------------|

(PIP in synch) |

|

SYNCTR = SYNCH\_VALUE ----------|

(proper PIP for fuel firing) |

|AND -| FUEL\_SYNC = 1

INJ\_BANK = 0 ------------------| | (PIP is synched with fuel)

(signature PIP must contain | |

bank A) | |

| |

INJ\_PIP\_CNT = 1 ---------------| |

| --- ELSE ---

SYNFLG = 1 --------------------| |

|AND -| NO\_SYNC = 1

SYNCTR = SYNCH\_VALUE ----------| | (PIP is synched but fuel is on

| wrong bank)

always ------------------------------| Decrement INJ\_PIP\_CNT

INJ\_PIP\_CNT > 0 ---------------------| EXIT "FUEL SERVICE" routine

| (no fuel to be output this PIP)

6-97

FUEL STRATEGY, FUEL SERVICE ROUTINE - LHBH0

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FOREGROUND FUEL DETERMINATION

FFULFG = 1 --------------------------| FUELPW = (FFULM \* MAP\_WORD) + FFULC

| (use foreground fuel calculation)

|

| --- ELSE ---

|

FFULFG = 0 --------------------------| FUELPW = BGFUEL

| (use background fuel calculation)

MINIMUM PULSEWIDTH CLIP

DSFFLG = 0 --------------------|

(not in DFSO) |

|

RUNNING = 0 -------------------|

(not in VIP) |AND -| FUELPW = MINPW \* FREQ18

| | (convert to clock ticks)

FUELPW < MINPW ----------------| |

(less than minimum pulse) | |

| |

FFULFG = 1 --------------------| |

| --- ELSE ---

FUELPW >= 0.250 ---------------| |

|AND -| FUELPW = .25 \* FREQ18

FFULFG = 1 --------------------| |

| --- ELSE ---

|

FFULFG = 1 --------------------------| FUELPW = FUELPW \* FREQ18

| (FREQ18 = 1/3 \* 10E-6 ticks per sec)

always ------------------------------| INJ\_PIP\_CNT = FUEL\_PIPS

| (FUEL\_PIPS = [PIPOUT \* OUTINJ]

| /NUMOUT)

| FUEL\_SUM\_TKS = FUEL\_SUM\_TKS + FUELPW

CRKFLG = 1 --------------------------| INJ\_PIP\_CNT = CRKPIP

(crank mode) | (fire every CRKPIP PIPs in

| crank mode)

UNDSP = 0 ---------------------|

(run mode) |AND -| Decrement INJ\_PIP\_CNT

| | (walk injector bank B

NO\_SYNC = 1 -------------------| | back 1 PIP at a time)

(fuel not synched)

6-98

FUEL STRATEGY, FUEL SERVICE ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

INJ\_PIP\_CNT <= 0 --------------------| INJ\_PIP\_CNT = 1

| FUEL\_FINISHED = 0

|

| --- ELSE ---

|

| FUEL\_FINISHED = 0

OUTINJ = 2 --------------------------| INJ\_BANK = 0

(simultaneous injections) | (always start with bank A)

always ------------------------------| NEW\_DELAY = 1

| (request new IBETA)

6-99

FUEL STRATEGY, FUEL SERVICE ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FUEL\_REPEAT

This section sets up the fuel output edge, if required.

TLS\_NV\_FLG = 0 ----------------|

|

TLS\_24\_FLG = 0 ----------------|AND -| TLSCTR = 1

| | Do: "SET UP INJECTOR OUTPUT EDGE"

TLS\_34\_FLG = 0 ----------------| |

| --- ELSE ---

|

| Decrement TLSCTR

| (check next bit in pattern)

TLSCTR = 0 --------------------------| TLSCTR = 16

(pattern completed) | TLS\_SHFTR = TLSPAT

Always ------------------------------| Shift TLS\_SHFTR 1 bit to the left

carry bit = 1 -----------------------| Do: "SET UP INJECTOR OUTPUT EDGE"

(OK to output fuel this PIP) |

| --- ELSE ---

|

| SKIP "SET UP INJECTOR OUTPUT EDGE"

| but continue through FUEL\_REPEAT

SET UP INJECTOR OUTPUT EDGE

UNDSP = 1 ---------------------------| injector edge = (Time of last PIP

| rising edge)

| Set immediate output request

|

| --- ELSE ---

|

| injector edge = (Time of last PIP

| rising edge) +

| (DT12S \* IBETA)

FUELPW <> 0 -------------------|

|AND -| INJ1\_PIP = 0

INJ\_BANK = 0 ------------------| | (injection A occurred)

|

| --- ELSE ---

|

| INJ2\_PIP = 0

| (injection B occurred)

NUMOUT = 2 --------------------------| Toggle INJ\_BANK

(2 banks) | (do next bank)

6-100

FUEL STRATEGY, FUEL SERVICE ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

NUMOUT = 2 --------------------|

(2 outputs) |

|

FUEL\_FINISHED = 0 -------------|AND -| FUEL\_FINISHED = 1

| | NO\_SYNC = 0

CRKFLG = 1 --------------| | | Do: "FUEL\_REPEAT"

| | |

OUTINJ = 2 --------------|OR --| |

| |

PIPOUT = 2 --------| | |

|AND -| |

NO\_SYNC = 1 -------| |

| --- ELSE ---

|

| NO\_SYNC = 0

| EXIT "FUEL SERVICE" routine

6-101

FUEL STRATEGY, INJECTOR TIMING ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

INJECTOR TIMING ROUTINE

(Done during PIP\_DATA foreground routine)

OVERVIEW

CRANK or UNDERSPEED mode (UNDSP = 1) OR MHPFD = 0.99

The injector synchronization routine is disabled and SYNFLG is cleared.

RUN mode (UNDSP = 0) AND MHPFD < 0.99

The injector synchronization routine is enabled. The objective of the

routine is to identify the cylinder #1 PIP and to alter the injector timing

schedule so that Injector Output Port "A", which fires Injector #1, is

synchronized with the cylinder #1 PIP.

NOTE: THE USER MUST SET UP THE TWO INJECTOR OUTPUT PORTS SUCH THAT THE

CYLINDER #1 INJECTOR IS FIRED BY INJECTOR OUTPUT PORT "A".

A Signature PIP distributor must be used in order to achieve the

identification of the cylinder #1 PIP. Refer to the Spark Section for a

description of the Signature PIP Distributor.

When a new PIP down-edge-interrupt is received, HFDLTA (the elapsed time

since the last up-edge-interrupt was seen) is calculated.

Next, the fractional difference between HFDLTA and the previous up-edge to

down-edge elapsed time, PHFDLT, is calculated and compared to a critical

value, MHPFD, as shown below:

(PHFDLT - HFDLTA) / PHFDLT > MHPFD ?

MHPFD is a calibration constant which is dependent only upon number of

cylinders and the value of the Signature PIP duty cycle. The user must

calibrate MHPFD to the appropriate value as shown below:

- If 8-cyl & Signature PIP duty cycle <= 35%, then set MHPFD = .20

- If 6-cyl & Signature PIP duty cycle <= 30%, then set MHPFD = .24

- If 4-cyl & Signature PIP duty cycle <= 30%, then set MHPFD = .29

NOTE: IF A SIGNATURE PIP DISTRIBUTOR IS NOT PRESENT, THEN SET MHPFD = .99

When the above comparison is true, then the current PIP is the Signature PIP.

If Injector Output Port "A", which fires Injector #1, is timed from the

up-edge of the Signature PIP, then the system is synchronized.

6-102

FUEL STRATEGY, INJECTOR TIMING ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

If the system is determined to be unsynchronized, then Injector Output Port

"B" is fired one PIP earlier than normal. This causes the injector firing

schedule to be shifted one PIP per revolution until synchronization is

achieved.

A decrementing counter, SYNCTR, that starts at the number of cylinders and

counts down to 0, 1 count per PIP, is used to predict when the Signature PIP

should be seen again after it is first identified.

Each time that SYNCTR = 0 and the above comparison is true, a synchronization

flag, SYNFLG, is set to 1 and SYNCTR is reset to the number of cylinders.

If the above comparison is ever false when SYNCTR = 0, then SYNFLG is set to

0, and the entire synchronization routine of first finding the Signature PIP

and then "Stepping" the injection firing schedule to it is repeated.

6-103

FUEL STRATEGY, INJECTOR TIMING ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- ENGCYL = Number of PIPs (or injections) per revolution.

- HFDLTA = Most recent PIP first half period.

- MHPFD = Signature PIP difference check value.

- MKAY = Half period multiplier to correct for average error caused by Hall

effect sensor in distributor and armature.

- PHFDLT = Previous PIP first 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.

- SYNCTR = Counter which counts PIP signals until its value is equal to

NUMCYL (number of cylinders). SYNCTR is initialized to 0.

Bit Flags:

- SIGPIP = A flag that indicates that signature PIP half period has been

identified; 1 -> signature PIP, 0 -> not signature PIP.

- UNDSP = Flag indicating engine mode; 1 -> Cranking or Underspeed, 0 ->

Run mode.

OUTPUTS

Registers:

- HFDLTA = See above.

- SYNCTR = See above.

Bit Flags:

- SIGPIP = See above.

- SYNFLG = Signature PIP correctly identified flag; 1 -> Signature PIP in

correct place, 0 -> not Signature PIP or in wrong place.

6-104

FUEL STRATEGY, INJECTOR TIMING ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: FUEL\_INJ\_TIM\_COM2

(PHFDLT - HFDLTA) / PHFDLT > MHPFD -| SIGPIP = 1

| (this is signature PIP)

|

| --- ELSE ---

|

| SIGPIP = 0

| (not signature PIP)

SYNCTR <> 0 ------------------------| EXIT

(not cylinder #1) |

| --- ELSE ---

|

UNDSP = 1 --------------------------| SYNCTR = 2 \* ENGCYL

(not RUN mode) | EXIT

| (do not attempt to

| synchronize fuel in

| CRANK or UNDERSPEED)

|

| --- ELSE ---

SIGPIP = 1 -------------------| |

(signature PIP) |AND -| SYNFLG = 1

| | (in synch OK to

SYNCTR = 0 -------------------| | synchronize fuel)

(cylinder #1) | HFDLTA = (HFDLTA \*

| SIGKAL) / MKAY

| (correct signature PIP to

| 50% duty cycle)

| SYNCTR = 2 \* ENGCYL

| EXIT

|

| --- ELSE ---

|

| SYNFLG = 0

| (not in synch)

| SYNCTR = (2 \* ENGCYL) - 1

| EXIT

6-105

FUEL STRATEGY, INJECTOR TIMING ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

6-106

CHAPTER 7

IGNITION TIMING STRATEGY

7-1

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BASE SPARK ANGLE CALCULATION

(background calculation)

OVERVIEW

The spark advance provided by the Ignition Timing Strategy depends on the

engine operating mode. The three modes are:

1. SELF TEST - See SELF TEST Section

2. CRANK/UNDERSPEED MODE

The Spark Advance, SAF, is set at 10 deg BTDC. The spark is fired when

the PIP rising edge signal is received.

3. RUN MODE (includes all throttle modes)

During RUN MODE, the spark strategy can operate in any one of the

following four distinct states:

- state 0 = Normal spark state. Spark advance is calculated from the

spark tables and modifying functions. Normal spark is used as the

starting point for the transition ramp into idle spark, and as the

ending point for the transition out of idle spark.

- state 1 = Entry spark state. The purpose of this state is to provide

a smooth transition into feedback spark state. Spark is ramped from

its last value in normal spark state to the mean operating point for

feedback spark state. At the same time, the proportional component

is increased to its maximum contribution.

- state 2 = Feedback spark state. In this state, there is a mean value

for idle spark. A proportional gain term increases spark above the

mean value if RPM is too low, and decreases spark below the mean

value if RPM is too high. The error term, RPMERR\_S, is filtered

using time constant TCFBS.

- state 3 = Exit spark state. The purpose of this state is to provide

a smooth transition from feedback spark state to normal spark state.

Spark is filtered toward the value of normal spark at a rate which is

proportional to TAR using filter constant FKEXIT. At high throttle

rates, spark moves immediately to the normal value.

7-2

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

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Depending on the value of SPK\_STATE, the base spark advance in RUN MODE

equals:

SAF = SPK\_NORM (SPK\_STATE = 0)

or

SPK\_ENTRY (SPK\_STATE = 1)

or

SPK\_FBS (SPK\_STATE = 2)

or

SPK\_EXIT (SPK\_STATE = 3)

7-3

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SPARK STATE TRANSITION DIAGRAM

(For transitions between normal and feedback spark)

DEFAULT

--------- \_\_ POWER UP

| | /

2 | V V

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

| normal spark | ENTRY CONDITIONS

EXIT COMPLETE | | TRUE

--------->| SPK\_STATE = 0 |----------

| | SAF = SPK\_RUNUP | 1 |

| | or SPK\_NORM | |

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

| |

| 2 ENTRY CONDITIONS V

D 3 ----------------- TRUE ----------------- D

E ---| exit spark |-------------------->| entry spark |<--- E

F | | | 1 | | | F

A | | SPK\_STATE = 3 | | SPK\_STATE = 1 | | A

U | | SAF = SPK\_EXIT | 1 | SAF = SPK\_ENTRY | | U

L -->| |<--------------------| |---- L

T ----------------- EXIT CONDITIONS ----------------- 3 T

TRUE 2 |

| |

| |

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

| | feedback spark | |

| 1 | | |

----------| SPK\_STATE = 2 |<---------

EXIT CONDITIONS | SAF = SPK\_FBS | ENTRY COMPLETE

TRUE | |

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

2 |

| |

---------

DEFAULT

NOTES:

- Boxes represent the 4 states in which the RUN MODE spark can exist.

- The contents of the boxes show the actions which take place during that

state.

- Arrows represent transitions from one state to another (from one box to

another).

- Numbers on the arrows indicate priority of that transition, compared to

the priorities of other transitions out of the same state (out of the

same box).

- Labels on the arrows represent logic which determines whether of not that

particular transition is to take place.

7-4

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- ACT = Air Charge Temperature, deg F.

- APT = Throttle Mode; -1 -> Closed Throttle, 0 -> Part Throttle, 1 -> Wide

Open Throttle.

- ATMR1 = Time since leaving CRANK Mode, sec. See TIMER chapter.

- BRDRLN\_SPK = Maximum SAF clip in spark states 1 and 2. Calculated using

MBT and OCTANE subtractor terms in SPK\_NORM equation, deg BTDC.

- DASPOT = Dashpot contribution to idle air flow, ppm. See Idle Speed

Control chapter for calculation. Used here as input to Dashpot Spark

multiplier, FN839.

- DNDT\_SPK = Filtered rate of change of engine RPM for OSCMOD, RPM/sec.

Filtered using time constant TCNDT\_SPK.

- DSDRPM = Desired engine idle speed, RPM.

- ECT = Engine Coolant Temperature, deg F.

- EGRACT = Actual EGR Percentage, \_%.

- FKEXIT = TAR/TARMAX, unitless. Filter constant for spark ramping

function in SPK\_STATE 3. FKEXIT is clipped between FKEXIT\_MAX as a

maximum, and FKEXIT\_MIN as a minimum.

- IDLTMR = Time since entering Idle mode, sec. See TIMER Chapter.

- ISCFLG = ISC mode indicator; -1 -> Dashpot Mode; 0 -> Dashpot Preposition

Mode; 1 -> Closed Loop RPM Control Mode; 2 -> Closed Loop RPM Control

(Lock-out entry to RPM control).

- KSPARK = Gain term for feedback spark, (deg/RPM). There are 4 values:

KSPKDO, KSPKDU, KSPKNO and KSPKNU for drive/speed high, drive/speed low,

neutral/speed high, and neutral/speed low, respectively.

- MAP = Manifold Absolute Pressure, "Hg.

- N = Engine Speed, RPM.

- N\_BYTE = Engine Speed, rpm; resolution is 16 RPM.

- OSCMOD = Oscillation mode spark multiplier, unitless.

- OSCTMR = OSCMOD spark delay timer, sec. See TIMERS chapter.

- RPMERR = DSDRPM - N. Idle speed error term, RPM.

- RPMERR\_S = RPM error term for feedback spark. Time dependent rolling

average filter of the instantaneous RPM error, RPMERR, using time

constant TCFBS.

7-5

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SAF = Final Spark Advance, deg BTDC. Method of calculation depends on

SPK\_STATE.

- SPKAD(n) = Spark advance adjustment term for knock for cylinder "n". See

KNOCK Strategy.

- SPK\_ENTRY = Spark advance used when in SPK\_STATE "1" to ramp from normal

spark to feedback spark, deg BTDC.

- SPK\_EXIT = Spark advance used when in SPK\_STATE "3" to ramp from feedback

spark to normal spark, deg BTDC.

- SPK\_FBS = Spark advance used in SPK\_STATE "2" to do feedback spark

control, deg BTDC.

- SPK\_IDLE = Mean operating point for spark in feedback spark state, deg

BTDC. Equals SPKIDR in drive, or SPKINU - FN180 in neutral.

- SPK\_NORM = Normal Mode Spark value, deg BTDC.

- SPK\_RAMP = Time dependent rolling average filter of spark advance, deg

BTDC. Uses SPK\_IDLE as the "new" value and time constant TCRAMP. Used

in calculating SPK\_ENTRY in SPK\_STATE "1" to ramp spark from the last

value in the previous state to the spark for feedback spark mode.

- SPK\_STATE = Spark State indicator; 0 -> Normal spark, 1 -> entry spark, 2

-> feedback spark, 3 -> exit spark.

- SPKTMR = Spark feedback entry transition timer, sec. Used to pace the

transition into feedback spark control. Set to 0 on entry into SPK\_STATE

"1". Otherwise, counts up.

- TAPBAR = A time and MAP dependent rolling average of TP, counts.

- TAR = Throttle angle rate of change, deg/sec.

- TCSTRT = ECT at start-up, deg F.

- TIPRET = Tip-in Spark retard term, deg BTDC. See KNOCK section.

- TP = Throttle Position, counts.

- TP\_REL = Relative Throttle Position, counts. TP - RATCH.

- TPDLBR = Filtered change of throttle position, counts. Time constant is

TCTPDL.

- TRANS\_T = SPKTMR/STTIM, unitless. Transition pacer used to ramp in the

effect of feedback spark during SPK\_STATE "1". Set to 0 on transition

into state 1, and clipped to 1.0 maximum. Feedback spark cannot be

entered until TRANS\_T reaches ENTRY\_T.

- VSBAR = Filtered vehicle speed, MPH.

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

7-6

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- CSSFLG = Cold start spark flag: 0 -> no cold start spark required; 1 ->

cold start spark required.

- DNDSUP = Delayed Neutral/Drive state flag. Set equal to NDSFLG when

delay is complete; 1 -> drive, 0 -> neutral. See SYSTEM EQUATIONS

chapter.

- MPGFLG = Flag that indicates state of Fuel Economy mode: 1 -> in Fuel

Economy mode; 0 -> Not in Fuel Economy mode.

- NEWSA = Flag which indicates that a new spark advance calculation is

required; 1 = new PIP received since last spark calculation.

- PTSCR = Part throttle since crank mode flag: 0 -> driver has not tipped

in since start; 1 -> driver tipped in, kick down desired RPM.

- RUNUP\_FLG = Flag indicating if initial runup is complete; 0 -> runup not

complete, 1 -> runup complete.

- SA10FG = Flag indicating if spark advance should echo PIP in RUN mode; 0

-> do RUN mode spark advance logic, 1 -> Set SAF to 10 deg. BTDC and

fire spark on rising edge of PIP.

- UNDSP = Flag indicating Engine mode; 0 -> RUN mode, 1 -> UNDERSPEED or

CRANK mode.

- V\_MODE\_SETUP = VIP throttle adjust mode enabled flag; 1 -> enabled.

Calibration Constants:

- CSHIGH = Maximum TCSTRT for cold start spark, deg F.

- CSLOW = Minimum TCSTRT for cold start spark, deg F.

- CSSPRK = Cold start spark multiplier, unitless.

- CSSTIM = Maximum time to use cold start spark, sec.

- DELTA\_SPK = Deadband to determine when spark transitions are complete,

deg BTDC.

- DFTRPM = Maximum engine rpm to issue spark on the rising edge of PIP when

at WOT, RPM.

- DFTRPH = Hystersis term for DFTRPM, RPM.

- DRBASE = Base desired engine idle speed in drive, RPM.

- DRBASE\_ALT = Alternative Cal DRBASE.

- ENGCYL = Number of PIP up edges per revolution; (number of cylinders/2).

- ENTRY\_T = Time threshold for entry into feedback spark, sec.

- FBS\_MIN = Minimum clip on SAF in states 1 and 2, deg BTDC.

- FBS\_MIN\_ALT = Alternative Cal FBS\_MIN.

7-7

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FKEXIT\_MAX = Maximum clip for FKEXIT, SPK\_EXIT filter constant, unitless.

- FKEXIT\_MIN = Minimum clip for FKEXIT, SPK\_EXIT filter constant, unitless.

- FN070(N) = RPM normalizing function for FN1120, FN1121, FN1122, FN1126,

FN1127 and FN1129.

- FN071(MAP) = MAP normalizing function for FN1120, FN1121, FN1122, FN1126,

FN1127 and FN1129.

- FN091(TEMP\_FRAC) = TEMP\_FRAC normalizing function for FN1128, where

TEMP\_FRAC = FRCCTM \* ACT + (1 - FRCCTM) \* ECT.

- FN092(TP - TAPBAR) = TP - TAPBAR normalizing function for FN1128.

- FN151(ECT) = Octane Table (FN1122) multiplier vs. ECT.

- FN152(ACT) = Octane Table (FN1122) multiplier vs. ACT.

- FN153(N) = WOT Spark Adder for Fuel Enrichment (APT = 1) vs engine speed.

- FN180(IDLTMR) = Spark reduction vs. time at idle (IDLTMR). Used as part

of the inspection/maintenance strategy.

- FN182(DNDT\_SPK) = Oscillation mode spark adder vs rate of change of

engine speed.

- FN183(VSBAR) = Multiplier on oscillation mode spark adder (FN182) vs

VSBAR.

- FN839(DASPOT) = Decel spark multiplier as a function of dashpot air flow.

- FN1120(N,MAP) = Base MBT Spark Table, deg BTDC.

- FN1121(N,MAP) = Spark Advance Adder Table for EGR, deg BTDC per 1% EGR.

- FN1122(N,MAP) = Spark Advance Reduction Table for Octane, deg BTDC.

- FN1126(N,MAP) = Base spark table for MPG mode, deg BTDC.

- FN1127(N,MAP) = Spark Advance Adder Table for Cold Temperatures and

tip-ins.

- FN1128 = Multiplier for FN1127 vs TEMP\_FRAC and TP - TAPBAR

- FN1129(N,MAP) = Spark Advance Adder Table for EGR in MPG mode, deg BTDC

per 1\_% EGR.

- FN1150 = Spark octane multiplier of FN1122(N,MAP); inputs are FN051(ECT)

and FN052(ACT).

- FN1150\_ALT = Alternate FN1150.

- FRCCTM = ACT/ECT proportioning factor for temperature input to FN1128.

- KS1 = Spark Adder, deg BTDC.

7-8

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- KSPKDO = Feedback spark gain - Drive/speed high, deg BTDC/RPM.

- KSPKDU = Feedback spark gain - Drive/speed low, deg BTDC/RPM.

- KSPKNO = Feedback spark gain - Neutral/speed high, deg BTDC/RPM.

- KSPKNU = Feedback spark gain - Neutral/speed low, deg BTDC/RPM.

- MINMPH = Minimum speed to enter Closed Loop RPM control and do feedback

spark control, MPH. ..Typical value - 3 MPH.

- NUBASE = Base desired engine idle speed in neutral, RPM.

- NUBASE\_ALT = Alternative Cal NUBASE.

- OSCDLY = OSCMOD disable time after large negative change in TP, secs.

- SPKCTL = Maximum difference between DSDRPM and DRBASE/NUBASE to enable

spark feedback, RPM.

- SPKCTL\_ALT = Alternative Cal SPKCTL.

- SPKIDR = Nominal feedback spark operating point in drive, deg BTDC.

- SPKIDR\_ALT = Alternative Cal SPKIDR.

- SPKINU = Nominal feedback spark operating point in neutral, deg BTDC.

- SPKINU\_ALT = Alternative Cal SPKINU.

- SPK\_RUNUP = Value used for SAF after entering RUN mode and before initial

runup is complete, deg BTDC.

- SPLCLP = Lower spark clip for total spark advance (SAFTOT, including

knock and TIPRET terms), deg BTDC.

- SPKLIM = Percent of "crank degrees between PIPs" used to determine the

maximum spark advance increase allowed between consecutive spark events.

Do NOT calibrate higher than 0.06 without Ignition Department approval.

Maximum spark advance increase between events varies with the number of

cylinders; Maximum increase = SPKLIM \* 360/ENGCYL.

For 4 cyl; 0.06 \* 360/2 = 10.8 degrees

6 cyl; 0.06 \* 360/3 = 7.2 degrees

8 cyl; 0.06 \* 360/4 = 5.4 degrees

- SPUCLP = Upper spark clip for total spark advance (SAFTOT, including

knock and TIPRET terms), deg BTDC.

- STTIM = Time after transition into SPK\_STATE "1" when TRANS\_T will equal

1.0, sec. Controls rate at which feedback spark is included in

SPK\_ENTRY.

- TARMAX = Maximum TAR to ramp into normal spark. deg/sec. Higher TARs

will cause SAF to jump to SPK\_NORM.

7-9

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TCFBS = Time constant for RPMERR\_S rolling average filter, sec.

- TCRAMP = Time constant for SPK\_RAMP rolling average filter, sec.

- TPDLMX = Maximum filtered TP change for oscillation mode spark, counts.

- TPOBP2 = Maximum TP\_REL for oscillation mode spark, counts.

- TPOH2 = Hysteresis for TPOBP2, counts.

- Y = Calibration development spark multiplier, unitless.

- VSOMAX = Maximum VSBAR for oscillation mode spark, MPH.

- VSOMXH = Hysteresis for VSOMAX, MPH.

7-10

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- BRDRLN\_SPK = See above.

- FKEXIT = See above.

- KSPARK = See above.

- OSCMOD = See above.

- SAF = See above.

- SAFTOT = Total spark advance, including knock and tip-in retard, deg

BTDC. SAFTOT = SAF + SPKAD(n) + TIPRET

- SPK\_ENTRY = See above.

- SPK\_EXIT = See above.

- SPK\_FBS = See above.

- SPK\_IDLE = See above.

- SPK\_NORM = See above.

- SPK\_RAMP = See above.

- SPK\_STATE = See above.

- SPKTMR = See above.

- TRANS\_T = See above.

Bit Flags:

- CSSFLG = See above.

- NEWSA = See above.

- SA10FG = See above.

7-11

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SPARK\_BASE\_COM2

NORMAL SPARK CALCULATION (SPK\_NORM)

(All spark states)

SPK\_NORM refers to the value of spark advance determined from the spark

tables and appropriate modifying functions as shown below. SPK\_NORM is the

value used for SAF when SPK\_STATE = 0. However, SPK\_NORM is always

calculated, even if SPK\_STATE is not 0, to provide the correct value to the

SPK\_EXIT calculation when leaving feedback spark.

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

|AND -|S Q--| SA10FG = 1

N\_BYTE < DFTRPM -----------------| | |

| | --- ELSE ---

APT < 1 -------------------------| | |

|OR --|C | SA10FG = 0

N\_BYTE > DFTRPM + DFTRPH --------|

UNDSP = 1 -----------------------------|

|OR --| SAF = 10 deg BTDC

SA10FG = 1 ----------------------------| | EXIT Base Spark Angle Logic

|

| --- ELSE ---

|

NEWSA = 0 -----------------------------------| Do NOT update SAF

(previous value not used yet) | EXIT Base Spark Angle Logic

|

| --- ELSE ---

|

NEWSA = 1 -----------------------------------| Continue with Base Spark

| Angle Logic

| Calculate new SAF based on

| SPK\_STATE

7-12

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ALT\_CAL\_FLG = 1 -----------------------------| fn1150 = FN1150\_ALT(ECT,ACT)

|

| --- ELSE ---

|

| fn1150 = FN1150(ECT,ACT)

SPK\_NORM = {(FN1120 or FN1126 MBT SPARK

+ FN1127 \* FN1128 COLD TEMP and TIP IN ADDER

+ (FN1121 or FN1129) \* EGRACT EGR ADDER

- FN1122 \* fn1150(ECT,ACT) OCTANE SUBTR.

[+ FN153] WOT ADDER

[+ OSCMOD]) OSCILLATION SPARK ADDER

[\* FN839] DASHPOT MULT.

[\* CSSPRK] COLD START MULT.

\* Y} DEVELOPMENT MULT.

+ KS1 DEVELOPMENT ADDER.

MPGFLG = 0 ----------------------------| Use FN1120(N,MAP) and FN1121(N,MAP)

(not MPG mode) |

| --- ELSE ---

|

| Use FN1126(N,MAP) and FN1129(N,MAP)

NOTE: Terms enclosed by "[ ]" are optional. See following logics to

determine their usage.

WIDE OPEN THROTTLE SPARK ADDER

APT = 1 -----------------------------| Include FN153(N) in SPK\_NORM

(WOT mode) |

| --- ELSE ---

|

| Do NOT include FN153

7-13

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

LIGHT LOAD RPM OSCILLATION ADDER

Spark advance can be modulated by to reduce engine RPM oscillations under

light load conditions as follows:

TP\_REL <= TPOBP2 --------------|S Q--|

(Near closed throttle) | |

| |

TP\_REL > TPOBP2 + TPOH2 -------|C |

|

VSBAR <= VSOMAX ---------------|S Q--|AND -| Include OSCMOD =

(Not at high speed) | | | FN182(DNDT\_SPK) \* FN183(VSBAR)

| | | in SPK\_NORM

VSBAR > VSOMAX + VSOMXH -------|C | |

| | --- ELSE ---

TPDLBR <= TPDLMX --------------------| |

(Not a quick tip in) | | Do NOT include OSCMOD in

| | SPK\_NORM

OSCTMR >= OSCDLY --------------------|

(Gear change delay) |

|

ISCFLG <= 0 -------------------------|

(Dashpot or preposition)

DASHPOT SPARK MULTIPLIER

ISCFLG = -1 ---------------------------| Include FN839(DASPOT) in SPK\_NORM

(Dashpot mode) |

| --- ELSE ---

|

| Do NOT include FN839

COLD START SPARK FLAG AND MULTIPLIER

CSLOW < TCSTRT < CSHIGH ---------|

(Warm start) |

|

ATMR1 < CSSTIM ------------------|AND -| CSSFLG = 1

(Cold start spark time) | | (Set cold start spark flag)

| | Include CSSPRK in SPK\_NORM

PTSCR = 0 -----------------------| |

| --- ELSE ---

|

| CSSFLG = 0

| Do NOT include CSSPRK in SPK\_NORM

7-14

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MISCELLANEOUS SPARK CALCULATIONS

TRANS\_T CALCULATION

Always ----------------------------------| TRANS\_T = SPKTMR / STTIM

| Clip TRANS\_T to 1.0 as a maximum

SPK\_IDLE SELECT LOGIC

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

|AND -| SPK\_IDLE = SPKIDR\_ALT

ALT\_CAL\_FLG = 1 ----------------| |

| --- ELSE ---

|

DNDSUP = 1 ---------------------------| SPK\_IDLE = SPKIDR

|

| --- ELSE ---

|

V\_MODE\_SETUP = 1 ---------------------| SPK\_IDLE = SPKINU

(VIP Throttle Adjust mode) |

| --- ELSE ---

|

ALT\_CAL\_FLG = 1 ----------------------| SPK\_IDLE = SPKINU\_ALT -

| FN180(IDLTMR)

|

| --- ELSE ---

|

| SPK\_IDLE = SPKINU -

| FN180(IDLTMR)

7-15

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

KSPARK SELECT LOGIC

V\_MODE\_SETUP = 1 ------------------------| KSPARK = 0

(VIP Throttle Adjust Mode)0 |

| --- ELSE ---

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

|AND -| KSPARK = KSPKDO

RPMERR\_S < 0 ----------------------| | (Drive, speed high)

|

| --- ELSE ---

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

|AND -| KSPARK = KSPKDU

RPMERR\_S >= 0 ---------------------| | (Drive, speed low)

|

| --- ELSE ---

DNDSUP = 0 ------------------------| |

|AND -| KSPARK = KSPKNO

RPMERR\_S < 0 ----------------------| | (Neutral, speed high)

|

| --- ELSE ---

DNDSUP = 0 ------------------------| |

|AND -| KSPARK = KSPKNU

RPMERR\_S >= 0 ---------------------| | (Neutral, speed low)

7-16

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENTRY LOGIC -- ENTRY INTO IDLE SPARK

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

(RPM control or lockout) |

|

ALT\_CAL\_FLG = 1 --------------| |

| |

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

| | |

DSDRPM - DRBASE\_ALT | | |

<= SPKCTL\_ALT ------------| | |

| |

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

|AND -| |

DSDRPM - DRBASE <= SPKCTL ----| | |

(Near Idle RPM) |OR --|AND -| ENTRY CONDITIONS TRUE

| | |

DNDSUP = 0 -------------------| | | | --- ELSE ---

|AND -| | |

DSDRPM - NUBASE <= SPKCTL ----| | | | ENTRY CONDITIONS NOT TRUE

| |

| |

ALT\_CAL\_FLG =1 ---------------| | |

| | |

DNDSUP = 0 -------------------|AND -| |

| |

DSDRPM - NUBASE\_ALT | |

<= SPKCTL\_ALT ------------| |

|

CSSFLG = 0 -------------------------------|

(Cold Start spark not in use)

EXIT LOGIC -- EXIT FROM IDLE SPARK

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

(Tip in) |OR --| EXIT CONDITIONS TRUE

| |

VSBAR > MINMPH -----------------------| | --- ELSE ---

(Vehicle moving) |

| EXIT CONDITIONS NOT TRUE

ENTRY COMPLETE LOGIC -- CONTINUE WITH FEEDBACK SPARK

|SPK\_RAMP - SPK\_IDLE| <= DELTA\_SPK ---|

(Spark ramp to idle done) |AND -| ENTRY COMPLETE

| |

TRANS\_T >= ENTRY\_T -------------------| | --- ELSE ---

(Transition time complete) |

| ENTRY NOT COMPLETE

7-17

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EXIT COMPLETE LOGIC -- CONTINUE WITH NORMAL SPARK

|SPK\_NORM - SAF| <= DELTA\_SPK --------------| EXIT COMPLETE

(Spark has filtered to normal value) |

| --- ELSE ---

|

| EXIT NOT COMPLETE

7-18

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SPARK STATE DETERMINATION LOGIC

SPK\_STATE = 0 ------------------------| | (Do fixed runup spark)

(Current state is 0) |AND -| SPK\_STATE = 0

| | SAF = SPK\_RUNUP

RUNUP\_FLG = 0 ------------------------| | NEWSA = 0

(Initial runup not complete) |

| --- ELSE ---

SPK\_STATE = 0 ------------------| |

(Current state is 0) |OR --| |

| | | (Transition to entry spark)

SPK\_STATE = 3 ------------------| |AND -| SPK\_STATE = 1

(Current state is 3) | | SPKTMR = 0

| | TRANS\_T = 0

ENTRY CONDITIONS TRUE ----------------| | SPK\_RAMP = SAF

(See entry logic) | Do SPK\_ENTRY calculations

| SAF = SPK\_ENTRY

| NEWSA = 0

|

| --- ELSE ---

SPK\_STATE = 0 ------------------------| |

(Current state = 0) | | (Do normal spark)

|OR --| SPK\_STATE = 0

SPK\_STATE = 3 ------------------| | | SAF = SPK\_NORM

(Current state = 3) |AND -| | NEWSA = 0

| |

EXIT COMPLETE ------------------| |

(See exit complete logic) |

| --- ELSE ---

SPK\_STATE = 1 ------------| |

(Current state is 1) |OR --| |

| | |

SPK\_STATE = 2 ------------| |AND -| |

(Current state is 2) | | |

| | | (Do exit spark)

EXIT CONDITIONS TRUE -----------| |OR --| SPK\_STATE = 3

(See exit logic) | | Do SPK\_EXIT calculations

| | SAF = SPK\_EXIT

SPK\_STATE = 3 ------------------------| | NEWSA = 0

(Current state is 3) |

| --- ELSE ---

(continued on next page)

7-19

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

SPK\_STATE = 1 ------------------| |

(Current state is 1) |AND -| |

| | | (Do feedback spark)

ENTRY COMPLETE -----------------| |OR --| SPK\_STATE = 2

(See entry complete logic) | | Do PK\_FBS calculations

| | SAF = SPK\_FBS

SPK\_STATE = 2 ------------------------| | NEWSA = 0

(Current state is 2) |

| --- ELSE ---

|

| (Continue entry spark)

SPK\_STATE = 1 ------------------------------| SPK\_STATE = 1

(Current state is 1) | Do SPK\_ENTRY calculations

| SAF = SPK\_ENTRY

| NEWSA = 0

7-20

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENTRY SPARK CALCULATION (SPK\_ENTRY)

(state 1)

The entry spark calculation is performed in entry spark state (SPK\_STATE =

1). The purpose of entry spark state is to perform a smooth transition into

feedback spark. This is accomplished by ramping spark from the last value in

the previous state to the mean value in feedback spark state. This 'ramp' is

referred to as SPK\_RAMP. Superimposed on SPK\_RAMP is the feedback spark

term, KSPARK \* RPMERR\_S. This term is phased in by a multiplier, TRANS\_T,

which starts at 0 when the entry state is first entered, and increases to 1.0

at a calibratable rate (the parameter, STTIM defines when TRANS\_T reaches

1.0). Therefore, at the same time SPK\_RAMP is approaching SPK\_IDLE, the

feedback component increases from 0 to its maximum contribution (TRANS\_T =

1.0). SPK\_ENTRY is clipped between FBS\_MIN as a minimum and BRDRLN\_SPK as a

maximum. The minimum clip is done last, so that if BRDRLN\_SPK is less than

FBS\_MIN, SPK\_ENTRY will equal FBS\_MIN.

SPK\_ENTRY = SPK\_RAMP + TRANS\_T \* KSPARK \* RPMERR\_S

clips: maximum clip (done first): SPK\_ENTRY <= BRDRLN\_SPK

minimum clip (done last): SPK\_ENTRY >= FBS\_MIN

(or FBS\_MIN\_ALT if ALT\_CAL\_FLG = 1)

where,

- BRDRLN\_SPK = FN1120(N,MAP) - FN1122(N,MAP) \* FN1150(ECT,ACT)

- KSPARK = KSPKDO, KSPKDU, KSPKNO or KSPKNU

- RPMERR\_S = ROLAV(RPMERR, TCFBS)

- SPK\_IDLE = SPKIDR or (SPKINU - FN180)

- SPK\_RAMP = ROLAV(SPK\_IDLE, TCRAMP)

- SPK\_RAMP is initialized to the previous value of SAF on the

transition into state 1.

- The ramp is considered complete when SPK\_RAMP is within DELTA\_SPK of

SPK\_IDLE, and SPK\_RAMP is set equal to SPK\_IDLE.

- |SPK\_RAMP - SPK\_IDLE| <= DELTA\_SPK ---------| SPK\_RAMP = SPK\_IDLE

- TRANS\_T = SPKTMR/STTIM

SPKTMR and TRANS\_T are set to zero on the transition into state 1.

Otherwise, SPKTMR always counts up, and TRANS\_T is clipped to 1.0

maximum.

7-21

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FEEDBACK SPARK CALCULATION (SPK\_FBS)

(state 2)

The feedback spark calculation is performed in feedback spark state

(SPK\_STATE = 2). Spark is increased or decreased about a mean value based on

a filtered RPM error term (RPMERR\_S). Note the equation for SPK\_FBS is

identical to SPK\_ENTRY with TRANS\_T = 1.0, and SPK\_RAMP = SPK\_IDLE. The

feedback spark gain has four values: KSPKDO, KSPKDU, KSPKNO and KSPKNU for

drive/neutral and overspeed/underspeed, based on DNDSUP and RPMERR\_S.

SPK\_FBS is clipped between FBS\_MIN as a minimum and BRDRLN\_SPK as a maximum.

The minimum clip is done last, so that if BRDRLN\_SPK is less than FBS\_MIN,

SPK\_FBS will equal FBS\_MIN. SPK\_IDLE has values for both neutral and drive.

SPK\_FBS = SPK\_IDLE + KSPARK \* RPMERR\_S

clips: maximum clip (done first): SPK\_ENTRY <= BRDRLN\_SPK

minimum clip (done last): SPK\_ENTRY >= FBS\_MIN

(or FBS\_MIN\_ALT if ALT\_CAL\_FLG = 1)

where,

- BRDRLN\_SPK = FN1120(N,MAP) - FN1122(N,MAP) \* FN1150(ECT,ACT)

- KSPARK = KSPKDO, KSPKDU, KSPKNO or KSPKNU

- RPMERR\_S = ROLAV(RPMERR, TCFBS)

- SPK\_IDLE = SPKIDR or (SPKINU - FN180)

NOTE: KSPARK is set to zero when in VIP throttle adjust mode;

V\_MODE\_SETUP = 1

7-22

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EXIT SPARK CALCULATION (SPK\_EXIT)

(state 3)

The exit spark calculation is performed in exit spark state (SPK\_STATE = 3).

The purpose of exit spark is to perform a smooth transition to normal spark

state. This is accomplished by filtering spark from the last value of SAF in

the previous state to the present value of normal spark. Normal spark is

calculated in all spark states so it will be available as an input to the

exit spark equation.

The exit rate is controlled by the filter constant, FKEXIT, which is a

function of TAR. Higher TARs result in faster filter constants. This allows

the exit rate to vary with the type of tip-in which occurs - fast tip-ins

have a filter constant of 1.0, so SPK\_EXIT goes immediately to SPK\_NORM. The

relationship between the filter constant and TAR is calibratable.

SPK\_EXIT = (1 - FKEXIT) \* SAF + FKEXIT \* SPK\_NORM

where,

- FKEXIT = TAR/TARMAX

clips: FKEXIT <= FKEXIT\_MAX

FKEXIT >= FKEXIT\_MIN

- SAF = Spark advance from the previous calculation. On the transition

into state 3, it will be the last value from the previous state.

Otherwise, it will be the previous value of SPK\_EXIT.

7-23

IGNITION TIMING STRATEGY, BASE SPARK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

NOTES:

- The register 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. SAFTOT does include SPKAD(n) and TIPRET. However,

since SAFTOT is updated on PIP interupts, it may NOT display every update

if the background loop time is longer than a PIP period. Refer to the

knock strategy documentation within this chapter for additional

information on SPKAD and TIPRET.

- The final value of spark advance, SAFTOT, is limited to the range:

SPLCLP <= SAFTOT <= SPUCLP

where,

SAFTOT = SAF + SPKAD(n) + TIPRET

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.

- 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.

- 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 0.06 and should not be increased without

the prior approval of the Ignition Department. This clip is performed

just prior to issuing the the spark, and is not reflected in SAF or

SAFTOT. Therefore, the actual delivered spark may not be as advanced as

indicated by SAF or SAFTOT.

new actual spark <= previous actual spark + SPKLIM \* 360/ENGCYL

7-24

IGNITION TIMING STRATEGY, DWLBSE/DWLCOR CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DWLBSE/DWLCOR CALCULATION

OVERVIEW

This strategy is designed to work with both Thick Film Ignition - Improved

Computer Control Dwell (TFI-ICCD)(IGN\_TYPE = 1) and Low Data Rate -

Distributorless Ignition System (LDR-DIS)(LGN\_TYPE = 2) ignition systems.

When in operation, this strategy will provide control of the ignition coil

charge time as well as the correct positioning of the ignition spark with

both events being commanded by the EEC-IV module. Because the requirement

remains that spark timing is paramount, the positioning of the SPOUT up-edge

could not be changed. The difference between the two ignition systems, as it

effects the strategy, is the type of signal available from the ignition

module on the Ignition Diagnostic Monitor (IDM) input to the EEC computer.

For the TFI-ICCD module, the signal provides information indicating when the

coil starts to charge and when it reaches current limit. The LDR-DIS module

IDM signal is a digital signal that indicates coil start to charge and

discharge. The strategy can use the current limit information in the IDM

signal from the TFI-ICCD module to reduce the dwell so the ignition system

operates at near zero excess dwell at low engine speeds. Because the current

limit information is not available from the LDR-DIS module, the strategy will

not be able to reduce the dwell from the base dwell value and will have to

operate with some excess dwell at all times.

The Computer Controlled Dwell strategy is designed to provide a function that

determines when both the dwell edge of SPOUT and the spark edge of SPOUT can

be positioned within the time limits after the PIP down edge and the spark

rotor registry. In those instances when the dwell edge can not be positioned

after the PIP down edge, the dwell strategy provides PIP acceleration and

spark change factors to the dwell calculation. Under steady state

conditions, this will produce some excess dwell, but will protect for cases

of acceleration rates of up to 8000 RPM/second and/or spark changes of up to

6 percent of a PIP period.

During CRANK or UNDERSPEED engine modes, the strategy schedules the dwell

signal at the down edge of PIP due to the highly variable acceleration rates

of the engine and the low data rate of the incoming PIP signal. For LDR-DIS

systems, to protect the ignition module, the SPOUT signal is held high to

prevent the coil from charging, when the engine stalls or during power-up

before the first PIP edge is detected.

7-25

IGNITION TIMING STRATEGY, DWLBSE/DWLCOR CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Falling edge dwell mode: (DWLELD = 1)

Calculations:

|<-- desired spark position

-->| |<-- DWLIDM

-->||<-- excess dwell

-->| |<-- DWELL

max. spark advance permitted -->| |<-- (2 \* SPKLIM \*HFDLTA)

-->| |<-- NEXT\_SPOUT\_ADVANCED

-->| |<-- SPOUT\_ICCD\_DELTA

Schedule SPOUT edge from vertical bar using information computed on down edge of

PIP:

|---------->|-->| |---------->|-->|

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

PIP | | | | |

\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|

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

| | | | |

|\_\_\_| SPOUT |\_\_\_| |\_\_\_|

\_ \_ \_

/ | COIL CURRENT / | / |

\_/ |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_/ |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_/ |\_\_\_

\_ \_\_ \_

| | IDM as seen at CPU | | | |

\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_

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

| | | | | |

|\_| IDM at Corporate Connector |\_\_| |\_|

7-26

IGNITION TIMING STRATEGY, DWLBSE/DWLCOR CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Rising edge dwell mode: (DWLELD = 0)

Dwell is calculated on the up edge of PIP but is not used until after the up-edge

of SPOUT has been scheduled. Up-edge of SPOUT is calculated and queued from the

down of edge of PIP if there is sufficient time.

Calculations:

|<-- desired spark position

| |<-- excess dwell

-->| |<-- DWELL

max. spark advance permitted -->| |<-- (2 \* SPKLIM \*HFDLTA)

-->| |<-- NEXT\_SPOUT\_ADVANCED

-->||<-- SPOUT\_ICCD\_DELTA

->| |<-- SPOUT\_LOW\_DELTA

-->| |<-- dwell\_extra

Schedule SPOUT edge from vertical bar using spark information computed on down edge

of PIP and dwell information computed on previous up edge of PIP:

|------------>|------------------>|

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

PIP | | | | |

\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|

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

| | | | |

\_\_| SPOUT |\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_|

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

| COIL CURRENT / | / |

|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_/ |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_/ |\_\_\_\_\_

\_ \_

IDM as seen at CPU | | | |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

IDM at Corporate | | | |

Connector |\_| |\_|

7-27

IGNITION TIMING STRATEGY, DWLBSE/DWLCOR CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DWLBSE/DWLCOR\_CALCULATION

(background calculation)

DEFINITIONS

INPUTS

Registers:

- DWELL = Value for system required dwell.

- DWLBSE = Dwell required for particular battery voltage.

- DWLCOR = Interactive correction to DWLBSE.

- DWLIDM = Measured Coil Rise Time.

- VBAT = Battery voltage.

Bit Flags:

- DWLELD = Dwell edge leads spark edge 1 <- falling edge dwell.

- NEW\_DWLIDM = Flag indicating when new excess dwell can be computed.

- UNDSP = Flag indicating Engine mode; 0 -> RUN mode, 1 -> UNDERSPEED or

CRANK mode.

Non-Calibratable:

- FREQ18 = Seconds to clock ticks conversion factor. 1 clock tick = 3 \*

10E-6 seconds.

Calibration Constants:

- DWELLA = Base Dwell additive element.

- DWELLM = Base Dwell multiplicative element.

- DWLMIN = Minimum dwell allowed.

- DWL\_XS\_MIN = Minimum excess dwell in falling edge dwell.

- ENGCYL = Number of PIP up edges per revolution; (number of cylinders/2).

- IGN\_TYPE = Indicator of ignition type (0 = TFI, 1 = TFI\_ICCD, 2 =

LDR-DIS).

- PACOFF = Offset in RPM-PIP accel bata function.

- PACPER = PIP period time switchpoint for change between PIPACL equations.

- VBAT\_DWELL = Minimum battery voltage to use IDM for dwell correction.

- VBAT\_DWL\_HYS = Battery voltage to enable the use of IDM for dwell

correction.

7-28

IGNITION TIMING STRATEGY, DWLBSE/DWLCOR CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- DWELL = Value for system required dwell.

- DWLBSE = Dwell required for particular battery voltage.

- DWLCOR = Interactive correction to DWLBSE.

- POFFENG = Foreground value of PACOFF divided by ENGCYL.

- PPERENG = Foreground value of PACPER divided by ENGCYL.

Bit Flags:

- CCD\_HP = Flag indicating presence of computer controlled dwell hardware.

- NEW\_DWLIDM = Flag indicating when new excess dwell can be computed.

PROCESS

1. Determine if there is hardware present that will support computer

controlled dwell.

IGN\_TYPE = 1 ----------------------|

(TFI-ICCD) |

|OR -----| CCD\_HP = 1

ING\_TYPE = 2 ----------------------| |

(LDR-DIS) | --- ELSE ---

|

| CCD\_HP = 0

2. When CCD hardware is present, the amount of dwell required to charge a

coil is related to the battery voltage and the values used for DWELLM and

DWELLA are calibrated by the Ignition Department to include the worst case

coil. The calculation of base dwell is:

CCD\_HP = 1 ----| DWLBSE(ticks) = [1 / (DWELLM \* (VBAT - DWELLA))]

\* FREQ18 (ticks/sec)

3. Calculate values for use in the maximum PIP acceleration calculation that

is performed in the foreground:

PPERENG = PACPER / ENGCYL

POFFENG = PACOFF / ENGCYL

7-29

IGNITION TIMING STRATEGY, DWLBSE/DWLCOR CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DWLBSE/DWLCOR\_CALCULATION (continued)

4. The base dwell will be larger than the coil requires in most cases and in

the TFI-ICCD system, can be reduced by a correction that uses the information

supplied by the Ignition Diagnostic Monitor (IDM) signal. If the IDM signal

is not present to allow the calculation of a new DWLIDM, the base dwell

correction is not altered. The calculation of dwell and base dwell

correction are determined by the logic below:

UNDSP = 1 -------------------------|

(Not in run mode) |

|

IGN\_TYPE = 2 ----------------------|OR ------| DWLCOR = 0

(LDR-DIS hardware) | | DWELL = DWLBSE

| | (Initial dwell)

VBAT < VBAT\_DWELL -------|S Q ----| | NEW\_DWLIDM = 0

(Low battery voltage) | |

| |

VBAT > VBAT\_DWL\_HYS -----|C |

(Slightly higher voltage) |

| --- ELSE ---

IGN\_TYPE = 1 ----------------------| |

(TFI-ICCD hardware) | |

| |

DWLELD = 1 ------------------------| |

(Falling edge dwell mode) | |

| |

UNDSP = 0 -------------------------|AND -----| DWLCOR = DWLCOR +

(In run mode) | | [(DWELL - DWLIDM) / 2]

| | DWELL = DWLBSE - DWLCOR

DWLIDM < (DWELL - DWL\_XS\_MIN) -----| | NEW\_DWLIDM = 0

(Too much excess dwell) | |

| |

NEW\_DWLIDM = 1 --------------------| |

(New dwell error available) |

| --- ELSE ---

|

IGN\_TYPE = 1 ----------------------| |

| |

DWLELD = 1 ------------------------| |

| |

UNDSP = 0 -------------------------|AND -----| DWLCOR = DWLCOR -

| | DWL\_XS\_MIN

DWLIDM >= DWELL -------------------| | (Clip DWLCOR to zero as

(Insufficient charge time) | | a minimum)

| | DWELL = DWLBSE - DWLCOR

NEW\_DWLIDM = 1 --------------------| | NEW\_DWLIDM = 0

|

| --- ELSE ---

|

IGN\_TYPE = 1 --------------------------------| DWELL = DWLBSE - DWLCOR

| NEW\_DWLIDM = 0

7-30

IGNITION TIMING STRATEGY, DWLBSE/DWLCOR CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

5. Prevent the dwell value from being computed below a calibratable value

by:

DWELL < DWLMIN ------------------------------| DWELL = DWLMIN

7-31

IGNITION TIMING STRATEGY, DWELL\_CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DWELL\_CALCULATION

(called from various foreground routines)

OVERVIEW

Calculate the percent change in PIP period under maximum acceleration

for use in the calculation of the possible dwell requirement. The

acceleration factor is comprised of two linear functions which can be related

to the current PIP period. The decision on which function to use is based on

the number of cylinders in the engine and the possible acceleration rate for

that engine. There is a clip on the maximum amount of acceleration factor

since as the engine speed goes down the amount of time required to protect

for any acceleration increases expontentially, and the amount of time desired

for the coil to be in current limit has a finite limit.

DEFINITIONS

INPUTS

Registers:

- DT12S = The value, in clock ticks, of the current pip period.

- DWELL = Value for system required dwell.

- HFDLTA = Most recent PIP first half period.

- PIPACL = Percentage change in PIP under acceleration of 8K RPM/sec.

- POFFENG = Foreground value of PACOFF divided by ENGCYL.

- PPERENG = Foreground value of PACPER divided by ENGCYL.

Bit Flags:

- CCD\_HP = Flag indicating presence of computer controlled dwell hardware.

- DWLELD = Dwell edge leads spark edge 1 <- falling edge dwell.

Calibration Constants:

- DWLMAX = Maximum dwell allowed.

- DWLTSW = Time switchpoint for maximum percentage dwell.

- MINDLA = Maximum percent of PIP period not charging coil for PIP periods

greater than DWLTSW.

- MINDLB = Maximum percent of PIP period not charging coil for PIP periods

less than DWLTSW.

- PACLIM = PIP period acceleration factor for dwell.

- PACSLO = Slope in RPM-PIP accel beta function.

7-32

IGNITION TIMING STRATEGY, DWELL\_CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SPKLIM = Percent of "crank degrees between PIPs" used to determine the

maximum spark advance increase allowed between consecutive spark events.

Do NOT calibrate higher than 0.06 without Ignition Department approval.

Maximum spark advance increase between events varies with the number of

cylinders; Maximum increase = SPKLIM \* 360/ENGCYL.

For 4 cyl; 0.06 \* 360/2 = 10.8 degrees

6 cyl; 0.06 \* 360/3 = 7.2 degrees

8 cyl; 0.06 \* 360/4 = 5.4 degrees

OUTPUTS

Registers:

- PIPACL = Percentage change in PIP under acceleration of 8K RPM/sec.

- SPOUT\_LOW\_DELTA = Delta time from spark edge to dwell edge.

7-33

IGNITION TIMING STRATEGY, DWELL\_CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

CCD\_HP = 1 --------------| | PIPACL = PACSLO \* DT12S - POFFENG

(ICCD hardware present) | | clip PIPACL so that:

| | 0 < PIPACL <= PACLIM

DWLELD = 0 --------------|AND -----| dwell\_extra = [(SPKLIM + PIPACL)

(not in ICCD mode) | | \* DT12S] + DWELL

| |

DT12S >= PPERENG --------| |

(RPM below accel bkpt) |

|

|

| --- ELSE ---

|

CCD\_HP = 1 --------------| | PIPACL = 2 \* DT12S

|AND -----| dwell\_extra = [(SPKLIM + PIPACL)

DWLELD = 0 --------------| | \* DT12S] + DWELL

Under the most adverse conditions, the ignition department has

determined that there is a maximum amount of dwell. This amount is the clip,

DWLMAX.

CCD\_HP = 1 --------------|

|AND -----| dwell\_extra = DWLMAX

dwell\_extra > DWLMAX ----| |

(too much dwell)

7-34

IGNITION TIMING STRATEGY, DWELL\_CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DWELL\_CALCULATION (continued)

In Rising edge computer controlled dwell, it is necessary to schedule the

SPOUT down or dwell edge from the SPOUT up or spark edge. The logic below

decides if the PIP period minus the dwell period (i.e. time coil is off) is

greater than some value, typically 50% at low speeds and 20% at all other

speeds, and extends the amount of time the coil is off until the percentage

is within these limits.

CCD\_HP = 1 --------------|

|

DWLELD = 0 --------------|

(rising edge mode) |

|AND -----| SPOUT\_LOW\_DELTA = MINDLA \* DT12S

DT12S > DWLTSW ----------| | (extend coil off time for low speeds)

(RPM below switchpoint) | |

| |

[(DT12S - dwell\_extra)/ | |

DT12S] <= MINDLA -----| |

(coil off percentage too short) |

| --- ELSE ---

|

CCD\_HP = 1 --------------| |

| |

DWLELD = 0 --------------|AND -----| SPOUT\_LOW\_DELTA = MINDLB \* DT12S

| | (extend coil off time)

[(DT12S - dwell\_extra)/ | |

DT12S] <= MINDLB -----| |

| | --- ELSE ---

|

CCD\_HP = 1 --------------| |

|AND -----| SPOUT\_LOW\_DELTA = DT12S - dwell\_extra

DWLELD = 0 --------------| |

| --- ELSE ---

|

IGN\_TYPE = 0 ----------------------| SPOUT\_LOW\_DELTA = HFDLTA

(TFI hardware present) |

| --- ELSE ---

|

| Do not calculate value for

| SPOUT\_LOW\_DELTA

7-35

IGNITION TIMING STRATEGY, MKAY/SIGKAY CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MKAY/SIGKAY CALCULATIONS

DEFINITIONS

INPUTS

Registers:

- 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.

- 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.

- PSGDLT = Previous uncorrected signature PIP half period.

- 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.

Calibration Constants:

- 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.

- IGN\_TYPE = Indicator of ignition type (0 = TFI, 1 = TFI-ICCD, 2 =

LDR-DIS-DP, 3 = LDR-DIS, and 4 = HDR-DIS).

- KLLIM = Lowest value for MKAY multiplier - initial value = 0.9.

- KULMT = Highest value for MKAY multiplier - initial value = 1.1.

- 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.

- SSFCTR = Steady state factor for MKAY and signature KAY calculations.

7-36

IGNITION TIMING STRATEGY, MKAY/SIGKAY CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SKSSLC = Steady state factor for Signature Kay calculation.

Bit Flags:

- 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.

OUTPUTS

Registers:

- DTPCYC = PIP period ENGCYL \* 2 + 1 cylinders previous.

- DTSIG = PIP period of last signature PIP.

- 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.

- PSGDLT = Previous uncorrected signature PIP half period.

- 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.

7-37

IGNITION TIMING STRATEGY, MKAY/SIGKAY CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

PIP\_DATA MODULE

IGN\_TYPE < 4 ------------------------| Call EOS\_KAY\_CALCULATIONS module

| (perform MKAY/SIGKAY calculation)

|

| --- ELSE ---

|

| Skip this module and continue

| with PIP\_DATA processing

MKAY/SIGKAY CALCULATIONS

Foreground module KAY (EOS\_KAY\_CALCULATIONS)

(called from PIP\_DATA during PIP rising edge)

SIGPIP = 1 --------------------------|

|AND ---| Do Signature Kay

SYNFLG = 1 --------------------------| | Caculation

|

| --- ELSE ---

|

| Skip Signature Kay

| calculation. Go on

| to MKAY calc. entry point

SIGNATURE KAY CALCULATION

|DT12S - DTSIG| < SKSSLC \* DT12S -----| | DTSIG = DT12S

| | sigkal' = DT12S/(SIGDLT\*2)

|DT12S - DT23S| < SKSSLC \* DT12S -----|AND ---| SIGKAL = FKSKAY\*sigkal' +

| | (1 - FKSKAY)\*SIGKAL

|SIGDLT - PSGDLT| < SKSSLC \* SIGDLT --| | SIGKLL < SIGKAL < SIGKLU

|

| --- ELSE ---

|

| DTSIG = DT12S

MKAY CALC. ENTRY POINT

KAYCTR > ENGCYL \* 2 --------------------------| Set KAYCTR = 1

| Set DTPCYC = DT12S

| Set HFPCYC = HFDLTA

|

| Return

|

| --- ELSE ---

|

| Increment KAYCTR

7-38

IGNITION TIMING STRATEGY, MKAY/SIGKAY CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SIGPIP = 0 --------------------------|

|AND ---| Do MKAY Kay

KAYCTR <= ENGCYL \* 2 ----------------| | Calculation

|

| --- ELSE ---

|

| Return

MKAY CALCULATION

|DT12S - DTPCYC| <= SSFCTR \* DT12S ------|

|

|HFDLTA - HFPCYC| <= SSFCTR \* HFDLTA ----|AND -| mkay' =

| | 0.5\*(DT12S+DTPCYC)/

mkay' < 1.2 -----------------------------| | (HFDLTA + HFPCYC)

| MKAY =

| FKMKAY \* MKAY' +

| (1 - FKMKAY) \* MKAY

|

| KLLIM < MKAY < KULMT

|

| --- ELSE ---

|

| Return

NOTE: On every PIP down edge transition, in the PIP\_DATA routine

SIGPIP = 1------------------|

|AND ---| PSGDLT = SIGDLT

SYNFLG = 1 -----------------| | SIGDLT = HFDLTA

| HFDLTA = (HFDLTA\*SIGKAL)/MKAY

7-39

IGNITION TIMING STRATEGY, TRANSIENT SPARK COMPENSATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TRANSIENT SPARK COMPENSATION

DEFINITIONS

INPUTS

Registers:

- DIFCTR = Counter for TL0FLG state changes.

- DIFF0 = Steady State Spark TL0 error.

- DIFF1 = Transient Spark TL0 error.

- DT12S = Last PIP period.

- DT23S = Previous PIP period before DT12S.

- HFDLTA = Last period from PIP up-edge to down-edge.

- MKAY = Half period multiplier to correct for average error caused by Hall

effect sensor in distributor and armature.

- PHFDLT = Previous time elapsed between up-edge to down-edge of PIP.

- SPOUT = Time to fire spark.

- TPPLW = Actual time at PIP down edge (SPOUT reference).

- TSPKUP = Time to output SPOUT.

Bit Flags:

- TL0FLG = Transient Spark calculation flag.

Calibration Constants:

- DFMIN0 = Minimum number of TS0FLG 1 to 0 state changes.

- DFMIN1 = Minimum number of TS0FLG 0 to 1 state changes.

- TRSRPM = Minimum RPM to enable transient spark routine.

- TRSRPH = Hysteresis for TRSRPM.

7-40

IGNITION TIMING STRATEGY, TRANSIENT SPARK COMPENSATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- DIFCTR = see above.

Bit Flags:

- TL0FLG = See above.

TRANSIENT SPARK COMPENSATION LOGIC

:<-----------DT23S----------->:<-----------DT12S----------->:

:<---PHFDLT--->: :<---HFDLTA--->:

.--------------. .--------------. .---

| | | | |

| | | |<-----tlo---->|

| | | | |

----. .--------------. .--------------.

:<--TSPKUP-->:

: :

TPPLW SPOUT

7-41

IGNITION TIMING STRATEGY, TRANSIENT SPARK COMPENSATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

After a PIP up-edge occurs, the following logic is executed:

DIFF0 <= DIFF1 ---------|

|AND -|

TLOFLG = 1 -------------| |

|OR --| DIFCTR = DIFCTR + 1

DIFF0 > DIFF1 ----------| | |

|AND -| | --- ELSE ---

TLOFLG = 0 -------------| |

| DIFCTR = 0

DIFF0 <= DIFF1 ---------------|

|AND -| TLOFLG = 0

DIFCTR >= DFMIN0 -------------| | DIFCTR = 0

|

DIFF0 > DIFF1 ----------------| | --- ELSE ---

|AND -|

DIFCTR >= DFMIN1 -------------| | TLOFLG = 1

| DIFCTR = 0

|

| --- ELSE ---

|

| No change to TLOFLG

Where:

DIFF0 = | DT12S - 2 \* HFDLTA \* MKAY |

DIFF1 = | DT12S - HFDLTA - (HFDLTA \* (DT23S - PHFDLT))/PHFDLT |

After a PIP down-edge occurs, TLOFLG is checked and the appropriate tlo

calculation is included for SPOUT.

TLOFLG = 1 -----------------------|

|

N > TRSRPM ---------------|S Q --|AND ---| tlo = (DT12S - PHFDLT

| | \* MKAY) / PHFDLT

N < TRSRPM - TRSRPH ------|C |

| --- ELSE ---

|

| tlo = HFDLTA \* MKAY

7-42

IGNITION TIMING STRATEGY, PIP\_DATA - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PIP\_DATA

OVERVIEW

The spark output routine (SPARK\_KNOCK\_CALCULATION) is called from the PIP

edge processing routine. Depending on the conditions and the hardware, the

SPARK\_KNOCK\_CALCULATION routine may be called from either the PIP high

transition or the PIP low transition. Additionally, when the engine is in

crank mode, underspeed mode, or SA10FG mode, the SPOUT signal will reflect

the PIP signal input.

DEFINITIONS

INPUTS

Registers:

Bit Flags:

- CCD\_HP = Flag indicating presence of computer controlled dwell hardware.

- DWLELD = Dwell edge leads spark edge 1 <- falling edge dwell.

- ECHO\_PIP A flag that indicates when the spark output signal is output

coincident with the PIP edges as they are received.

- ECHO\_TRANS = A flag that indicates when the spark output signal is in the

process of transitioning to or from normal spark output to the ECHO\_PIP

mode.

- PIP\_DOUBLE = A flag indicating which edge is referenced for spark: 1 ->

use PIP down edge; 0 -> use PIP up-edge.

OUTPUTS

Registers:

- OLD\_BETA = The percentage of PIP period from the reference PIP edge used

on the last spark output.

Bit Flags:

- DOUBLE\_EDGE = A foreground (DOS) flag used to indicate the current spark

output calculation method.

- ECHO\_TRANS = A flag that indicates when the spark output signal is in the

process of transitioning to or from normal spark output to the ECHOPIP

mode.

7-43

IGNITION TIMING STRATEGY, PIP\_DATA - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

RISING EDGE CALCULATIONS

Determine if and when to perform the rising edge dwell calculation by the

following logic:

CCD\_HP = 0 --------------------------|

|OR ---| Call DWELL\_CALCULATION

DWLELD = 0 --------------------------|

(Rising edge mode)

| (reflect PIP in SPOUT)

|

ECHO\_PIP = 1 ------------| | "echo the PIP edge

(Not in echo mode) |AND ---------------| transition as a

| | SPOUT transition"

ECHO\_TRANS = 0 ----------| | DOUBLE\_EDGE = 0

(Transition completed) | OLD\_BETA = 1

| "continue PIP processing"

|

| --- ELSE ---

| (transition from normal

| spark to PIP echo mode)

|

ECHO\_PIP = 1 --------------------------------| DOUBLE\_EDGE = 0

| OLD\_BETA = 1

| "continue PIP processing"

|

| --- ELSE ---

PIP\_DOUBLE = 0 ----------| |

(Double edge spark not | | (transition from PIP echo

requested) | | to normal spark mode)

| |

| | SPOUT\_HIGH\_EDGE = DATA\_TIME

| |

|AND ---------------| "echo the PIP edge

ECHO\_TRANS = 1 ----------| | transition as a

| SPOUT transition"

|

| ECHO\_TRANS = 0

| Call SPOUT\_CALCULATION

| "continue PIP processing"

|

| --- ELSE ---

|

| (normal spark mode)

|

PIP\_DOUBLE = 0 ------------------------------| Call SPOUT\_CALCULATION

| "continue PIP processing"

|

| --- ELSE ---

|

| "continue PIP processing"

7-44

IGNITION TIMING STRATEGY, PIP\_DATA - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FALLING EDGE CALCULATIONS

ECHO\_PIP = 1 ------------| | (transition from falling edge

(In PIP echo mode) | | dwell to PIP echo mode)

| |

ECHO\_TRANS = 1 ----------|AND -----| DWLELD = 0

(In transition) | |

| | ECHO\_TRANS = 0

DWLELD = 1 --------------| |

(In falling edge dwell) | "Echo the PIP transition as a

| SPOUT transition"

|

| "continue with PIP processing"

|

| --- ELSE ---

|

| (transition from normal spark to

ECHO\_PIP = 1 ------------| | PIP echo mode)

(In echo pip mode) |AND -----|

| | ECHO\_TRANS = 0

ECHO\_TRANS = 1 ----------| | "continue with PIP processing"

(In transition) |

| --- ELSE ---

ECHO\_PIP = 1 ------------| |

|OR ------| (reflect PIP as SPOUT)

PIP\_DOUBLE = 0 --| | |

(Double edge |AND ---| | "echo the PIP transition as a

spark nor | | SPOUT transition"

spark not | |

requested) | | "continue with PIP processing"

| |

ECHO\_TRANS = 1 --| |

| --- ELSE ---

|

| (normal falling edge spark mode)

|

PIP\_DOUBLE = 1 --------------------| Call SPOUT\_CALCULATION

| ECHO\_TRANS = 0

| "continue with PIP processing"

|

| --- ELSE ---

|

| "continue with PIP processing"

7-45

IGNITION TIMING STRATEGY, SPOUT\_KNOCK ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SPOUT\_KNOCK ROUTINE

OVERVIEW

Falling edge computer controlled dwell can only be used in falling edge spark

(PIP\_DOUBLE = 1) and when there is sufficient time to permit the dwell edge

to be scheduled after the high-to-low transition of PIP. The period of time

between the high-to-low transition of PIP and the desired position of spark

in time is calculated as a temporary value and also saved as NEXT\_SPOUT\_BETA.

DEFINITIONS

INPUTS

Registers:

- DWELL = Value for system required dwell.

- HFDLTA = Most recent PIP first half period.

- LAST\_HI\_PIP = Time of last PIP up-edge.

- NEW\_BETA = Percent of PIP period from reference PIP edge to the spark

firing signal.

- MKAY = Half period multiplier to correct for average error caused by Hall

effect sensor in distributor and armature.

- NEXT\_SPOUT\_ADVANCED = Delta time from PIP down edge to position of spark

with maximum spark advance on next cylinder.

- NEXT\_SPOUT\_BETA = The percentage of PIP period (betas) from the reference

PIP edge to the signal on the spark output (SPOUT) that causes the

ignition module to discharge the coil across the spark plug.

- SPOUT\_HIGH\_EDGE = Time of next scheduled SPOUT transition from low to

high.

- SPOUT\_ICCD\_DELTA = Delta time from PIP down edge to the dwell edge when

in falling edge mode.

- SPOUT\_LOW\_DELTA = Delta time from spark edge to dwell edge.

- SPOUT\_LOW\_EDGE = Time of next scheduled SPOUT transition from high to

low.

Bit Flags:

- CCD\_HP = Flag indicating presence of computer controlled dwell hardware.

- DWLELD = Dwell edge leads spark edge; 1 -> falling edge dwell.

- PIP\_DOUBLE = A flag indicating which edge is referenced for spark; 1 ->

use PIP down-edge, 0 -> use PIP up-edge.

7-46

IGNITION TIMING STRATEGY, SPOUT\_KNOCK ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Non-Calibratable:

- TICKS\_DOUBLE = The value in clock-ticks when there is sufficient time in

Rising-edge mode to put out spark from the falling edge (currently set

equivalent to 0.0010 seconds).

- TICKS\_SINGLE = The value in clock-ticks when here is insufficient time to

put out spark from the falling edge of PIP (currently set equivalent of

0.0010 seconds).

Calibration Constants:

- SPKLIM = The maximum percentage of a PIP period by which the spark may be

advanced between two outputs.

OUTPUTS

Registers:

- NEXT\_SPOUT\_ADVANCED = Delta time from PIP down edge to position of spark

with maximum spark advance on next cylinder.

- NEXT\_SPOUT\_BETA = The percentage of PIP period (betas) from the reference

PIP edge to the signal on the aprk output (SPOUT) that causes the

ignition module to discharge the coil across the spark plug.

- SPOUT\_HIGH\_EDGE = Time of next scheduled SPOUT transition from low to

high.

- SPOUT\_ICCD\_DELTA = Delta time from PIP down edge to the dwell edge when

in falling edge mode.

- SPOUT\_LOW\_EDGE = Time of next scheduled SPOUT transition from high to

low.

Bit Flags:

- DWLELD = Dwell edge leads spark edge 1 <- falling edge dwell.

7-47

IGNITION TIMING STRATEGY, SPOUT\_KNOCK ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

1. The temporary value for NEXT\_SPOUT\_BETA is calculated by the following

logic:

PIP\_DOUBLE = 1 --------------------| beta = (NEW\_BETA - 0.5) \* 2

(Falling edge spark) | temp\_value = (tlo \* beta) +

| (MKAY - 1) \* HFDLTA

| NEXT\_SPOUT\_BETA = temp\_value

|

| --- ELSE ---

|

| NEXT\_SPOUT\_BETA = NEW\_BETA \* DT12S

2. Based on the current requested position of spark and the maximum amount

of change allowed in the advance direction, calculate the amount of time from

the next PIP down edge to the earliest possible spark position on the next

cylinder. This term will be used to decide whether there is a need to switch

modes for dwell.

CCD\_HP = 1 ----| NEXT\_SPOUT\_ADVANCED = temp\_value - (2 \* SPKLIM \* HFDLTA)

3. Compute the time for turning on the coil (dwell edge) for the current

cylinder based on the spark time and the amount of dwell required to reach

current limit.

CCD\_HP = 1 ----| SPOUT\_ICCD\_DELTA = temp\_value - DWELL

7-48

IGNITION TIMING STRATEGY, SPOUT\_KNOCK ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SPOUT\_KNOCK ROUTINE

4. Determine the output values and sequence for both edges of SPOUT:

CCD\_HP = 1 ---------------|

(CCD hardware present) |

|

PIP\_DOUBLE = 1 -----------|

(spark from PIP down) |

|

DWLELD = 1 ---------------|AND ----| FALLING EDGE DWELL MODE

(falling edge mode) | | (compute time for coil start

| | to charge and schedule as the

(NEXT\_SPOUT\_ADVANCED | | SPOUT\_LOW\_EDGE:)

- DWELL) >= | | SPOUT\_LOW\_EDGE = LAST\_HI\_PIP + HFDLTA

TICKS\_SINGLE --------| | + SPOUT\_ICCD\_DELTA

(sufficient time to output | (when SPOUT\_LOW\_EDGE is output

dwell edge from PIP down) | compute time of spark and schedule

| the SPOUT\_HIGH\_EDGE:)

| SPOUT\_HIGH\_EDGE = SPOUT\_LOW\_EDGE

| + DWELL

|

| --- ELSE ---

|

| TRANSITION FROM FALLING EDGE DWELL

| MODE TO RISING EDGE CCD

| DWLELD = 0 (change to CCD mode)

| (compute time for coil start to

| charge and schedule as the

CCD\_HP = 1 ---------------| | SPOUT\_LOW\_EDGE:)

| |

PIP\_DOUBLE = 1 -----------|AND ----| SPOUT\_LOW\_EDGE = LAST\_HI\_PIP + HFDLTA

| | + SPOUT\_ICCD\_DELTA

DWLELD = 1 ---------------| | (when SPOUT\_LOW\_EDGE is output,

| compute time of spark and

| schedule the SPOUT\_HIGH\_EDGE:)

| SPOUT\_HIGH\_EDGE = SPOUT\_LOW\_EDGE

| + DWELL

| (when SPOUT\_HIGH\_EDGE is output,

| call DWELL\_CALCULATION to

| calculate the next coil turn on

| time, SPOUT\_LOW\_DELTA and then

| schedule the SPOUT\_LOW\_EDGE:

| SPOUT\_LOW\_EDGE = SPOUT\_HIGH\_EDGE

| + SPOUT\_LOW\_DELTA

|

| --- ELSE ---

(continued on next page)

7-49

IGNITION TIMING STRATEGY, SPOUT\_KNOCK ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SPOUT\_KNOCK ROUTINE

(continued from previous page)

CCD\_HP = 1 --------------| |

|AND -----| TRANSITION FROM RISING EDGE DWELL

PIP\_DOUBLE = 1 ----------| | MODE TO FALLING EDGE DWELL MODE

| | DWLELD = 1 (change to ICCD mode)

(NEXT\_SPOUT\_ADVANCED | | (when the SPOUT\_LOW\_EDGE is no

- DWELL) >= | | longer pending in the queue,

TICKS\_DOUBLE ------| | compute time of spark and schedule)

(sufficient time to output | SPOUT\_HIGH\_EDGE:

dwell edge from PIP down) | SPOUT\_HIGH\_EDGE = LAST\_HI\_PIP

| + NEXT\_SPOUT\_BETA

| + HFDLTA

|

| --- ELSE ---

|

| RISING EDGE DWELL MODE OR TFI WITH

| FALLING EDGE SPARK MODE

| (compute time of spark and

| schedule as the SPOUT\_HIGH\_EDGE:)

|

PIP\_DOUBLE = 1 --------------------| SPOUT\_HIGH\_EDGE = LAST\_HI\_PIP

| + NEXT\_SPOUT\_BETA

| + HFDLTA

| (when SPOUT\_HIGH\_EDGE is output,

| compute time for coil start to

| charge and schedule as

| SPOUT\_LOW\_EDGE:)

| SPOUT\_LOW\_EDGE = SPOUT\_HIGH\_EDGE

| + SPOUT\_LOW\_DELTA

|

| --- ELSE ---

|

| RISING EDGE DWELL MODE OR TFI WITH

| RISING EDGE SPARK MODE

| SPOUT\_HIGH\_EDGE = LAST\_HI\_PIP

| + NEXT\_SPOUT\_BETA

| (when SPOUT\_HIGH\_EDGE is output,

| compute time for coil start to

| charge and schedule as

| SPOUT\_LOW\_EDGE:)

| SPOUT\_LOW\_EDGE = SPOUT\_HIGH\_EDGE

| + SPOUT\_LOW\_DELTA

7-50

IGNITION TIMING STRATEGY, VIP, EOS\_IDM - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

VIP, EOS\_IDM

OVERVIEW

Upon the change in state of the high speed input for Ignition Diagnostic

Monitor, the flag IDM\_INT is set to one. When new input data is processed, a

check is made of the flag IDM\_INT, and if set, will cause this module to be

called to process the IDM state change. If the transition has been high to

low at the CPU (IDM\_HIGH = 0), the self test logic is notified by setting the

flag NEW\_IDM. If the ignition system provides an IDM signal that can be used

to determine the amount of excess dwell and the EEC is controlling the dwell

(IGN\_TYPE = 1), the time of coil charging is determined and a flag,

NEW\_DWLIDM, is set.

NOTE: IDM\_HIGH reflects the state of the High Speed Input (HSI) pin and not

the IDM voltage. Because of an inversion, when IDM voltage = 0, IDM\_HIGH =

1, and when IDM voltage is greater than 3.5 volts, IDM\_HIGH = 0.

DEFINITIONS

INPUTS

Registers:

- DATA\_TIME = Time of latest digital input edge.

- SPOUT\_LOW\_EDGE = Time of next scheduled SPOUT transition from high to

low.

Bit Flags:

- DWLELD = Dwell edge leads spark edge 1 <- falling edge dwell.

- IDM\_HIGH = Flag that reflects the state of the High speed Input (HSI)

pin. Because of an inversion, when IDM voltage = 0, IDMHIGH = 1, and

when IDM voltage is greater than 3.5 volts, IDMHIGH = 0.

- IDM\_INT = Flag that indicates that a change of state has occurred on the

IDM input pin.

Calibration Constants:

- IGN\_TYPE = Indicator of ignition type (0 = TFI, 1 = TFI\_ICCD, 2 =

LDR-DIS).

7-51

IGNITION TIMING STRATEGY, VIP, EOS\_IDM - LHBH0

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OUTPUTS

Registers:

- DWLIDM = Measured Coil Rise Time.

Bit Flags:

- IDM\_INT = Flag that indicates that a change of state has occurred on the

IDM pin.

- NEW\_DWLIDM = Flag indicating when new excess dwell can be computed.

- NEW\_IDM = A flag that indicates that the EOS has processed new IDM

information for use by the self test (VIP) strategy.

PROCESS

Always ----------------------------------------| Clear IDM\_INT

IDM\_HIGH = 0 -----------------| | Calculate Dwell Time

(High-to-low transition) | |

| | DWLIDM = (DATA\_TIME -

DWLELD = 1 -------------------|AND ------------| SPOUT\_LOW\_EDGE)

(In ICCD mode) | |

| | Set NEW\_DWLIDM

IGN\_TYPE = 1 -----------------| | Set NEW\_IDM

|

| --- ELSE ---

|

IDM\_HIGH = 0 ----------------------------------| Set NEW\_IDM

|

| --- ELSE ---

|

| Return

7-52

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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INDIVIDUAL CYLINDER KNOCK

OVERVIEW

KNOCK HARDWARE DESCRIPTION

The knock sensor is a piezo-electric accelerometer which 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

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 this period of knock, the software withholds KTS for WINCLD

PIP periods to avoid raising the noise threshold too high.

7-53

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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DEFINITIONS

INPUTS/OUTPUTS:

- APT = Throttle Mode Flag.

- CTFLG = Flag set to 1 to indicate Closed Throttle Tip-in.

- CWCTR = Cancel Window Counter incorporated each PIP period.

- ECT = Engine Coolant Temperature, deg F.

- KI = Knock indicated, knock level is higher than noise level; called

KNK\_HIGH in code.

- KIHP = Knock hardware present switch; 1 -> Knock sensor present.

- KNOCK\_DETECTED = Flag set to 1, if knock occurred in current PIP

half-period.

- KNOCK\_OCCURRED = Flag set to 1, if knock occurred in current or last PIP

period.

- KTS = Pulsewidth (clock ticks) of the charging pulse. (This signal is

internal to the EEC.) Start time = LAST HI-PIP + (WINDOW\_BETA \* MKAY \* 2

\* HFDLTA).

- "LAST PIP PERIOD" = MKAY\*2\*HFDLTA. (MKAY and HFDLTA are defined in Base

Spark Chapter)

- 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)

- SPKADn = Spark adder terms for the nth cylinder. It is added to SAF, may

be positive or negative degress.

- TBART = Filtered Throttle position (initialized to RATCH). =

UROLAV(TP,TCTPT)

- TCF = Value indicating difference between TP and TBART. TCF = (TP -

TBART)

- TIPFLG = Flag set to 1 to indicate a Tip-in.

- TIPRET = Degrees of tip-in retard added to SAF.

- TSLADV = Free-running millisecond timer which counts the time since the

spark was last advanced by the KNOCK STRATEGY.

FOX FUNCTIONS:

- FN143 = Retard Increment as function of N (positive degrees).

- FN144 = Width of KTS as a function of N, fraction of pip period.

7-54

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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- FN145 = Position of KTS as a function of N, fraction of PIP period.

- FN146A = Spark Advance rate (secs) as function of N.

- FN190 = Maximum spark advance allowed from SPKAD(n) registers as a

function of engine speed (N\_BYTE), degrees.

CALIBRATION CONSTANTS:

- ECTIP = Minimum ECT to enable TIP-in Knock logic, deg F.

- ECTNOK = Minimum ECT to enable Knock Strategy, deg F.

- ENGCYL = Number of PIPS per revolution. = (Number of Engine

Cylinders/2.)

- KACRAT = Minimum change in TP that indicates a Tip-in, counts.

- KIHP = KNOCK hardware present switch; 1 -> KNOCK sensor present.

- KNKCYL = Calibration constant which can be calibrated equal to number of

cylinders, or 1. This number determines whether it is an Individual

Cylinder Knock or Multi- cylinder knock strategy.

- LODNOK = Minimum MAPPA at which Knock Strategy is enabled, unitless.

- NTIP = Maximum rpm to enable Tip-in logic, rpm.

- RETLIM = Means of preventing excessive retard; SPKAD is clipped to

RETLIM, degrees.

- RPMCNL = Threshold rpm below which the window is always opened, rpm.

- RPMMIN = Minimum rpm to enable Knock Strategy. (Helps prevent Spark

Retard at Idle.) rpm.

- TIPINC = Advance per PIP following a Tip-in retard. (Must be a positive

number; units are degrees.)

- TIPMAX = Initial amount of retard following a Tip-in. (Must be a

negative number; units are degrees.)

- TPFK = Calibratible filter constant.

- WINCLD = Maximum number of PIP periods to withhold KTS KTS (to refresh

NOISE threshold level) during periods of sustained knock, PIP periods.

- WINLEN = Minimum KTS pulsewidth, (fraction of PIP period).

- WOPEN = Minimum delay after the rising edge of PIP before the KTS pulse

will be output (fraction of PIP period).

7-55

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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PROCESS

STRATEGY MODULE: SPKKNOCK\_LL

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)

7-56

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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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

4. SPARK ADVANCE LOGIC

7-57

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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KNOCK STRATEGY ENABLE LOGIC

The following logic is checked every background loop:

KIHP = 1 -------------------------|

|

MAPPA > LODNOK -------------------|

|AND -| ENABLE KNOCK STRATEGY

ECT > ECTNOK ---------------------| |

| | --- ELSE ---

N > RPMMIN -----------------------| |

| DISABLE KNOCK STRATEGY

| SPKAD(ALL) = 0

| 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.

7-58

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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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 (FN144, FN145) and two calibration

constants (WOPEN, WINLEN). 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 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 WINDOW LOGIC and calculations shown below are checked every rising edge

of PIP except in Engine Running VIP (RUNNING = 1):

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

At the start of the Goose Test, the pulsewidth of KTS is set to V\_KTS.

The timing of KTS is equal to

(WOPEN + FN145(N)) \* ("LAST PIP PERIOD")

Where, WOPEN is the minimum delay after the rising edge

of the PIP before the KTS pulse will be output.

FN145(N) is fraction of pip period, BETA Units.

7-59

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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The WINDOW LOGIC show below is checked every falling edge of PIP:

KIHP = 0 -------------------------------| DO NOT OUTPUT KTS

(KNOCK input hardware not present) |

| --- ELSE ---

N <= RPMCNL ----------------------| |

| | CWCTR = 0

CWCTR >= WINCLD ------------------|OR --| OPEN WINDOW AT CALCULATED TIME

| |

NOT SIGNATURE PIP ----------| | | --- ELSE ---

|AND -| |

KNOCK\_DETECTED = 0 ---------| | Increment CWCTR

(No KNOCK in current PIP | DO NOT OPEN WINDOW

half period)

NOTE: If KIHP = 1, 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.

|<--"LAST PIP PERIOD"-->|

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

| | | | |

| | | | |

| | | | |

PIP \_\_\_| |\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_|

|<-------A--------->|

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

| | | |

| | |<-B->|

| | | |

KTS \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_

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.

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

| | | |

| | | |

| | | |

KI \_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

| | | |

| | | |

| | | |

KNOCK\_DETECTED \_| |\_\_\_\_| |\_\_\_

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

|

KNOCK\_OCCURRED \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|

7-60

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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EXAMPLES

EXAMPLE 1: N < RPMCNL

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

| | | |

| | | |

| | | |

PIP \_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_

| |

| |

| \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_

| | | | | |

| | | | | |

KI \_\_\_\_\_\_| | |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_

| |

| |

\_\_\_ | \_\_\_

| | | | |

| | | | |

KTS \_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

| |

^ ^

| |

Calculate & schedule Cancel window logic checked here, but window

next KTS not cancelled because rpm is low

EXAMPLE 2: N > RMPCNL

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

| | | |

| | | |

PIP \_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_

| |

| \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_

| | | | | |

| | | | | |

KI \_\_\_\_\_\_| | |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

| |

| |

\_\_\_ |

| | |

| | |

KTS \_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

| |

^ ^

| |

Calculate & schedule Cancel Window Logic Checked here, next KTS

next KTS. cancelled bacause KNOCK sensed and rpm is high.

7-61

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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The following logic is checked every pip UP edge before calculating SPOUT.

KIHP = 0 -------------------------------| KNOCK\_DETECTED = 0

| KNOCK\_OCCURRED = 0

|

| --- ELSE ---

KNOCK\_DETECTED = 1 ---------------| |

|AND -| KNOCK\_OCCURRED = 1

KNK\_HIGH = 1 ---------------------| |

(KI currently indicating KNOCK) | --- ELSE ---

|

KNOCK\_DETECTED = 1 ---------------| | KNOCK\_OCCURRED = 1

|AND -| KNOCK\_DETECTED = 0

MKNK\_HIGH = 0 --------------------| |

(KI currently indicating no KNOCK) | --- ELSE ---

|

| KNOCK\_OCCURRED = 0

The following code is executed in real time (almost).

KNOCK\_INTERRUPT ------------------|

(HI or LOW transition) |

|AND -| KNOCK\_DETECTED = 1

KIHP = 1 -------------------------| | VIP\_KNOCK = 1

(KNOCK sensor present)

KNOCK INTERRUPT ENABLE LOGIC

The following logic is executed upon Power-up, upon Re-Init, and every

Background Loop.

KIHP = 1 ----------------------| ALLOW KNOCK INTERRUPTS TO OCCUR.

|

| --- ELSE ---

|

| PREVENT KNOCK INTERRUPTS FROM OCCURRING.

7-62

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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 = FN143(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 --| SPKAD(n-1) = SPKAD(n-1) - RETINC

Period) | | (Clip min. SPKAD(n-1) to RETLIM)

TIPRET = 0 ---------|

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 MAP 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 MAP 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. 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.

7-63

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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The following Tip-in logic is checked every background loop:

CTFLG LOGIC

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

|AND -|S Q--| CTFLG = 1

MAP < TIPMAP --------------------| | |

| | --- ELSE ---

MAP > TIPMAP + TIPHYS -----------------|C |

| CTFLG = 0

TIPFLG LOGIC

ECT > ECTIP ---------------------------|

|

TCF >= KACRAT -------------------------|AND -| TIPFLG = 1

| |

N\_BYTE < NTIP -------------------------| | --- ELSE ---

|

| TIPFLG = 0

Where,

TCF = TP - TBART

TBART = UROLAV(TP,TCTPT) (TBART is initialized to RATCH)

TCTPT = calibratable time constant

KACRAT = calibration constant

ECTIP = calibration constant

NTIP = calibration constant

NOTE: TIPMAP + TIPHYS is clipped to 31.875 in. Hg.

7-64

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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The following Tip-in logic is checked every rising edge of PIP:

TIPRET = 0 -----------------------|

|

TIPFLG = 1 -----------------------|

|AND -| TBART = TP

KNOCK\_OCCURRED = 1 ---| | | TIPRET = TIPMAX

| | |

KNOCK\_ENABLED = 1 ----| | | --- ELSE ---

|AND -| | |

KNKCYL <> 1 ----------| |OR --| | TIPRET = TIPRET + TIPINC

| | (Clip MAX TIPRET to 0)

CTFLG = 1 ------------------|

Where,

TIPRET = Tip-in retard

TIPMAX = initial amount of retard following a Tip-in

(Must be a negative number; units are degrees)

TIPINC = advance per PIP following a TIP-in retard

(Must be a positive number; units are degrees)

NOTE: The final value of Spark advance is calculated by the EOS immediately

prior to calculating the waiting time:

CALCULATED SPARK OUT = SAF + TIPRET

7-65

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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SPARK ADVANCE LOGIC

The following logic is checked every rising edge of PIP:

KNOCK STRATEGY ENABLED -|

|AND --| SPKAD(ALL) = SPKAD(ALL) +

TSLADV >= FN146A/4 -----| | 0.25 deg.

| (Clip SPKAD(ALL) to FN190(N\_BYTE)

| as a maximum)

|

| TSLADV = TSLADV - FN146A/4

TSLADV is a free running millisecond timer which counts the time since the

spark was last advanced by the KNOCK STRATEGY.

If the Knock Strategy is enabled, all of the spark adders, SPKAD1 through

SPKADn are incremented 0.25 degrees every FN146A/4 seconds. FN146A is

equivalent to 1/FN146A (used in previous strategies). Each of the SPKADn's

is clipped to FN190. If FN190 = 0, the KNOCK STRATEGY will not advance the

spark beyond SAF. The output of function FN190 is the maximum amount of

advance beyond the SAF value that can be tolerated for a particular engine

speed. The input to FN190 is N\_BYTE, engine speed in 16 rpm increments, and

the output is in degrees of spark, with a range of 0 to 31.875 and a

resolution of 0.25 degrees.

NOTE: If the Knock Strategy is enabled and no cylinders are knocking, the

spark to each cylinder will advance to SAF + FN190. 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, FN146A should be greater than or equal to

1/FN143. When FN146A is large, then the spark advance rate is small. For

example, FN146A = 0.5 is equivalent to a spark advance rate of 2 degrees/sec.

FN146A = 0.25 is equivalent to spark advance rate of 4 degrees/sec.

7-66

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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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.

7-67

IGNITION TIMING STRATEGY, INDIVIDUAL CYLINDER KNOCK - LHBH0

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7-68

CHAPTER 8

EGR STRATEGY

8-1

EGR STRATEGY, EGR SELECT LOGIC - LHBH0

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EGR SELECT LOGIC

PFEHP = 0 -----------------------------| DO SONIC EGR CONTROL

|

| --- ELSE ---

|

| EGR IS DISABLED, NO EGR CONTROL

| REQUIRED

| EM = 0

| EGRACT = 0

| RETURN

DEFINTIONS

INPUTS

Registers:

- APT = Throttle mode flag; -1 -> closed throttle.

- ATMR1 = Time since startup (entering RUN mode), sec.

- ATMR2 = Time since Engine Coolant temperature exceeded TEMPFB, sec.

- EOFF = The EGR valve reading when the valve is full closed in A/D counts.

- EVP = EGR valve position (Sonic EGR) in A/D counts.

- MAP = Manifold Absolute Pressure, BIN 3.

- NACTMR = Time not at closed throttle, seconds.

- RATCH = Lowest closed throttle position, counts.

- TCSTRT = Engine Coolant Temperature at Start-up, deg F.

- TP = Throttle position, A/D counts.

- TP\_REL = Relative Throttle Position, TP - RATCH.

Bit Flags:

- AFMFLG = Flag indicating ACT sensor has failed; 1 -> failure.

- CFMFLG = Flag indicating ECT sensor has failed; 1 -> failure.

- CRKFLG = Crank mode flag; 0 -> underspeed or run, 1 -> crank.

- EFMFLG = Flag indicating EVP sensor has failed; 1 -> failure.

- IMS = Inferred Mileage Sensor input; 0 -> low mileage, 1 -> high mileage

or no sensor present.

- MFMFLG = Flag indicating ECT sensor has failed; 1 -> failure.

8-2

EGR STRATEGY, EGR SELECT LOGIC - LHBH0

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- TFMFLG = Flag indicating TP sensor has failed; 1 -> failure.

- WOT\_EGR\_FLG = Flag to enable WOT EGR.

Calibration Constants:

- EGRDED = EVP breakpoint above/below EOFF to determine open/closed EGR

valve and if EOFF has learned closed valve position, counts.

- EGRTD1 = Hot Start Time Delay before enabling EGR, secs. Low mileage.

- EGRTD2 = Time delay before enabling EGR when the coolant temperature at

Start-up was in the mid-range, sec. Low mileage.

- EGRTD3 = Cold Start Time delay before enabling EGR after the coolant

temperature exceeds TEMPFB, sec. Low mileage.

- EGRTD4 = Hot Start Time delay before enabling EGR, secs. High mileage or

no IMS.

- EGRTD5 = Time delay before enabling EGR when the coolant temp at start-up

was in the mid-range, secs. High mileage or no IMS.

- EGRTD6 = Cold Start Time delay before enabling EGR after the coolant temp

exceeds TEMPFB sec. High mileage or no IMS.

- EGRTD8 = Time delay at part throttle before EGR enabled.

- EGRTB1 = Throttle angle breakpoint to disable EGR, counts.

- EGTB1H = Hysteresis for EGR disable throttle angle, counts.

- CTHIGH = Hot Start Engine Coolant Temperature, deg F.

- CTLOW = Cold Start Engine Coolant Temperature, deg F.

- MAP\_WOT\_EGRC = MAP below which WOT EGR is disabled.

- MAP\_WOT\_EGRS = MAP above which WOT EGR is enabled.

- PFEHP = PFE hardware present; 0 -> Sonic EGR being used, 1 or 2 -> EGR

not used.

OUTPUTS

Bit Flags:

- EGREN = Flag indicating of EGR is enabled; 0 -> disabled, 1 -> enabled.

8-3

EGR STRATEGY, EGR SELECT LOGIC - LHBH0

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PROCESS

STRATEGY MODULE: EGR\_ENABLE\_LH

EGR ENABLE/DISABLE LOGIC

APPLICATION: SONIC AND PFE WITH IMS AND OCTANE ADJUST

The following logic describes the operating conditions during which EGR is

enabled. (When PFEHP = 1 or 2, no EGR is required and the EGR Strategy is

always disabled)

MAP > MAP\_WOT\_EGRS --------------|S Q -| WOT\_EGR\_FLG

|

MAP < MAP\_WOT\_EGRC --------------|C

"A" (See Below) -----|

|AND -|

IMS = 0 -------------| |

|OR --|

"B" (See Below) -----| | |

|AND -| |

IMS = 1 -------------| |

|

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

|

EFMFLG = 0 ----------------------|

(EGR sensor is OK) |

|

MFMFLG = 0 ----------------------|

(MAP sensor is OK) |

|

AFMFLG = 0 ----------------------|

(ACT sensor is OK) |AND -| egr\_rdy = 1

| | V\_EGR\_RDY = 1

CFMFLG = 0 ----------------------| | (set flag to initiate

(ECT sensor is OK) | | EGR self test as

| | applicable)

TFMFLG = 0 ----------------------| |

(TP sensor is OK) | |

| |

EVP >= (EOFF - EGRDED) ----------| |

| |

NACTMR >= EGRTD8 ----------------| |

(EGR turn on delay time) |

| --- ELSE ---

|

| egr\_rdy = 0

8-4

EGR STRATEGY, EGR SELECT LOGIC - LHBH0

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"A" AND "B" LOGIC

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

|AND -|

ATMR1 >= EGRTD1 -----------| |

|

CTLOW < TCSTRT < CTHIGH ---| |

|AND -|OR --| "A"

ATMR1 >= EGRTD2 -----------| |

|

TCSTRT <= CTLOW -----------| |

|AND -|

ATMR2 >= EGRTD3 -----------|

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

|AND -|

ATMR1 >= EGRTD4 -----------| |

|

CTLOW < TCSTRT < CTHIGH ---| |

|AND -|OR --| "B"

ATMR1 >= EGRTD5 -----------| |

|

TCSTRT <= CTLOW -----------| |

|AND -|

ATMR2 >= EGRTD6 -----------|

TP\_REL < EGRTB1 - EGTB1H ---------------|S Q -| EGRTPQ

|

TP\_REL >= EGRTB1 -----------------------|C

egr\_rdy = 1 ----------------------------|

(Time, Temprature, etc) |AND -| EGREN = 1 (egr enabled)

| |

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

(part throttle) |OR --| |

| | |

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

(At WOT) |AND -| | |

| | |

WOT\_EGR\_FLG = 1 ------------| | |

(MAP high) | |

| |

EGRTPQ = 1 -----------------------------| |

(tp within range) |

| --- ELSE ---

|

| EGREN = 0 (egr disabled)

8-5

EGR STRATEGY, SONIC EGR - LHBH0

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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:

- EGR flow can be precisely varied depending upon engine operating

conditions.

- Spark advance can be precisely adjusted to compensate for the actual EGR

flow.

The Sonic EGR system consists of:

\_ Sonic EGR valve

\_ EGR valve position (EVP) sensor

\_ 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:

- Applies more vacuum to the EGR valve (increases EGR flow).

- Maintains existing EGR valve vacuum (maintains EGR flow).

- Applies less vacuum (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:

- Time since start is greater than a calibration value.

- Engine is in part throttle mode.

- Current EGR valve position is not less than the fully closed position.

8-6

EGR STRATEGY, SONIC EGR - LHBH0

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The sonic EGR strategy makes two sets of calculations:

1. Desired EGR rate = EGRATE (%)

Desired EGR mass = DESEM (PPM)

Desired EGR valve position = DELOPT (counts)

2. Actual EGR rate = EGRACT (%) (used in the spark equation)

Actual EGR mass = EM (PPM) (subtracted from AMPEM for fuel)

Actual EGR valve position = EVP (actual A/D reading)

(counts)

The feedback for the sonic system is the difference between the desired and

actual EGR valve position.

EGRERR = DELOPT - EVP

8-7

EGR STRATEGY, SONIC EGR - LHBH0

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DEFINITIONS

INPUTS

Registers:

- AM = Air Mass flow, lb/min.

- AMT = Air Mass flow for torque calculation.

- AMPEM = Air Mass plus EGR Mass Flow, lb/min. (See SYSTEMS EQUATIONS

Chapter).

- AMPEMT = Air Mass plus EGR Mass Flow for torque calculation.

- BP = Barometric pressure, in. Hg.

- BPCOR = Corrected BP = FN004(BP)

- DELOPT = Filtered desired EGR valve position.

- ECT = Engine Coolant Temperature.

- EGRACT = Filtered actual EGR Percentage = UROLAV(EM \* 100/AMPEM, TCEACT).

- EGRDC = Desired EVR duty cycle, %/100.

- EGRERR = DELOPT - EVP.

- EGRTMR = Accumulated time EGR is enabled, sec. (See TIMER Chapter)

- EM = Actual EGR mass flow, lb/min.

- EOFF = The lowest EGR valve reading when the valve is fully closed, in

A/D counts. See System Equations.

- EVP = EGR valve position reading in A/D counts.

- MAPOPE = MAP/PEXH

- PEXH = Absolute Exhaust Pressure, "Hg = FN074A(AM) \* (29.875/BPCOR) + BP.

- WOTTMR = Time at WOT.

Bit Flags:

- AFMFLG = Flag indicating ACT sensor has failed; 1 -> failure.

- CFMFLG = Flag indicating ECT sensor has failed; 1 -> failure.

- EFMFLG = Flag indicating EVP sensor has failed; 1 -> failure.

- EGREN = EGR enable/disable flag: 0 -> disable EGR; 1 -> enable EGR.

- EGRFLG = Flag that indicates whether DCOFF has been added to EGRDC.

- ISCFLG = Idle speed control mode flag (see Idle Speed Control Chapter).

8-8

EGR STRATEGY, SONIC EGR - LHBH0

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- MFMFLG = Flag indicating MAP sensor has failed; 1 -> failure.

- MPGFLG = Flag indicating Fuel Economy Mode.

- TFMFLG = Flag indicating TP sensor has failed; 1 -> failure.

Calibration Constants:

- DCOFF = Duty cycle required to start to open the valve equivalent to

LGAOD in the Vent/Vac system.

- EGRDED = EVP breakpoint above/below EOFF to determine open/closed EGR

valve and if EOFF has learned closed valve position, counts.

- EGRTD7 = Calibration time delay to ramp on EGR, sec.

- FN074A = Exhaust pressure as a function of AM. FN074A should be measured

at sea level when mapping the data.

- FN211 = EGR rate multiplier as a function of Engine Coolant Temperature

ECT.

- FN212A = EGR rate multiplier as a function of Barometric Pressure BP.

- FN218 = Ratio of mass flow to choked flow as a function of MAP/PEXH.

- FN219 = EGR mass flow as a function of EGR valve position EVP - EOFF.

- FN220 = EGR rate multiplier as a function of Air Charge Temperature, ACT.

- FN221 = Desired EGR valve position as a function of desired EM.

- FN239 = Change in EVR duty cycle as a function of the EGR valve position

error, EGRERR.

- FN1220 = EGR rate table as a function of LOAD and N, percent.

- FN1222 = Fuel Economy EGR Rate Table, percent.

- KPEI = Constant EGR adder.

- TCDLOP = Time constant for DELOPT rolling average filter.

- TCEACT = Time constant for EGRACT rolling average filter.

- X = EGRATE multiplier for development.

8-9

EGR STRATEGY, SONIC EGR - LHBH0

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OUTPUTS

Registers:

- DELOPT = See above.

- DESEM = Desired EM + EGRATE \* AMPEM/100

- EGRATE = Desired EGR rate in percent.

- EGRDC = See above.

8-10

EGR STRATEGY, SONIC EGR - LHBH0

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PROCESS

STRATEGY MODULE: EGR\_SONIC\_COM2

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

\* \*

\* DESIRED EGR MASS FLOW EQUATIONS \*

\* \*

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

If EGR is enabled, the base amount of EGR to be added is determined from

FN1220, or FN1222 if in MPG mode.

The table values are a function of engine speed (N) and load, where load =

MAP.

The base amount of EGR can be adjusted by ECT, ACT, and BP to reflect special

engine operating conditions.

EGREN = 0 ------| Turn off EGR, close EGR valve. Exit DESIRED EGR MASS

(EGR disabled) | FLOW EQUATIONS.

| EGRATE = 0

| DESEM = 0

| EGRDC = 0

| DELOPT = 0

|

| --- ELSE ---

|

| Calculate EGRATE as shown below and continue on to

| DESEM CALCULATION.

Desired EGR rate = EGRATE = [A \* FN211(ECT) \* FN212A(BP) \* FN220(ACT) \*

(EGRTMR/EGRTD7) \* FN240(WOTTMR) \* X] + KPEI

Where,

MPGFLG = 0 -------------------------| A = FN1220(N,MAP)

| (Base EGR table)

|

| --- ELSE ---

|

| A = FN1222(N,MAP)

| (MPG mode table)

8-11

EGR STRATEGY, SONIC EGR - LHBH0

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Desired EGR mass = DESEM = (EGRATE \* AMPEM)/100 (lbm/min)

Clip DESEM to 1.99 ppm as a maximum.

The desired EGR mass is then converted into a desired position as:

Desired EGR valve position = DELOPT' = FN221 + EOFF

NOTE: The input to FN221 is corrected desired EGR mass flow =

(DESEM/FN218) \* (29.875/BP)

where: 29.875/BP corrects for density, and

FN218 corrects for unchoked (i.e. sub-sonic flow).

To prevent over control of the EGR valve, the valve position, DELOPT'

filtered as DELOPT using the rolling average filter routine.

DELOPT = UROLAV(DELOPT',TCDLOP) (counts)

Clip DELOPT from 0 to 1023.99 counts.

8-12

EGR STRATEGY, SONIC EGR - LHBH0

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\* \*

\* ACTUAL EGR MASS FLOW EQUATIONS \*

\* \*

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

Actual EGR rate = EGRACT' = (EM/AMPEM) \* 100

EGRACT is used to modify spark advance (see SAF calculations). To prevent

large instantaneous changes in calculated spark, EGRACT' is filtered as

EGRACT using the rolling average filter routine.

EGRACT = UROLAV(EGRACT',TCEACT) (percent EGR)

ACTUAL EGR MASS

EFMFLG = 1 ------------------|

(EGR sensor is not OK) |

|

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

(LOAD sensor is not OK) |

|

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

(ACT sensor is not OK) |

|OR --| EGR IS OFF

CFMFLG = 1 ------------------| | EM = 0

(ECT sensor is not OK) | |

| |

TFMFLG = 1 ------------------| |

(TP sensor is not OK) | |

| |

ISCFLG = 1 OR 2 -------| | |

(RPM CONTROL) |AND -| |

| |

DELOPT = 0 ------------| |

(Filtered desired EGR position) |

| --- ELSE ---

|

| EM = FN218(MAPOPE) \* FN219(EVP-EOFF)

| \* (BP/29.875)

| Clip EM to 1.99 ppm as a maximum

AM = AMPEM - EM

(AM is used to calculate fuel flow in the FUELPW calculation)

AMT = AMPEMT - EM

(AMT is used to calculate ARCHG in the torque calculation)

8-13

EGR STRATEGY, SONIC EGR - LHBH0

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\* \*

\* FEEDBACK CONTROL \*

\* \*

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

The error signal used to control the EGR valve is the difference between

desired and actual EGR valve position.

EGR valve position error = EGRERR = DELOPT - EVP

EGRERR in turn is used to calculate the change in EVR duty cycle (plus or

minus) via FN239(EGRERR).

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).

8-14

EGR STRATEGY, SONIC EGR - LHBH0

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SONIC EGR VALVE OUTPUT CONTROL

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 valve position according to the following logic.

DELOPT = 0 -------------------------| EGRDC = 0

| Clear EGRFLG

|

| --- ELSE ---

EVP <= EOFF + EGRDED ---------| |

|AND -| EGRDC = DCOFF + FN239(EGRERR)

EGRFLG CLEAR -----------------| | EGRFLG

|

| --- ELSE ---

EVP > EOFF + EGRDED ----------| |

|OR --| EGRDC = EGRDC + FN239(EGRERR)

EVP <= EOFF + EGRDED ---| |

|AND -|

EGRFLG SET -------------|

NOTE: 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 the

second page of this Strategy Book.

8-15

EGR STRATEGY, EVR CONTROL ALGORITHM - LHBH0

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EVR CONTROL ALGORITHM

SONIC AND PFE

OVERVIEW

The EVR Control routine produces a variable frequency duty cycle signal to

the EVR solenoid. To produce an 80-180 Hz signal on a low speed output while

minimizing real execution time, a foreground repeater process is used. A

repeater is a section of code that is executed approximately every

millisecond as signaled by the internally-generated Output Interrupt #1.

Once a background loop, the EVR Control module converts the current EGR duty

cycle (EGRDC) into "on time" (EGRCNT) and total period (EGRPER) for use by

the foreground repeater. The foreground repeater module transfers these

values into corresponding foreground registers, EGRCTF and EGRPRF when EGR is

requested and the current value of EGRPRF < 1.0. The values of the

foreground registers, which are decremented by one each time through the

repeater, determine if the EVR is to be energized. If the foreground period

(EGRPRF) is >= 1.0 and the on-count (EGRCTF) > 0, the EVR is energized. If

the period >= 1 and the count is 0 ("on time" complete, period incomplete),

the EVR is de-energized. When the period becomes < 1.0 (period complete),

the foreground registers are updated with the current background counter and

period, and the process is repeated. Any fractional part left in EGRPRF is

included in the next period to produce duty cycles (on the average) not

obtainable with integer on times and periods.

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.

8-16

EGR STRATEGY, EVR CONTROL ALGORITHM - LHBH0

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DEFINITIONS

INPUTS

Registers:

- EGRCNT = Background EVR "on" count, unitless.

- EGRCTF = Foreground EVR "on" count, unitless.

- EGRDC = Requested EVR duty cycle, unitless.

- EGRPER = Background EVR duty cycle period, unitless.

- EGRPRF = Foreground EVR duty cycle period, unitless.

Bit Flags:

- NO\_START = Engine off VIP enable flag.

OUTPUTS

Registers:

- EGRCNT = See above.

- EGRCTF = See above.

- EGRPER = See above.

- EGRPRF = See above.

Bit Flags:

- EVR = Flag indicating state of EVR output, 0 = OFF, 1 = ON.

8-17

EGR STRATEGY, EVR CONTROL ALGORITHM - LHBH0

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PROCESS

STRATEGY MODULE: EGR\_EVR\_CONTROL\_COM1

BACKGROUND EVR CONTROL MODULE

EGRDC = 0 -----------------------------| EGRCNT = 0

| EGRPER = 0

|

| --- ELSE ---

|

EGRDC > 0.86 --------------------------| EGRCNT = 6

|

| --- ELSE ---

|

0.69 < EGRDC <= 0.86 ------------------| EGRCNT = 5

|

| --- ELSE ---

|

0.50 < EGRDC <= 0.69 ------------------| EGRCNT = 4

|

| --- ELSE ---

|

0.35 < EGRDC <= 0.50 ------------------| EGRCNT = 3

|

| --- ELSE ---

|

0.18 < EGRDC <= 0.35 ------------------| EGRCNT = 2

|

| --- ELSE ---

|

0.08 < EGRDC <= 0.18 ------------------| EGRCNT = 1

|

| --- ELSE ---

|

| EGRCNT = 0

EGRDC <> 0 ----------------------------| EGRPER = (EGRCNT/EGRDC)

| (clip EGRPER to 12.0 as

| maximum)

8-18

EGR STRATEGY, EVR CONTROL ALGORITHM - LHBH0

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EVR FOREGROUND REPEATER MODULE

(Performed on one-millisecond interrupt)

NO\_START = 1 --------------------------| EVR IS UNDER VIP CONTROL

(in KOEO VIP Test) | Do NOT Update EVR in this

| Module

|

| --- ELSE ---

|

EGRCNT = 0 ----------------------------| EVR = 0

(EGR not requested) | (turn EVR off)

| EGRPRF = 0

|

| --- ELSE ---

|

EGRPRF < 1.0 --------------------------| EVR = 1

(last period complete, | (turn EVR on)

get new data) | EGRCTF = EGRCNT - 1

| EGRPRF = EGRPRF

| + EGRPER - 1.0

|

| --- ELSE ---

|

EGRPRF >= 1.0 -------------------| | EVR = 1

(period incomplete) | | (continue EVR on)

|AND -| EGRCTF = EGRCTF - 1

EGRCTF > 0 ----------------------| | EGRPRF = EGRPRF - 1.0

(on time incomplete) |

| --- ELSE ---

|

EGRPRF >= 1.0 -------------------| | EVR = 0

(period incomplete) | | (turn EVR off, or

|AND -| continue off)

EGRCTF = 0 ----------------------| | EGRPRF = EGRPRF - 1.0

(on time complete)

8-19

EGR STRATEGY, EVR CONTROL ALGORITHM - LHBH0

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8-20

CHAPTER 9

IDLE SPEED CONTROL

9-1

IDLE SPEED CONTROL, GENERIC IDLE SPEED CONTROL - LHBH0

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GENERIC IDLE SPEED CONTROL

OVERVIEW

This chapter describes the adaptive air bypass idle speed control system. In

general, the ISC system is designed to regulate the duty cycle to an air

bypass solenoid as necessary to obtain the desired engine speed for all idle

operating conditions (base idle; hi-cam; various accessory loads) and provide

for a dashpot action. Predicted airflows for the different load states at

idle are adaptively corrected to minimize the impact of hardware variability.

Acceptable idling performance is achieved by a careful balance of bypass air

solenoid control, feedback spark control, and idle fuel modulation.

Idle Fuel Modulation is used to eliminate the fueling errors common to speed

density systems. Although Idle Fuel Modulation is important to overall

idling performance, it should not be used to control idle rpm. Idle Fuel

modulation is described in the fuel chapter.

Feedback Spark offers the fastest way to change engine torque. As such, its

use is important in the control of load transitions like A/C, power steering,

and neutral/drive changes. Aggressive use of Feedback Spark is very

effective in limiting rpm changes during these conditions. The Feedback

Spark strategy is described in the spark chapter.

The amount of airflow through the air bypass is controlled by the solenoid

position, which is in turn determined by the solenoid duty cycle. The

objective of the idle speed control strategy is to determine ISCDTY. As

mentioned above, calibration of the bypass actuator control must be

coordinated with that of Feedback Spark and Idle Fuel Modulation.

The overall bypass air ISC logic sets ISCDTY to one of the following:

I. CRANK

a) Engine Stopped:

ISCDTY = 0%

b) Engine Moving:

ISCDTY = FN884(TCSTRT)%

II. FMEM (MAP or TP sensor out of range):

ISCDTY = FMMISC

III. NORMAL RUNNING ISC:

ISCDTY = IDCMUL \* FN800(DEBYMA) \* FN820(VACUUM) + IDCOFS

9-2

IDLE SPEED CONTROL, GENERIC IDLE SPEED CONTROL - LHBH0

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NORMAL ISC

Under most operating conditions, ISCDTY is obtained from the Normal ISC

logic. During Normal ISC, the strategy can operate in any one of four modes:

DASHPOT PREPOSITION, DASHPOT, RPM CONTROL, or LOCKOUT. The modes will be

described in more detail shortly.

Regardless of which of the four modes is active, the strategy first

calculates a total desired idle airflow, DESMAF:

DESMAF = DESMAF\_PRE + DASPOT + IPSIBR + ISCKAM

DESMAF represents the total engine airflow required for idle. There are

slight differences in the calculation of DESMAF depending on which mode is

active. These differences are summarized below and will be described in more

detail in the discussion of each individual mode.

DASHPOT PREPOSITION MODE (ISCFLG = 0)

- DESMAF\_PRE = Initial prediction, based on rpm, load, and temperature

- DASPOT = DASPTK \* (DSTPBR - (RATCH + DELHYS)) + DASPTO

- IPSIBR = Fixed at last calculated value (not updated in this mode)

- ISCKAMn = KAM cell n, where n is selected by ISFLAG

DASHPOT MODE (ISCFLG = -1)

- DESMAF\_PRE = Initial prediction, based on rpm, load and temperature

- DASPOT = old DASPOT - FN879(DASPOT)

- IPSIBR = Fixed at last calculated value (not updated in this mode)

- ISCKAMn = KAM cell n, where n is selected by ISFLAG

RPM CONTROL MODE (ISCFLG = 1)

- DESMAF\_PRE = Initial prediction, based on rpm, load and temperature

- DASPOT <= DASCTL (DASPOT must be below DASCTL to enter rpm control)

- IPSIBR = old IPSIBR + ISCPSI

- ISCKAMn = KAM cell n, where n is selected by ISFLAG

RPM CONTROL LOCKOUT MODE (ISCFLG = 2)

- DESMAF\_PRE = Initial prediction, based on rpm, load and temperature

- DASPOT <= DASCTL (DASPOT must be below DASCTL to enter Lockout Mode

- IPSIBR = old IPSIBR + ISCPSI

- ISCKAMn = KAM cell n, where n is selected by ISFLAG

9-3

IDLE SPEED CONTROL, GENERIC IDLE SPEED CONTROL - LHBH0

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During Normal ISC, the strategy executes a number of tasks in a specific

order. These tasks perform the actual logic and calculations required for

any of the four modes of operation. The order of execution of the tasks is

listed below. The details of each task are described in separate sections

which follow.

NORMAL ISC TASKS

1) DSDRPM\_CALC - calculation of DSDRPM & DESMAF\_PRE

2) RPMERR\_CALC - calculation of RPMERR\_A & RPMERR\_S

3) DASPOT\_CALC - calculation of DASPOT

4) MODE\_SELECT - selection of mode & setting of ISCFLG

5) IPSIBR\_CALC - IPSIBR update & calculation of DESMAF

6) ISCDTY\_CALC - calculation of DEBYMA & ISCDTY

7) ISCKAM\_UPDATE - adaptive update of ISCKAM

9-4

IDLE SPEED CONTROL, GENERIC IDLE SPEED CONTROL - LHBH0

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DEFINITIONS

INPUTS

Registers:

- APT = Throttle Mode flag.

- ATMR3 = Time since entering RUN mode, secs.

- N = Engine revolutions, RPM.

- N\_RATCH = RPM value which only ratchets down. When not at closed

throttle, N = N\_RATCH. When at closed throttle, N\_RATCH is only allowed

to go down. N\_RATCH is an input to the minimum daspot clip. N\_RATCH

ratchets down to prevent rpm flares after a declutch.

- RATCH = Closed throttle position, counts.

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

- TSLPIP = Time since last PIP, msecs.

- VACUUM = Intake manifold vacuum.

- VSBAR = Filtered vehicle speed for transmission.

Bit Flags:

- AFMFLG = ACT Failure flag; 1 -> ACT out of range.

- CFMFLG = ECT Failure flag; 1 -> ECT out of range.

- CRKFLG = Crank Mode flag; 1 -> Crank mode.

- DISABLE\_ISC = Flag used by VIP to disable the ISC strategy and freeze

ISCDTY at it's present value.

- DNDSUP = Delayed Neutral/Drive switch position. Set when drive

engagement delay is exceeded; 1 -> Drive engaged.

- ISC\_LATCH = ISC delay logic flag; 1 -> Enable delay logic.

- MFMFLG = MAP Failure flag; 1 -> MAP out of range.

- NDSFLG = 0 -> transmission in Neutral, 1 -> transmission in gear.

- REFLG = Re-initialization flag; 1 -> Re-init occurred.

- RUNUP\_FLG = Flag indicating that initial runup is complete; 1 -> runup

rpm exceeded.

- TFMFLG = TP Failure flag; 1 -> TP out of range.

Calibration Constants:

- CRKTIM = Time in run mode to clear 100% cranking duty cycle.

9-5

IDLE SPEED CONTROL, GENERIC IDLE SPEED CONTROL - LHBH0

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- DASMHYST = Hysteresis for DASMPH, mph.

- DASMPH = Minimum VSBAR for declutch DASPOT clip, mph.

- FMMDSD = Failure mode management default desired rpm.

- FMMISC = Default Duty Cycle to ISC, fraction.

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

- TRLOAD = Transmission Load.

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

forced neutral state (NDSFLG = 0).

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

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

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

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

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

(AXOD).

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

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

9-6

IDLE SPEED CONTROL, GENERIC IDLE SPEED CONTROL - LHBH0

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OUTPUTS

Registers:

- DSDRPM = Desired engine speed.

- DSTPBR = Dashpot filtered throttle position.

- ISCDTY = Idle speed control duty cycle.

- N\_RATCH = See above.

Bit Flags:

- FLG\_DASMNQ = VSBAR flip-flop flag for minimum DASPOT clip.

- HCAMFG = Flag indicating the completion of Hi-Cam; 0 -> No desired engine

speed adder exists, 1 -> an RPM adder above base idle is present. Flag

is used in the ISC adaptive update routine to disable updates when HCAMFG

= 1.

- ISCFLG = ISC mode flag; -1 -> Dashpot Mode, 0 -> Dashpot Preposition

Mode, 1 -> Closed Loop rpm Control Mode, 2 -> Closed Loop rpm Control

(Lock-out entry to rpm control).

- RUNUP\_FLG = See above.

9-7

IDLE SPEED CONTROL, GENERIC IDLE SPEED CONTROL - LHBH0

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PROCESS

STRATEGY MODULE: ISC\_OVERVIEW\_COM3

The purpose of the ISC logic is to determine ISCDTY. Under certain

conditions, ISCDTY is set to specific values. Under most operating

conditions, ISCDTY is determined from the Normal ISC logic which is described

later. The logic below describes, at highest level, how ISCDTY is

determined.

OVERALL BYPASS AIR ISC LOGIC

DISABLE\_ISC = 1 ------------------------| (ISC logic disabled)

(Flag set by VIP logic) | freeze ISCDTY

|

| EXIT ISC LOGIC

|

| --- ELSE ---

|

CRKFLG = 1 -----------------------| | (engine stopped)

(in crank mode) |AND -| ISCDTY = 0

| | (0% - actuator closed)

TSLPIP >= 2 sec. -----------------| | DSTPBR = RATCH

(no PIPs yet or stall) |

| EXIT ISC LOGIC

|

| --- ELSE ---

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

(in crank mode) | | (engine moving)

|OR --| ISCDTY = FN884(TCSTRT)%

CRANK DUTY CYCLE | | (duty cycle function of

DELAY LOGIC TRUE -----------------| | temperature at start)

(see logic below) | Do DSDRPM\_CALC

| Do RPMERR\_CALC

| (Update RUNUP\_FLG)

| DSTPBR = RATCH

| EXIT ISC LOGIC

|

| --- ELSE ---

|

MFMFLG = 1 -----------------------| | (FMEM fault present)

|OR --| ISCFLG = 0

TFMFLG = 1 -----------------------| | HCAMFG = 1

| RUNUP\_FLG = 1

| DSDRPM = FMMDSD

| ISCDTY = FMMISC

|

| EXIT ISC LOGIC

|

| --- ELSE ---

|

| (normal ISC)

|

| update FLG\_DASMNQ

| update N\_RATCH

| ISCDTY is calculated from the

| Normal ISC logic described later

9-8

IDLE SPEED CONTROL, GENERIC IDLE SPEED CONTROL - LHBH0

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CRANK DUTY CYCLE DELAY LOGIC

This logic is part of the overall Bypass Air ISC logic described previously.

The duty cycle used during engine cranking is 100%. The following logic

(crank duty cycle delay) can be used to cause the 100% crank duty cycle to

continue to be used for a calibratable time after entering run mode.

REFLG = 0 ------------------------|

(Not a reinit) |

|

RUNUP\_FLG = 0 --------------| |AND -| "TRUE"

(runup not complete) | | |

| | |

| | |

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

(in drive) | | |

| | |

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

(closed throttle) |AND -| |

| |

ATMR3 < CRKTIM -------| |

(time since run | |

mode) | |

| |

ISC\_LATCH = 1 --------| |

| --- ELSE ---

|

| "FALSE"

ISC\_LATCH LOGIC

ISC\_LATCH is a software flag which is used to implement the above crank duty

cycle delay logic. It is not displayable and is only included here to

describe the above logic function.

DISABLE\_ISC = 0 ------------|

(not disabled by VIP) |AND -|S Q-| ISC\_LATCH = 1

| | |

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

(in crank mode) | |

| |

DISABLE\_ISC = 0 ------------| | |

(not disabled by VIP) | | |

| | |

CRKFLG = 0 -----------------|AND -|C |

(not closed throttle) | |

| |

DUTY CYCLE DELAY -----------| |

LOGIC "FALSE" |

| --- ELSE ---

|

| ISC\_LATCH = 0

9-9

IDLE SPEED CONTROL, GENERIC IDLE SPEED CONTROL - LHBH0

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FLG\_DASMNQ and N\_RATCH LOGIC

This logic is used by DASPOT. It is shown here because it is executed as

part of the OVERALL ISC LOGIC. It is executed anytime the Normal Isc logic

is done so it will be available, if required by DASPOT mode.

FLG\_DASMNQ

VSBAR >= DASMPH + DASMHYST -------|S Q-| FLG\_DASMNQ = 1

| | (Prepare to add dashpot

VSBAR < DASMPH -------------------|C | to prevent declutch stall)

|

| --- ELSE ---

|

| FLG\_DASMNQ = 0

N\_RATCH

APT = 0 OR 1 ---------------------|

|OR --| N\_RATCH = N

NDSFLG = 1 -----------------| | |

|AND -| | --- ELSE ---

TRLOAD = 3 -----------------| |

|

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

|AND -| N\_RATCH = N

N <= N\_RATCH ---------------------| | (let N\_RATCH come down)

|

| --- ELSE ---

|

| No change to N\_RATCH

| (RPM flare, keep N\_RATCH

| the same)

9-10

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

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DSDRPM CALCULATION

OVERVIEW

This section describes the calculation of desired idle rpm (DSDRPM) and the

predicted mass air flow at idle (DESMAF\_PRE). DSDRPM is used to calculate

DESMAF\_PRE, and also as a control input for closed loop and adaptive idle

speed control.

The strategy calculates a desired value for engine speed, DSDRPM, which it

attempts to maintain while in idle speed control. DSDRPM is composed of a

Base portion, plus a Hicam portion, plus additional adders for A/C, Power

Steering and Low ACT.

DSDRPM = Base + Hicam [+ RPMINC] [+ DNAC] [+ DNPOWS]

The square brackets indicate that the adders may or may not be present,

depending on certain control logic. Whenever a square bracket appears in the

text, there will be control logic which follows to indicate under what

conditions the adder is used.

GPAS Requirements:

Automatic transmission vehicles operating in drive are limited by Ford GPAS

requirements to a maximum desired idle RPM. Under these conditions, DSDRPM,

including all adders, is clipped to the value ISCLPD as a maximum.

Base portion of DSDRPM:

The Base portion of DSDRPM is the part that does not go away after the engine

warms up.

Base = NUBASE or DRBASE

Hicam portion of DSDRPM:

In normal (non-VIP) strategy, the Hicam portion of DSDRPM is composed of a

variety of adders for special operating conditions (ECT, ACT, IDLTMR, etc).

Non-VIP: Hicam = pre\_fn825a + FN825B [+pre\_bzzrpm]

[+FN826A] [+ (FN880 + FN821A)]

In VIP, a special equation is used for DSDRPM:

VIP: DSDRPM = RVIPRPM [+RPMINC] [+DNAC] [+DNPOWS]

DSDRPM is allowed to rise instantaneously, but any decrease in value is

filtered to prevent a sudden drop. This filtered value of DSDRPM is called

DESNLO (time constant TCDESN for non-VIP, VTCDSN for VIP). If DSDRPM is

decreasing, it is set to the filtered value, DESNLO. The flag, HCAMFG, is

set if Hicam is non-zero, or if DSDRPM is decreasing. HCAMFG is used to

prevent adaptive airflow updates (ISCKAM).

9-11

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

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DESMAF\_PRE CALCULATION

The predicted desired mass air flow (DESMAF\_PRE) is the airflow which is

expected to be required to provide a particular engine speed. The prediction

is a function of DSDRPM, ECT, ATMR3 (time since entering run mode), power

steering, A/C, and Cold Start Spark. This term is later added to an

integration term (IPSIBR), a dashpot term (DASPOT), and an adaptive term

(ISCKAM), to produce the total DESMAF.

DESMAF\_PRE = (FN875D or FN875N) \* FN1861 [+ AC\_PPM] [+ PSPPM] [+ CSSMAF]

- DESMAF\_PRE is a non-displayable parameter.

- FN875N and D are functions of DSDRPM. This means that, if a DSDRPM adder

is used for power steering or A/C, the airflow to give the RPM increase

is already accounted for in DESMAF\_PRE. AC\_PPM, PSPPM, and CSSMAF

represent only the airflow needed for the increased load, not the

increased RPM.

9-12

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

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DEFINITIONS

INPUTS

Registers:

- AC\_PPM = AC delta air mass, calculated.

- ACT = Air charge temperature, deg F.

- A3CTMR = A/C state transition timer. Timer is reset to 0 on every A/C

state change.

- APT = Throttle mode flag.

- ATMR1 = Timer which counts up in run/underspeed mode.

- ATMR3 = Timer which counts up in run mode. (Reset to 0 only at powerup)

- Base = Symbol used to represent the base RPM portion of DSDRPM. Base is

not displayable.

- DSDRPM = Desired engine speed. See Overview section for definition of

the various uses of this register.

- DESNLO = Filtered value of DSDRPM. Applied only when DSDRPM is

decreasing, using time constant TCDESN. Engine running VIP uses time

constant VTCDSN.

- ECT = Engine coolant temperature, deg. F.

- Hicam = Symbol used to represent the hi-cam adders to DSDRPM. Hicam is

not displayable.

- ISFLAG = Flag that indicates the degree of loading on the engine at Idle.

See table at the end of the DSDRPM logic.

- ISLAST = Register which indicates the engine load state from the previous

background pass.

- LOACT = Lowest value of ACT since startup.

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.

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

- CSSFLG = Cold start spark flag; 0 -> no cold start spark required, 1 ->

cold start spark required.

- DNDSUP = Delayed neutral/drive flag: 0 -> in neutral, no load; 1 -> in

drive, loaded.

9-13

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

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- 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.

- PTSCR = Part throttle since crank mode flag: 0 -> driver has not tipped

in since start; 1 -> driver tipped in, kick down desired RPM.

- VRUN\_ISCFLG = 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:

- 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.

- BZZRPM\_ALT = Alternate BZZRPM.

- BZZTM = Time for which BZZRPM adder is in effect. ..Typical value - 3

seconds.

- BZZTM\_ALT = Alternate BZZTM.

- CHGRPM = Maximum RPM delta above base to enable battery charge, I/M

logic. Also upper clip on DSDRPM adder due to battery charge and I/M.

(FN821A + FN880), RPM.

- CSSMAF = Cold start spark DESMAF multiplier. Used to compensate for

increased airflow requirement due to retarded spark.

- 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.

- DRBASE = Base desired engine speed in drive.

- DRBASE\_ALT = Alternative Cal DRBASE.

- FN825A(ECT) = RPM adder as a function of ECT. Provides base Hi-Cam

function.

- FN825A\_ALT = Alternative FN825A.

- FN825B(ACT) = RPM adder as a function of ACT. Provides higher idle at

very low ambients.

9-14

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

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- FN826A(TCSTRT) = RPM adder as a function of ECT at start. This adder is

not used when either the first part throttle transition since exiting

crank is observed or the time since start exceeds a calibrated value

(TKDTM).

- FN875D(DSDRPM) = Airflow required for closed throttle operation in drive.

Input to this function is 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).

A hot wire airmeter can be remotely mounted to measure airflow directly over

the desired speed range. Equipment is available at APTL to perform this

procedure.

- FN875N(DSDRPM) = Airflow required for closed throttle operation in

neutral. Input to this function is DSDRPM.

- FN880(IDLTMR) = DSDRPM adder vs. time at idle (IDLTMR). Used as part of

the inspection/maintenance strategy. Remember 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.

- FN885 = A/C DESMAF adder based on N.

- FN887A(ACT) = A/C air flow correction based on ACT.

- 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.

- ISCLPD = A clip on the maximum desired speed that can be requested with

vehicle in drive. Usually the GPAS defined speed allowed at 0.2 miles on

a cold start. ..Typical value - 1100 RPM.

- MINACT = Minimum ACT before adding RPMINC to desired RPM.

- NUBASE = Base desired engine speed in neutral.

- NUBASE\_ALT = Alternative Cal NUBASE.

- PSPPM = Airflow increment required when power steering load is sensed.

Value increments the desired flow through the ISC actuator to account for

increased load. ..Typical value - 0.10 ppm.

- PSPSHP = Software switch used to indicate if Power Steering Pressure

Switch is present; 1 -> switch used; 0 = no switch.

- TCDESN = Filter constant for the desired engine speed calculated value

(DSDRPM). Used to slow changes in desired speed in the decreasing

direction. ..Typical value - 3.5 sec

9-15

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

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- TKDTM = Time since start after which FN826A is eliminated as a desired

RPM adder. ..Typical value - 20 seconds.

- TRLOAD = Transmission Load switch - 0 -> Manual transmission, no clutch

or gear switch, NDSFLG = 0; 1 -> Manual trans, no clutch or gear switch;

2 -> Manual trans, one clutch or gear switch; 3 -> Manual trans, both

switches; 4 -> Automatic trans, NDS; 5 -> Automatic trans, NPS; 6 ->

Automatic trans, 7 position PRNDL; 7 -> Automatic trans, PRNDL switches

(4EAT).

- RVIPRPM = Desired RPM controlled by Engine Running VIP strategy.

- VTCDSN = Filter constant for ISC ramp down down, unitless.

OUTPUTS

Registers:

- DSDRPM = See above.

- DESMAF\_PRE = Predicted desired idle air flow, ppm. This is the open loop

air flow prediction which is required to idle, calculated as a function

of ECT and time since start and including A/C, power steering and heated

windshield adders. It does not include any closed loop or KAM

corrections, and is NOT DISPLAYABLE.

- DESNLO = See above.

- LOACT = See above.

Bit Flags:

- HCAMFG = Flag indicating the completion of Hi-Cam; 0 -> no desired engine

speed adder exists, 1 -> an rpm adder above base idle is present. Flag

is used in the ISC adaptive update routine to disable updates when HCAMFG

= 1.

- ISFLAG = See above.

- PSFLAG = Flag to indicate last pass value of power steering to check for

transitions: 1 -> power steering was on.

9-16

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

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PROCESS

STRATEGY MODULE: ISC\_DSDRPM\_COM1

For Normal Strategy: (VRUN\_ISCFLG = 0)

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

DSDRPM = (NUBASE or DRBASE) + Hicam [+ RPMINC] [+ DNAC] [+ DNPOWS]

ALT\_CAL\_FLG = 1 ------------------------| Hicam = FN825A\_ALT + FN825B

| [+ FN821A] [+ FN880]

| [+ pre\_bzzrpm] [+ FN826A]

| pre\_nubase = NUBASE\_ALT

| pre\_drbase = DRBASE\_ALT

|

| --- ELSE ---

|

| Hicam = FN825A + FN825B [+FN821A]

| [+ FN880] [+ pre\_bzzrpm] [+ FN826A]

| pre\_nubase = NUBASE

| pre\_drbase = DRBASE

For VIP strategy: (VRUN\_ISCFLG = 1)

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

DSDRPM = RVIPRPM [+ RPMINC] [+ DNAC] [+ DNPOWS]

If DSDRPM is decreasing, the following filtering is done:

DSDRPM < DESNLO -----------------| (Filter DSDRPM - see notes below)

(Decreasing) | DESNLO = UROLAV(DSDRPM,TCDESN)

| DSDRPM = DESNLO

|

| --- ELSE ---

|

| (Do Not filter DSDRPM)

| DESNLO = DSDRPM

NOTES:

- For VIP: The time constant VTCDSN is used in place of TCDESN. If VTCDSN

= 0, the time constant defaults to TCDESN.

- DESNLO carries an extra byte of resolution which is not reflected in

DSDRPM.

9-17

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

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ALT\_CAL\_FLG = 1 -------------------------| pre\_bzzrpm = BZZRPM\_ALT

| pre\_fn825a = FN825A\_ALT

| pre\_bzztm = BZZTM\_ALT

|

| --- ELSE ---

|

| pre\_fn825a = FN825A

| pre\_bzzrpm = BZZRPM

| pre\_bzztm = BZZTM

If automatic transmission and in drive, the GPAS clip is applied:

ALT\_CAL\_FLG = 1 -------------------------| pre\_isclpd = ISCLPD\_ALT

|

| --- ELSE ---

|

| pre\_isclpd = ISCLPD

TRLOAD > 3 ----------------|

(Not manual transmission) |

|

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

(In drive) |AND -| Clip DSDRPM to pre\_isclpd

| | as a maximum

DSDRPM > ISCLPD -----------| |

| --- ELSE ---

|

| Do not clip DSDRPM

NOTE: The square brackets above,"[ ]", indicate that a term is optional.

Anytime a square bracket appears in this chapter, there will be logic which

follows to indicate under what conditions the optional term is used. The

logic DOES NOT necessarily indicate the order in which software is executed.

9-18

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

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(NUBASE or DRBASE) Logic:

TRLOAD > 3 ---------------|

(Auto transmission) |OR --| Use pre\_drbase in DSDRPM calculation

| |

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

(In drive) |

| --- ELSE ---

|

| Use pre\_nubase in DSDRPM calculation

[+RPMINC] Logic: (Low ACT and A/C panel switch adder)

ACT < LOACT --------------------| LOACT = ACT (lowest ACT since

| startup)

LOACT <= MINACT ----------------|

(ACT below normal) |

|OR --| Add RPMINC to DSDRPM

ACD = 1 ------------------| | |

(A/C Panel Switch on) | | |

|AND -| |

ACDHP = 1 ----------------| |

(A/C Panel Switch present) |

| --- ELSE ---

|

| Do NOT add RPMINC

[+DNAC] Logic: (Air Conditioning adder)

ACCFLG = 0 ---------------|

(A/C Clutch off) |

|

ACIFLG = 0 ---------------|AND -|

(A/C Load off) | |

| |

A3CTMR < DACTM -----------| |OR --| Add DNAC to DSDRPM

(Delay to turn | |

off A/C adder) | |

| |

ACCFLG = 1 ---------------------| |

| |

ACIFLG = 1 ---------------------| |

| --- ELSE ---

|

| Do NOT add DNAC

[+DNPOWS] Logic: (Power Steering adder)

PSPSHP = 1 ---------------------|

(PSPS Present) |

|AND -| Add DNPOWS to DSDRPM

POWSFG = 1 ---------------------| |

(PS On) | --- ELSE ---

|

| Do NOT add DNPOWS

9-19

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

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OPTIONAL TERMS FOR Hicam CALCULATION

[+pre\_bzzrpm] Logic: (Buzz up adder)

ATMR1 < pre\_bzztm --------------------| Add pre\_bzzrpm to Hicam

(Buzz time not expired) |

| --- ELSE ---

|

| Do NOT add pre\_bzzrpm

[+FN826A] Logic: (Engine Cleanout adder)

ATMR1 < TKDTM ------------------|

(Kickdown time not up) |

|AND -| Add FN826A to DSDRPM

PTSCR = 0 ----------------| | |

(Not PT since Crank) |OR --| |

| |

ATMR1 < pre\_bzztm --------| |

(Buzz time not up) |

| --- ELSE ---

|

| Do NOT add FN826A

[+ (FN880 + FN821A)] Logic:

(Battery charge control and Inspection Maintenance)

DSDRPM < CHGRPM ----------------------| Add (FN880 + FN821A) to DSDRPM

| Clip DSDRPM to CHGRPM as a

| maximum

|

| --- ELSE ---

|

| Do NOT add (FN880 + FN821A)

9-20

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

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DESMAF\_PRE CALCULATION

DESMAF\_PRE = ((FN875N or FN875D) \* FN1861 [+AC\_PPM] [+PSPPM]) [\*CSSMAF]

(FN875N or FN875D) Logic:

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

(Manual transmission) |

|OR --| Use FN875N in DESMAF\_PRE

DNDSUP = 0 ---------------------| |

(In Neutral) | --- ELSE ---

|

| Use FN875D in DESMAF\_PRE

[+AC\_PPM] Logic:

ACCFLG = 1 ---------------------|

(A/C on) |

|OR --| AC\_PPM = FN885 \* FN887A

ACIFLG = 1 ---------------------| | Add AC\_PPM to DESMAF\_PRE

(A/C Load impending) |

| --- ELSE ---

|

| AC\_PPM = 0

| Add AC\_PPM to DESMAF\_PRE

[+PSPPM] Logic:

PSPSHP = 1 ---------------------|

(PSPS present) |

|AND -| Add PSPPM to DESMAF\_PRE

POWSFG = 1 ---------------------| |

(Power Steering on) | --- ELSE ---

|

| Do NOT add PSPPM

[\*CSSMAF] Logic:

CSSFLG = 1 ---------------------------| Multiply DESMAF\_PRE by CSSMAF

(Cold Start spark in use) |

| --- ELSE ---

|

| Do NOT Multiply by CSSMAF

NOTE: DESMAF\_PRE is a non-displayable parameter.

9-21

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ISFLAG/ISLAST LOGIC

ISLAST reflects the state of ISFLAG on the last program pass. ISFLAG is

set according to the following chart:

AUTO IN DRIVE MANUAL OR AUTO IN NEUTRAL

(DNDSUP = 1 ) (DNDSUP = 0)

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

A/C Off | 0 | 3 |

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

A/C Panel SW on or | | |

LOACT <= MINACT | 1 | 4 |

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

A/C On | 2 | 5 |

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

PSFLAG Logic: (Last state of POWSFG)

PSPSHP = 0 ----------------------------| Bypass PSFLAG logic

(No pressure switch) |

| --- ELSE ---

POWSFG = 0 ----------------------| |

(PS is off) | |

|AND -| PSFLAG = 0

PSFLAG = 1 ----------------------| | IBGPSI = 0

|

| --- ELSE ---

PSFLAG = 0 ----------------------| |

(PS is Off->On transition) | |

|AND -| PSFLAG = 1

POWSFG = 1 ----------------------| | IBGPSI = 0

|

| --- ELSE ---

|

| No Change to PSFLAG

9-22

IDLE SPEED CONTROL, DESIRED RPM CALCULATION - LHBH0

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HCAMFG Logic: (Enable/Disable Adaptive airflow updates)

VRUN\_ISCFLG = 1 -----------|

(In running VIP) |

|AND -|

RVIPRPM <> NUBASE ---------| |

|

VRUN\_ISCFLG = 0 -----------| |

(In Normal Strategy) | |

|AND -|OR --| (Disable Adaptive airflow

Hicam <> 0 ----------------| | | update)

(See Hicam Equation) | | HCAMFG = 1

| |

DSDRPM < DESNLO -----------------| |

(DSDRPM decreasing) | |

| |

PSPSHP = 1 ----------------| | |

(PSPS Switch present) | | |

|AND -| |

POWSFG = 1 ----------------| |

(PS is on) |

| --- ELSE ---

|

| (Allow Adaptive airflow

| update)

| HCAMFG = 0

9-23

IDLE SPEED CONTROL, RPM ERROR CALCULATION - LHBH0

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RPM ERROR CALCULATION

OVERVIEW

Two separate RPM error calculations are executed in RPMERR\_CALC. An

instantaneous value (RPMERR) is calculated as the difference between the

desired and actual RPM -- positive value of RPMERR is an engine speed below

desired, a negative value indicates engine speed above desired.

The instantaneous value of RPMERR is then filtered using time constants TCBPA

(for bypass air) and TCFBS (for feedback spark). The two filtered values.

RPMERR\_A and RPMERR\_S are used in bypass air RPM control and feedback spark,

respectively.

In addition, RPMERR\_CALC contains the set logic for RUNUP\_FLG, which is used

to disable IPSIBR updates, idle fuel modulation and feedback spark during the

initial runup. The flag is cleared in CRANK/UNDERSPEED/RUN mode selection.

DEFINITIONS

INPUTS

Registers:

- DSDRPM = Desired engine speed. See overview section for definition of

the various uses of this register.

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

- ISCFLG = ISC mode indicator flag; -1 -> Dashpot mode, 0 -> Dashpot

Preposition Mode, 1 -> Closed Loop RPM Control Mode, 2 -> Closed Loop RPM

Control (Lock-out entry to RPM control).

- N = Engine RPM.

- RPMERR\_A = Filtered rpm error for bypass air calculations.

- RPMERR\_S = Filtered rpm error for feedback spark.

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

- RUNUP\_FLG = Flag indicating initial runup is complete; 1 -> runup

complete.

- VRUN\_ISCFLG = RVIP idle speed control flag.

Calibration Constants:

- RUNUP\_DIFF = RPM difference from DSDRPM to set RUNUP\_FLG = 1.

- RUNUP\_DIFF\_A = Pre-delivery RPM difference from DSDRPM to set RUNUP\_FLG =

1.

9-24

IDLE SPEED CONTROL, RPM ERROR CALCULATION - LHBH0

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- TCBPA = Time constant for RPMERR\_A.

- TCFBS = Time constant for RPMERR\_S.

- V\_RUNUP\_DIFF = RPM difference from DSDRPM to set RUNUP\_FLG = 1 when in

VIP.

OUTPUTS

Registers:

- RPMERR = Instantaneous rpm error (DSDRPM - N).

- RPMERR\_A = See above.

- RPMERR\_S = See above.

Bit Flags:

- RUNUP\_FLG = See above.

9-25

IDLE SPEED CONTROL, RPM ERROR CALCULATION - LHBH0

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PROCESS

STRATEGY MODULE: ISC\_RPMERR\_COM3

always -------------------------| RPMERR = DSDRPM - N

ISCFLG > 0 ---------------------| RPMERR\_A = ROLAV(RPMERR,TCBPA)

(RPM control or lockout) | (calculate RPM error for airflow control)

| RPMERR\_S = ROLAV(RPMERR,TCFBS)

| (calculate RPM error for spark control)

|

| --- ELSE ---

|

| RPMERR\_A = RPMERR

| RPMERR\_S = RPMERR

VRUN\_ISCFLG = 1 ----------------| pre\_runup = V\_RUNUP\_DIFF

|

| --- ELSE ---

|

ALT\_CAL\_FLG = 1 ----------------| pre\_runup = RUNUP\_DIFF\_A

|

| --- ELSE ---

|

| pre\_runup = RUNUP\_DIFF

ECTCNT >= 8 --------------|

(TCSTRT OK to use) |

|

N > DSDRPM + pre\_runup ---|AND -| RUNUP\_FLG = 1

(runup RPM exceeded) | | (initial runup complete)

| |

RUNUP\_FLG = 0 ------------| |

(first time this start) |

| --- ELSE ---

|

| No change to RUNUP\_FLG

9-26

IDLE SPEED CONTROL, DASHPOT CALCULATIONS - LHBH0

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DASHPOT CALCULATIONS

OVERVIEW

Dashpot Pre-position

Logic controlling the dashpot pre-position airflow is intended to increase

the ISC duty cycle during part/WOT operation. Strategy determines the rate

at which ISC valve flow increases/decreases in part/WOT operation as well as

the maximum allowed pre-position airflow. Adequate pre-position airflow

(DASPOT) is essential prior to entering the dashpot control mode in order to

avoid HC spiking and/or deceleration stalls. The calculated pre-position

airflow increment is added to an adaptively corrected idle flow requirement

(DESMAF) prior to output of the ISC duty cycle. Pre-position airflow

(DASPOT) is a function of the difference between a filtered throttle position

(DSTPBR) and the lowest recorded throttle position (RATCH).

DSTPBR is a time dependent rolling average filter of Throttle position. It

is updated once per background loop while in RUN or Underspeed Mode. The two

time constants, TCDASU and TCDASD are calibratable. TCDASU is used when

DSTPBR is filtering UP to TP. TCDASD is used to filter DSTPBR DOWN to TP.

The DASPOT value is adjusted as TP changes to provide the desired dashpot

action to decelerations as initiated over the range of possible engine

operating conditions, using separate time constants (TCDASU/TCDASD) to

control the response of DSTPBR.

Dashpot Bleed

During Closed Throttle Mode, the DASPOT airflow is "bled off" by decrementing

it. This action smooths the transition into RPM control by gradually

eliminating the DASHPOT contribution to the Idle airflow, DESMAF. The bleed

rate is determined by FN879. This allows a more aggressive daspot

calibration to eliminate clunk in gear without affecting neutral.

9-27

IDLE SPEED CONTROL, DASHPOT CALCULATIONS - LHBH0

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DEFINITIONS

INPUTS

Registers:

- APT = Throttle Mode Flag; -1 -> Closed Throttle, 0 -> Part Throttle, 1 ->

Wide Open Throttle.

- DSTPBR = Time dependent rolling average filter of throttle position.

Filtered using TCDASU when filtering UP to TP, and TCDASD when filtering

DOWN to TP.

- ISCFLG = ISC mode indicator flag; -1 -> Dashpot Mode; 0 -> Dashpot

Preposition Mode; 1 -> Closed Loop RPM Control Mode; 2 -> Closed Loop RPM

Control (Lock-out entry to RPM control)

- N = Engine revolutions, RPM.

- N\_RATCH = RPM value which only ratchets down. When not at closed

throttle, N = N\_RATCH. When at closed throttle, N\_RATCH is only allowed

to go down. N\_RATCH is an input to the minimum daspot clip. N\_RATCH

ratchets down to prevent rpm flares after a declutch.

- RATCH = Closed throttle position, counts

- TP = Throttle position sensor.

- VSBAR = Vehicle speed, MPH.

Bit Flags:

- FLG\_DASMNQ = VSBAR flip-flop flag for minimum DASPOT clip.

- VRUN\_ISCFLG = RVIP Idle Speed Control flag; 1 -> running VIP ISC action,

0 -> normal ISC action.

Calibration Constants:

- 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 DASMAX and

divide the result by the throttle delta between RATCH and this maximum

dashpot airflow to determine the DASPTK value.

- DASPTO = An offset term applied to the DASPOT calculation. Insures at

least some dashpot airflow on rapid tip-in/tip-outs.

9-28

IDLE SPEED CONTROL, DASHPOT CALCULATIONS - LHBH0

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- DELHYS = Closed to part throttle hysteresis in TP counts. DELHYS should

be set equal to DELTA + HYSTS (closed throttle breakpoint). This starts

the dashpot calculation relative to the C.T./P.T. breakpoint to prevent

changes in dashpot when leaving closed throttle.

- DPNEU\_MUL = Neutral daspot multiplier, unitless.

- FN879 = A background driven decrement to the dashpot preposition airflow

register (DASPOT) as a function of DASPOT. FN879 can be calibrated to

achieve an exponentially decaying dashpot which is useful in decaying the

large DASPOT values used to control over-rich tip out conditions.

- FN882A(N - DSDRPM) = Maximum dashpot clip as a function of the RPM delta

above desired rpm. (N - DSDRPM) is clipped to 0 as a minimum.

- FN891(VSBAR) = Dashpot maximum clip as a function of vehicle speed. Used

in automatic transmission vehicles at higher vehicle speeds to prevent

harsh backout shifts by limiting large values of dashpot.

- FN894(N\_RATCH - DSDRPM) = Minimum DASPOT airflow clip for 1st, 2nd, and

3rd gears, ppm. For manual transmissions, FN894 can be used to prevent

declutch stalls. The input is N\_RATCH which only ratchets down after the

declutch. This is done to prevent the rpm from hanging up if it flares

after the declutch.

- TCDASD = Time constant used when TP is less than or equal to the filtered

TP value. Should be calibrated such that part throttle backouts where

closed throttle is not entered do not exhibit a run-on feel. Too fast a

filter can have the effect of greatly reducing dashpot airflow prior to

entry into dashpot control.

- TCDASU = Filter constant used when TP is greater than the filtered TP

value (DSTPBR). The larger the time constant the more slowly

pre-position airflow will be available to respond to tip in/tip out

actions. Fast response can also be obtained by use of the offset value

DASPTO without the potential runaway feel that may come with too fast a

filter constant/airflow gain (DASPTK) combination.

- V\_879\_MULT = VIP multipler for DASPOT function FN879.

9-29

IDLE SPEED CONTROL, DASHPOT CALCULATIONS - LHBH0

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OUTPUTS

Registers:

- DASPOT = Dashpot contribution to idle air flow. Used to provide a

preposition air flow in Part Throttle and Wide Open Throttle Modes, which

is "bled off" after a transition to Closed Throttle. This gradual air

decrement allows a smooth transition to RPM control.

- DSTPBR = See above.

CALIBRATION INFORMATION

Typical values are provided for the following calibration constants:

- DASPTK = 0.002 ppm/TP count

- DASPTO = 0.10 ppm

- FN879 = (0,0.001) (0.1,0.002) (0.3,0.006) (0.75,0.05) (2.00,0.10)

- TCDASD = 0.75 sec.

- TCDASU = 3.3 sec.

9-30

IDLE SPEED CONTROL, DASHPOT CALCULATIONS - LHBH0

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PROCESS

STRATEGY MODULE: ISC\_DASPOT\_COM1

DASHPOT-PREPOSITION MODE ( APT >= 0 )

(Mode select logic will set ISCFLG to 0)

While at PT or WOT, airflow is added to the DASPOT term to prepare for a

deceleration:

DASPOT = DASPTK \* (DSTPBR - (RATCH + DELHYS)) + DASPTO

Where, DSTPBR = ROLAV(TP,time constant)

time constant = TCDASU for increasing TP (TP > old DSTPBR)

= TCDASD for decreasing TP (TP <= old DSTPBR)

Clips:

- DASPOT is clipped to the smaller of FN882A(N - DSDRPM)\*FN891(VSBAR) or

2.99 as a maximum; clip (N - DSDRPM) to zero as a minimum.

- minimum clip may be in effect.

FN894 minimum DASPOT clip logic

FLG\_DASMNQ = 1 ---------------------|

(speed above threshold) |

|

DASPOT < FN894(N\_RATCH - DSDRPM) ---|AND -| Clip DASPOT to

(airflow too low) | | FN894(N\_RATCH - DSDRPM) \*

| | DPNEU\_MUL as a minimum

DNDSUP = 0 -------------------------| |

| --- ELSE ---

FLG\_DASMNQ = 1 ---------------------| |

(speed above threshold) | |

| |

DASPOT < FN894(N\_RATCH - DSDRPM) ---|AND -| Clip DASPOT to

(airflow too low) | | FN894(N\_RATCH - DSDRPM)

| | as a minimum

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

| --- ELSE ---

|

| Do not clip to FN894

9-31

IDLE SPEED CONTROL, DASHPOT CALCULATIONS - LHBH0

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DASHPOT MODE ( APT = -1 )

(Mode select logic will set ISCFLG to -1)

At closed throttle, the airflow which was previously added to the DASPOT term

is bled away. DASPOT is calculated from the equation below either during

non-VIP vehicle operation, or in running VIP when VRUN\_ISCFLG = 0.

DASPOT = DASPOT - FN879(DASPOT)

clips:

- no maximum clip

- DASPOT is clipped to either 0, FN894 \* DPNEU\_MUL, or FN894 as a minimum

(see FN894 on the previous page)

DASPOT is calculated from the equation below

when in running VIP, and VRUN\_ISCFLG = 1:

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

DASPOT = DASPOT - (FN879(DASPOT) \* V\_879\_MULT)

clips:

- no maximum clip

- DASPOT is clipped to either 0, FN894 \* DPNEU\_MUL, or FN894 as a minimum

(see FN894 on the previous page)

9-32

IDLE SPEED CONTROL, MODE SELECT - LHBH0

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MODE SELECT (MODE\_SELECT)

OVERVIEW

Bypass idle speed control has four modes of operation; dashpot, dashpot

preposition, RPM control, and RPM control lockout. A flag is used to

identify these modes for both calibrator convenience and required interaction

with fuel modulation and spark feedback strategies.

The mode select logic selects the mode of operation and sets a flag (ISCFLG)

which is used to adjust the total desired airflow through the air bypass

valve.

\* ISCFLG = -1 DASHPOT CONTROL

\* ISCFLG = 0 DASHPOT PRE-POSITION

\* ISCFLG = 1 CLOSED LOOP RPM CONTROL

\* ISCFLG = 2 CLOSED LOOP RPM CONTROL (Lock-out entry to RPM control)

- DASHPOT PRE-POSITION MODE (ISCFLG = 0)

In engine run/underspeed mode and when operating at part or wide open

throttle the ISC system is placed in dashpot pre-position mode. In this

mode the ISC duty cycle is incremented a calibratable amount in

anticipation of a required dashpot action. Proper dashpot operation is

essential on systems having speed density fuel controls in order to avoid

tip in/tip out stalls and HC spiking on decels.

- DASHPOT MODE (ISCFLG = -1)

In engine run/underspeed mode and having just transitioned from part to

closed throttle the system is placed in ISC dashpot control mode. The

length of time the ISC system will remain in dashpot control is both

hardware/strategy dependent (some applications have VSS; some manual

transmission applications have gear and clutch switches). Regardless of

the length of time required to enter RPM control, as long as closed

throttle operation is maintained the amount of airflow specified by the

dashpot pre-position (see dashpot pre- position logic) is decremented at

a constant rate until exhausted (until DASPOT = 0).

- CLOSED LOOP RPM CONTROL (ISCFLG = 1 OR 2)

For normal entry into C/L RPM control the following conditions must be

satisfied:

. If VSS hardware is used it must indicate a speed less than MINMPH

. If a manual trans. with gear/clutch switches; must indicate neutral

9-33

IDLE SPEED CONTROL, MODE SELECT - LHBH0

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\* Note: Although the system can provide acceptable function

without the above mentioned hardware either item will increase

reliability in production. The vehicle speed sensor has

calibration benefits outside of ISC (lean cruise control, etc.)

and should be considered when specifying system assumptions for

future applications utilizing ISC.

. Regardless whether the above hardware is used, normal entry into RPM

control requires that actual engine speed be less than or equal to

(DSDRPM + RPMCTL) and that closed throttle is indicated.

The following discussion will attempt to describe entry into C/L RPM control

through the lock-out logic (ISCFLG = 2). In a normal deceleration the

dashpot bleed time will be short relative to the vehicle coastdown time. As

soon as engine speed drops low enough the ISC system should enter RPM

control. However, due to hysteresis in the bypass valve, overspecification

of idle airflow requirements prior to adaptive ISC learning, ISC learning in

an unusually high state of engine load (400 psi A/C head pressure), etc. the

ISC actuator may flow too much air at the specified idle duty cycle to allow

normal entry in RPM control. When this condition occurs the system will

remain in dashpot control until it can recognize that it should in fact be in

RPM control.

Obviously this task is easy if you happen to have a VSS or have a manual

calibration with gear/clutch switches. The problem without this hardware is

to differentiate between a deceleration condition (especially a constant rate

of speed deceleration -- as in a coast down a mountain) and a true

locked-out-of-idle condition. Most of the logic in the above-mentioned

attachment deals with this lock-out feature.

To differentiate between deceleration and idle the rate of change in RPM is

first evaluated over a calibrated period of time (ISCTM). If the speed has

remained within a specified deadband (NDIF) for this time period a second

check is performed to compare MAP with a calibrated value (FN862(BP) for A/C

off; FN862(BP) + ACMAP for A/C on). The assumption is that all idle MAP

values, including green engine/altitude effects etc., will be greater than

this value and all true deceleration conditions, including the same

variabilities, will yield lower MAP. It goes without saying that great care

must be taken in selecting the correct calibration for FN862(BP).

If the ISC system were locked in dashpot control and both the rate of engine

speed change and MAP criteria were satisfied the strategy would be forced

into C/L RPM control with ISCFLG indicating 2. This state would be present

until the speed fell below the normal entry point. The adaptive ISC would

learn the required correction, assuming sufficient time at idle, and

subsequent dashpot to RPM control transitions should follow a normal entry

path.

9-34

IDLE SPEED CONTROL, MODE SELECT - LHBH0

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DEFINITIONS

INPUTS

Registers:

- APT = Throttle Mode flag.

- BP = Barometric Pressure.

- DASCTL = Value of DASPOT, below which RPM control can begin, with any

remaining DASPOT airflow being rolled into IPSIBR.

- DASPOT = Dashpot contribution to idle air flow. Used to provide a

preposition air flow in Part Throttle and Wide Open Throttle Modes, which

is "bled off" after a transition to Closed Throttle. This gradual air

decrement allows a smooth transition to RPM control.

- DSDRPM = Desired engine speed.

- ISCFLG = ISC mode indicator flag; -1 -> Dashpot Mode, 0 -> Dashpot

Preposition Mode, 1 -> Closed Loop RPM Control Mode, 2 -> Closed Loop RPM

Control (Lock-out entry to RPM control).

- ISCTMR = RPM sample timer for lockout logic, secs. Timer is cleared on

each RPM sample.

- MAP = Manifold Absolute Pressure.

- N = Engine speed, RPM.

- NLAST = Last sampled RPM for lockout logic. NLAST is re-calculated when

ISCTMR exceeds ISCTM.

- SETTMR = RPM control entry delay timer, secs. Used to delay entry into

RPM control until manifold stabilizes.

- VSBAR = Filtered vehicle speed, mph.

Bit Flags:

- ACCFLG = A/C engaged flag; 1 -> A/C engaged, 0 -> A/C disengaged.

- DNDSUP = Delayed neutral/drive flag; 1 -> in drive, loaded.

- VRUN\_ISCFLG = RVIP Idle Speed Control flag; 1 -> Running VIP ISC action,

0 -> normal ISC action.

Calibration Constants:

- ACMAP = An adder to FN862(BP) when A/C is on. Should be based on

observed differences between A/C on & A/C off idle MAP readings.

- FN862(BP) = Decel MAP value as a function of BP. This value takes the

place of LOWMAP and is used to vary decel MAP as a function of altitude.

9-35

IDLE SPEED CONTROL, MODE SELECT - LHBH0

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- 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.

- MINMPH = Minimum speed to enter C/L RPM control. Applies to systems

having VSS. Should be set below the speed at which an automatic trans.

vehicle rolls along in drive without the brakes. This is to prevent

going into RPM control during parking lot maneuvers.

- NDIF = The deviation in engine speed allowed over the ISCTM specified

time interval. Values too small could lock the ISC system out of C/L

speed control indefinitely. Values too large invalidate the check.

- RPMCTL = Added to DSDRPM. The total defines the engine speed threshold

below which entry into C/L RPM control is allowed. This value should be

reasonably small to avoid inadvertent entry into C/L ISC.

- SETLNG\_TM = Manifold stabilization time. Used to delay entry into RPM

control.

- TRLOAD = Transmission Load switch;

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

forced neutral state

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

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

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

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

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

(AXOD).

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

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

- V\_SETLNG\_TM = VIP delay to enter ISC rpm control.

OUTPUTS

Registers:

- ISCFLG = See above.

- ISCTMR = See above.

- NLAST = See above.

9-36

IDLE SPEED CONTROL, MODE SELECT - LHBH0

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CALIBRATION INFORMATION

Typical values are supplied for the following calibration constants:

- ACMAP = 2 " Hg (engine specific parameter).

- FN862(BP) = (0,6.5) (19.5,6.5) (31.875,8.5)

- ISCTM = 4 sec.

- MINMPH = 3 MPH

- NDIF = 32 RPM

- RPMCTL = 90 RPM

9-37

IDLE SPEED CONTROL, MODE SELECT - LHBH0

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PROCESS

STRATEGY MODULE: ISC\_MODE\_SELECT\_COM1

| (In Dashpot Preposition mode)

APT >= 0 -------------------------------| ISCFLG = 0

(Not closed throttle) | NLAST = N

| ISCTMR = 0

|

| --- ELSE ---

VSBAR <= MINMPH ------------| |

(Vehicle stopped) | | (In RPM Control Mode)

| |

DASPOT <= DASCTL -----------| |

(Dashpot complete) | |

| |

TRLOAD <> 3 ----------| | |

(Not man trans | | |

w/both switches) |OR --|AND -------| ISCFLG = 1

| | |

DNDSUP = 0 -----------| | |

(Neutral) | |

| |

SETTMR > SETLNG\_TM ---------| |

(Manifold stable) | |

| |

N <= (DSDRPM + RPMCTL) -----| |

|

| --- ELSE ---

VSBAR <= MINMPH ------------------| |

(Vehicle stopped) | | (In RPM Control Lockout mode;

| | same action as RPM Control mode)

DASPOT <= DASCTL -----------------| |

(Dashpot complete) | |

| |

TRLOAD <> 3 ----------------| | |

(Not manual transmission | | |

w/ both switches) |OR --|AND -| ISCFLG = 2

| | |

DNDSUP = 0 -----------------| | |

(Neutral) | |

| |

SETTMR > SETLNG\_TM ---------------| | --- ELSE ---

(Manifold stable) | |

| | (In Dashpot mode)

LOCKOUT LOGIC TRUE ---------------| |

(Locked out of RPM control) | ISCFLG = -1

NOTE: SETTMR and ISCTMR are cleared in MODE\_SELECT logic. See TIMERS

chapter for complete timer logic.

9-38

IDLE SPEED CONTROL, MODE SELECT - LHBH0

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LOCKOUT LOGIC

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

|

|OR ---| LOCKOUT LOGIC TRUE

VRUN\_ISCFLG = 1 --------| | | (Stay in lockout until RPM falls)

(VIP modifying ISC) |AND --| | EXIT LOCKOUT LOGIC

| |

SETTMR > V\_SETLNG\_TM ---| |

(manifold stable) |

| --- ELSE ---

|

ISCTMR < ISCTM -----------------------| LOCKOUT LOGIC FALSE

| (Not time to sample RPM yet)

| EXIT LOCKOUT LOGIC

|

| --- ELSE ---

|

|N - NLAST| > NDIF -------------------| LOCKOUT LOGIC FALSE

| (RPM changing quickly, must be

decel)

| NLAST = N

| ISCTMR = 0

| EXIT LOCKOUT LOGIC

|

TRLOAD >= 3 --------------------| | --- ELSE ---

(Auto trans) | |

|AND -| LOCKOUT LOGIC TRUE

DNDSUP = 0 ---------------------| | (Can't be decel when in neutral)

(In neutral) | EXIT LOCKOUT LOGIC

|

ACCFLG = 1 ---------------| | --- ELSE ---

(A/C on) |AND -| |

MAP < FN862(BP) + ACMAP --| |OR --| LOCKOUT LOGIC FALSE

(Decel MAP) | | (MAP indicates decel)

| | EXIT LOCKOUT LOGIC

ACCFLG = 0 ---------------| | |

(A/C off) |AND -| | --- ELSE ---

MAP < FN862(BP) ----------| |

(Decel MAP) | LOCKOUT LOGIC TRUE

| EXIT LOCKOUT LOGIC

9-39

IDLE SPEED CONTROL, KAM UPDATE - LHBH0

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KAM UPDATE (ISCKAM\_UPDATE)

OVERVIEW

This section describes the adaptive ISC update routine. In general, under

steady state conditions on a stabilized engine at idle, the adaptive ISC

logic will evaluate whether the open loop prediction of airflow requires

correction. If a correction factor was applied, IPSIBR has a non-zero value,

the adaptive ISC strategy will roll this correction value into KAM and drive

the IPSIBR term back to zero. Control of the rate at which the IPSIBR value

is driven to zero is calibration-dependent.

There are six ISCKAM cells designated for idle corrections. The appropriate

cell is pointed to by the flag ISFLAG which tracks the load state at idle.

The following logic must be satisfied to update KAM:

\* In RPM control

\* Within the RPM deadband for a calibrated time interval (UPDISC)

\* No hi-cam adder present (HCAMFG = 0)

\* IPSIBR non zero

\* No kam errors

\* IBGPSI >= 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.

DEFINITIONS

INPUTS

Registers:

- IBGPSI = Background loop counter, used to pace ISCKAMn update.

- ISCKAMn = Adaptive ISC correction for each load condition n, where n is

the value of ISFLAG. The calculated value of ISCKAMn is added to the

total desired idle air flow (DESMAF).

- ISCTMR = RPM sample timer for adaptive ISC, secs. Timer is cleared if

|RPMERR\_A| exceeds the rpm deadband, RPMDED.

- IPSIBR = The closed loop integration component of total DESMAF, ppm.

Designed to provide integral feedback, IPSIBR adjusts the value of DESMAF

to correct for sustained changes in idle load. An increase or decrease

in IPSIBR results in a corresponding change to bypass valve duty cycle.

Bit Flags:

- HCAMFG = Flag indicating the completion of Hi-Cam; 0 -> no desired engine

speed adder exists, 1 -> an rpm adder above base idle is present. Flag

is used in the ISC adaptive update routine to disable updates when HCAMFG

= 1.

9-40

IDLE SPEED CONTROL, KAM UPDATE - LHBH0

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- ISCFLG = ISC mode indicator flag; -1 -> Dashpot Mode; 0 -> Dashpot

Preposition Mode; 1 -> Closed Loop RPM Control Mode; 2 -> Closed Loop RPM

Control (Lock-out entry to RPM control)

- ISFLAG = Idle load state indicator used to select the ISCKAM cell.

- KAM\_ERROR = KAM error flag; 1 -> KAM data invalid.

Calibration Constants:

- PSIBRM = Maximum allowed value for ISCKAMn. ISCKAMn is clipped to this

value.

- PSIBRN = Minimum allowed value for ISCKAMn. ISCKAMn is clipped to this

value.

- RPMDED = Adaptive ISC learning deadband. Learning is disabled if

RPMERR\_A exceeds this deadband.

- UPDATM = Pacing at which the IPSIBR correction factor is rolled into KAM.

Value is in terms of background loop counts.

- UPDISC = Time that engine speed must be within the specified deadband

(RPMDED) prior to KAM update.

OUTPUTS

Registers:

- IBGPSI = See above.

- ISCKAMn = See above.

- ISCTMR = See above.

- ISKSUM = CHECKSUM for adaptive idle speed KAM cells, used in KAM

initialization strategy.

- IPSIBR = See above.

CALIBRATION INFORMATION

The following typical values are provided for calibration constants:

- RPMDED = 50 rpm.

- UPDATM = 5 background passes.

- UPDISC = 2 seconds.

9-41

IDLE SPEED CONTROL, KAM UPDATE - LHBH0

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PROCESS

STRATEGY MODULE: ISC\_ISCKAM\_COM1

always ---------------------------------| IBGPSI = IBGPSI + 1

| Clip to Maximum

ISCFLG <> 1 ----------------------------| IBGPSI = 0

| Exit ISCKAM\_UPDATE logic

|RPMERR\_A| > RPMDED --------------------| ISCTMR = 0

ISCTMR < UPDISC ------------------|

|

HCAMFG = 1 -----------------------|

|OR --| IBGPSI = 0

IPSIBR = 0 -----------------------| | Exit ISCKAM\_UPDATE logic

|

KAM\_ERROR = 1 --------------------|

IBGPSI < UPDATM ------------------------| Exit ISCKAM\_UPDATE logic

|

| --- ELSE ---

|

| IBGPSI = 0

IPSIBR > 0 -----------------------|

|AND -| Increment ISCKAMn

ISCKAMn < PSIBRM -----------------| | Increment ISKSUM

| Decrement IPSIBR

|

| --- ELSE ---

IPSIBR <= 0 ----------------------| |

|AND -| Decrement ISCKAMn

ISCKAMn > PSIBRN -----------------| | Decrement ISKSUM

| Increment IPSIBR

9-42

IDLE SPEED CONTROL, DUTY CYCLE CALCULATION - LHBH0

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DUTY CYCLE CALCULATION

OVERVIEW

The ISC duty cycle is calculated in ISCDTY\_CALC. The mass air flow through

the ISC actuator (DEBYMA) is calculated as the desired mass air flow at idle

(DESMAF) less the flow through the throttle plate etc, corrected for

altitude.

The desired duty cycle is calculated as follows:

Once the desired mass flow value is finalized, the appropriate duty cycle is

calculated and output. The final DESMAF value is calculated in IPSIBR\_CALC.

The calibrated leakage term (ITHBMA) is subtracted from DESMAF to obtain the

actual flow required from the ISC actuator (DEBYMA). If BPCOR\_SW is set,

DEBYMA is adjusted for altitude. This value, 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 a modulator (FN820A) is available to increase the

duty cycle as necessary to hold constant flow.

The final value of ISCDTY includes an offset and a multiplier (IDCOFS and

IDCMUL) used primarily as calibration tools.

9-43

IDLE SPEED CONTROL, DUTY CYCLE CALCULATION - LHBH0

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DEFINITIONS

INPUTS

Registers:

- BP = Barometric pressure, " Hg.

- DEBYMA = Desired mass air flow through the ISC valve, ppm. This quantity

is calculated as the total desired idle air flow (DESMAF) less the air

flow through the throttle plate, and is corrected for altitide using

FN890(BP).

- DESMAF = Total desired idle air flow, ppm. Calculated as the sum of

predicted air flow (DESMAF\_PRE), dashpot air flow (DASPOT), integral air

flow (IPSIBR) and KAM correction (ISCKAMn).

- VACUUM = Intake manifold vacuum.

Bit Flags:

- VRUN\_ISCFLG = RVIP Idle Speed Control flag; 1 -> Running VIP ISC action,

0 -> normal ISC action.

Calibration Constants:

- BPCOR\_SW = Calibration switch for BP correction to DEBYMA; 0 -> no

correction, 1 -> use correction.

- DEBYCP = Minimum allowed airflow through the ISC actuator. This is a

clip on DEBYMA.

- FN800(DEBYMA) = 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. The best way to get actual vehicle data is

to connect a duty cycle box to the ISC actuator, vary the duty cycle and

plot actual airflow using a hot wire type air meter. ..Typical values

vary based on engine application and flow capacity of the ISC actuator.

- FN820A(VACUUM) = ISC duty cycle multiplier versus VACUUM. Used to hold

constant actuator airflow on a decel after dashpot action is complete.

- FN890(BP) = ISC duty cycle altitude compensation subtractor. Required to

offset the effect with altitude of a varying pressure drop across the ISC

actuator, which affects its air flow.

- IDCMUL = ISCDTY multiplier, no units.

- IDCOFS = ISCDTY adder, fraction of fully open.

- ITHBMA = Throttle body idle mass air flow with throttle plate at idle

screw stop and 0% ISC duty cycle. This is any airflow which does not go

through the bypass air solenoid, i.e. throttle plate, PCV system, intake

leakage, etc.

- V820A = ISC duty cycle multiplier, used for VIP only.

9-44

IDLE SPEED CONTROL, DUTY CYCLE CALCULATION - LHBH0

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OUTPUTS

Registers:

- DEBYMA = See above.

- ISCDTY = Idle speed control valve duty cycle, fraction of fully open.

Calculated as a transfer function (FN800) of the desired mass flow

through the ISC valve.

PROCESS

STRATEGY MODULE: ISC\_ISCDTY\_COM1

DEBYMA AND ISCDTY CALCULATION

ISCDTY = IDCMUL \* FN800(DEBYMA) \* FN820A(VACUUM) + IDCOFS

where:

/ \

DEBYMA = ( DESMAF - ITHBMA ) \* [29.92/BP] - FN890(BP)

\ /

BP correction logic:

BPCOR\_SW = 1 -----------------| Use 29.92/BP in DEBYMA calculation

|

| --- ELSE ---

|

| Do not use 29.92/BP

- DEBYMA is clipped to DEBYCP as a minimum.

- ISCDTY is clipped to 1.0 as a maximum.

NOTE: During certain times, Running VIP may need to control ISC. When

this is the case, Running VIP will set VRUN\_ISCFLG = 1. This causes

V820A to be used in the ISCDTY equation above, instead of FN820A.

9-45

IDLE SPEED CONTROL, IPSIBR CALCULATION - LHBH0

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IPSIBR CALCULATION (IPSIBR\_CALC)

OVERVIEW

IPSIBR is the closed loop integration component of total DESMAF. Designed to

provide integral feedback, IPSIBR adjusts the value of DESMAF to correct for

sustained changes in idle load. An increase or decrease in IPSIBR results in

a corresponding change to bypass valve duty cycle.

The IPSIBR calculation has the following characteristics:

- IPSIBR is only updated in RPM control or lockout mode.

- Different time constants are used depending on whether RPM is too high or

too low.

- IPSIBR is not updated if the ISC valve is already at its maximum or

minimum position (PSIBRM and PSIBRN, respectively).

- On load state transitions (A/C, N/DR and CT/PT), IPSIBR is always clipped

to zero as a minimum.

- The IPSIBR update has no deadband. Instead, it is driven by an RPM error

term RPMERR\_A (A for "air"). The time constant is TCBPA.

- Calibration of gain is not required. The term (DESMAF\_PRE / DSDRPM) in

the ISCPSI calculation automatically adjusts the gain for RPM,

temperature and accessory loads.

- The IPSIBR pacing calibration is controlled by the two scalars TC\_OVER

and TC\_UNDER for speed higher and lower than desired, respectively.

These scalars represent time constants for the engine to respond to

changes in duty cycle.

DEFINITIONS

INPUTS

Registers:

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

- BG\_TMR = Background loop time, secs.

- DASPOT = Dashpot contribution to idle air flow. Used to provide a

preposition air flow in Part Throttle and Wide Open Throttle Modes, which

is "bled off" after a transition to Closed Throttle. This gradual air

decrement allows a smooth transition to RPM control.

9-46

IDLE SPEED CONTROL, IPSIBR CALCULATION - LHBH0

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- DEBYMA = Desired mass air flow through the ISC valve, ppm. This quantity

is calculated as the total desired idle air flow (DESMAF) less the air

flow through the throttle plate and is corrected for altitude using

FN890(BP).

- DSDRPM = Desired engine speed.

- ECT = Engine Coolant Temperature.

- ISCDTY = Idle speed control valve duty cycle, fraction of fully open.

Calculated as a transfer function (FN800) of the desired mass flow

through the ISC valve.

- ISCFLG = ISC mode indicator flag: -1 -> Dashpot Mode; 0 -> Dashpot

Preposition Mode; 1 -> Closed Loop RPM Control Mode; 2 -> Closed Loop RPM

Control (Lock-out entry to RPM control).

- ISCPSI = The quantity of air which is added to IPSIBR each background

pass.

- ISLAST = Register which tracks the state of engine load from the previous

background pass.

- IPSIBR = The closed loop integration component of total DESMAF. Designed

to provide integral feedback, IPSIBR adjusts the value of DESMAF to

correct for sustained changes in idle load. An increase or decrease in

IPSIBR results in a corresponding change to bypass valve duty cycle.

- ISCKAM(ISFLAG) = Adaptive correction for each load condition.

- ISFLAG = Idle load indicator, set according to the current state of the

A/C (on or off) and of the transmission (neutral or drive).

- KAM\_ERROR = KAM error flag; 1 -> KAM invalid.

- RPMERR = Unfiltered RPM error, DSDRPM - N.

- RPMERR\_A = Filtered RPMERR for airflow control, time constant TCBPA.

- RUNUPTMR = Time since runup RPM exceeded (0.125 sec).

Bit Flags:

- ACCFLG = A/C engaged flag; 1 = A/C engaged, 0 -> A/C disengaged.

- CTPTFG = Closed throttle to part / wide open throttle transition flag; 1

-> transition occurred.

- KAM\_ERROR = KAM error flag; 1 -> KAM invalid.

- V\_MODE\_SETUP = VIP throttle adjust mode enabled flag; 1 -> enabled.

- VRUN\_ISCFLG = Self test engine running flag; 1 -> Engine running self

test in progress.

- RUNUP\_FLG = Flag indicating the initial runup is complete; 1 -> Runup RPM

exceeded.

9-47

IDLE SPEED CONTROL, IPSIBR CALCULATION - LHBH0

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Calibration Constants:

- ACHPTM = Calibrated time since start to recognize high AC head pressure.

- DEBYCP = Minimum value of ISC valve airflow, ppm.

- ECT\_HP = ECT temperature where AC head pressure is capable of switching

the A/C off.

- FN852(RPMERR) = Proportional control function used to modify DESMAF.

- IPSIDLY = Time delay to disable IPSIBR Update, sec.

- PSIBRM = Maximum allowed value for IPSIBR when in normal strategy.

- PSIBRN = Minimum allowed value for IPSIBR when in normal strategy.

- TC\_OVER = Time constant used to control the integral gain (or pacing) of

the term, IPSIBR. TC\_OVER is used when RPMERR\_A <= 0, i.e., when the

actual speed is higher than desired. A large value of TC\_OVER

corresponds to a small integral gain, a small value corresponds to a high

gain.

- TC\_UNDER = Time constant used to control the integral gain (or pacing) of

the term, IPSIBR. TC\_UNDER is used when RPMERR\_A > 0, i.e., when the

actual speed is lower than desired. A large value of TC\_UNDER

corresponds to a small integral gain, a small value corresponds to a high

gain.

- VSIBRM = Maximum allowed value for IPSIBR when in Running VIP.

- VSIBRN = Minimum allowed value for IPSIBR when in Running VIP.

- VTC\_OVER = Time constant used to control the integral gain (or pacing) of

the term, IPSIBR, when in Engine Running VIP. VTC\_OVER is used when

RPMERR\_A <= 0, i.e. when the actual speed is higher than desired.

Corresponds to TC\_OVER in normal strategy.

- VTC\_UNDER = Time constant used to control the integral gain (or pacing)

of the term, IPSIBR, when in Engine Running VIP. VTC\_UNDER is used when

RPMERR\_A > 0, i.e. when the actual speed is lower than desired.

Corresponds to TC\_UNDER in normal strategy.

Non-displayable Parameters:

- DESMAF\_PRE = Predicted desired idle air flow, ppm. This is the open loop

air flow prediction which is required to idle, calculated as a function

of ECT and time since start and including A/C, power steering and heated

windshield adders. It does not include any closed loop or KAM

corrections.

9-48

IDLE SPEED CONTROL, IPSIBR CALCULATION - LHBH0

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OUTPUTS

Registers:

- DESMAF = Total desired idle air flow, ppm. Calculated as the sum of

predicted air flow (DESMAF\_PRE), dashpot air flow (DASPOT), integral air

flow (IPSIBR) and KAM correction (ISCKAM).

- IBGPSI = Background counter used to control pacing of ISC KAM learning.

- IPSIBR = See above.

- ISCPSI = See above.

- ISKSUM = Checksum for adaptive idle speed KAM cells, used in KAM

initialization strategy.

PROCESS

STRATEGY MODULE: ISC\_IPSIBR\_COM1

ISCFLG <= 0 ------------------------|

(Dashpot or dashpot preposition) |

|OR --| (Do not update IPSIBR unless

RUNUPTMR < IPSIDLY -----------------| | in RPM Control or RPM Control

(Delay IPSIBR update after start) | lockout)

| No change to IPSIBR

|

| --- ELSE ---

RPMERR\_A < 0 -----------------| |

(Overspeed error) | |

|AND -| |

DEBYMA <= DEBYCP -------------| | | (Actuator cannot respond

(Actuator airflow at minimum) | | to a change in IPSIBR)

|OR --| ISCPSI = 0

| | No change to IPSIBR

RPMERR\_A > 0 -----------------| | |

(Underspeed error) | | |

|AND -| |

ISCDTY >= 98% ----------------| |

| --- ELSE ---

|

| (OK to adjust IPSIBR)

| IPSIBR = IPSIBR + ISCPSI

| Clip IPSIBR to PSIBRN as a

| minimum and PSIBRM as a maximum

NOTE: In Engine Running VIP (VRUN\_ISCFLG = 1), IPSIBR is clipped to VSIBRM

as a maximum and VSIBRN as a minimum.

9-49

IDLE SPEED CONTROL, IPSIBR CALCULATION - LHBH0

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Where ISCPSI is calculated as follows:

Normal Conditions

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

ISCPSI = RPMERR\_A \* (DESMAF\_PRE)/DSDRPM \* BG\_TMR /(TC\_UNDER | TC\_OVER)

DECISION LOGIC

RPMERR\_A > 0 -----------------------------| Use TC\_UNDER in ISCPSI

| calculation

|

| --- ELSE ---

|

RPMERR\_A <= 0 ----------------------------| Use TC\_OVER in ISCPSI

| calculation

In Engine Running VIP (VRUN\_ISCFLG = 1)

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

ISCPSI = RPMERR\_A \* (DESMAF\_PRE)/DSDRPM \* BG\_TMR /(VTC\_UNDER | VTC\_OVER)

DECISION LOGIC

RPMERR\_A > 0 ----------------------------| Use VTC\_UNDER in ISCPSI

| calculation

|

| --- ELSE ---

|

RPMERR\_A <= 0 ---------------------------| Use VTC\_OVER in ISCPSI

| calculation

Where: "|" means "or"

9-50

IDLE SPEED CONTROL, IPSIBR CALCULATION - LHBH0

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TOTAL DESIRED IDLE AIR FLOW (DESMAF) CALCULATION

ISFLAG <> ISLAST ------------------|

|

CTPTFG = 1 ------------------| |OR --| Clip IPSIBR at 0 as a minimum

(Closed throttle to | | | (Reset IPSIBR for a new load)

part/WOT transition) |AND -| | IBGPSI = 0

| | (Reset C/L correction pacer)

VRUN\_ISCFLG = 0 -------------|

(Not in running VIP)

Total DESMAF CALCULATION

KAM\_ERROR = 1 ---------------------|

(KAM qualify error) |

|

ISCKAM(ISFLAG) > PSIBRM -----------|OR --| Assume ISCKAM cells are invalid

(greater than maximum) | | Reinitialize all ISCKAM cells:

| | All ISCKAM cells = 0

ISCKAM(ISFLAG) < PSIBRN -----------| | ISKSUM = 0

(less than minimum)

V\_MODE\_SETUP = 1 ------------------------| DESMAF = DESMAF\_PRE

(VIP Throttle Adjust Mode) |

| --- ELSE ---

ACCFLG = 1 ------------------------| |

| |

ECT > ECT\_HP ----------------------| |

|AND -| DESMAF = DESMAF\_PRE + IPSIBR +

ATMR1 > ACHPTM --------------------| | DASPOT + ISCKAM(ISFLAG) +

| | FN852

ISCFLG > 0 ------------------------| |

| --- ELSE ---

|

| DESMAF = DESMAF\_PRE + IPSIBR

| + DASPOT + ISCKAM(ISFLAG)

NOTE: If KAM\_ERROR = 1 (KAM data invalid), the adaptive ISC cells (ISCKAM)

are initialized to zero.

9-51

IDLE SPEED CONTROL, IPSIBR CALCULATION - LHBH0

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9-52

CHAPTER 10

7.0L GOVERNOR MAP SIGNAL

10-1

7.0L GOVERNOR MAP SIGNAL - LHBH0

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7.0L GOVERNOR MAP SIGNAL (GOVHP = 1)

OVERVIEW

The DPI output, HSO-0, is used on the 7.0L heavy duty truck application as an

input to the stand alone governor. It is used to provide information about

engine load, compensated for altitude, so that high governor gains can be used

to achieve a quick response on an unloaded engine, while lower gains can be used

on a loaded engine for normal throttle control. The value MAPPA is used as a

load parameter compensated for altitude.

The signal is a 100 Hz pulse width modulated signal.

TP\_REL is output to the Governor via the DOL. The strategy associated with this

is located in the DOL chapter.

CALIBRATION PHILOSOPHY

Set GOVHP = 1 to activate the logic.

DEFINITIONS

INPUTS

Registers:

- BP = Barometric pressure, " Hg.

- MAP = Manifold Absolute Pressure, " Hg.

- MAPPA = MAP/BP.

Bit Flags:

- MFMFLG = MAP sensor failure; 1 -> failure.

- TFMFLG = Flag indicating TP sensor has failed; 1 -> failure.

Calibration Constants:

- FN501(MAPPA) = MAPPA to duty cycle ratio transfer function.

- GOVHP = 7.0L Governor hardware present switch; set GOVHP = 1 to

activate this logic.

OUTPUTS

Registers:

- GMAPDC = Time of next high edge relative to master timer, ticks.

10-2

7.0L GOVERNOR MAP SIGNAL - LHBH0

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PROCESS

STRATEGY MODULE: ACC\_GOV\_MAP\_COM2

(follows calculation of MAPPA)

GOVHP = 1 ----------------|

|AND -|

MFMFLG = 0 ---------------| |

(MAP ok) |

|OR --| GMAPDC = FN501(MAPPA)

GOVHP = 1 ----------------| | | (GMAPDC is duty cycle)

| | |

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

(MAP not ok) | |

| |

TFMFLG = 0 ---------------| |

(TP ok) |

| --- ELSE ---

|

| GMAPDC = 0

| (duty cycle is zero, no output)

GOVHP = 1 ----------------------------| Output duty cycle GMAPDC at

| 100 Hz on HSO-0

NOTE:

- In LOS, the output will de-energize, giving no transitions. The

governor will detect this state and act accordingly.

- The DPI strategy is disabled when GOVHP = 1.

- Should the MAP sensor fail, MAP is simulated from TP and output.

Should the TP sensor also fail, no signal is output.

10-3

7.0L GOVERNOR MAP SIGNAL - LHBH0

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10-4

CHAPTER 11

CANISTER PURGE STRATEGY

11-1

CANISTER PURGE STRATEGY, CANISTER PURGE - LHBH0

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CANISTER PURGE

OVERVIEW

Canister Purge refers to the solenoid and valve combination that is located

in the line between the intake manifold and the carbon canister. When the

solenoid is energized the valve opens, allowing the flow of vapors from the

canister to the intake manifold.

The strategy enables canister purge during various engine operating modes.

These modes are calibration items. Typical calibrations will enable purge

when these conditions are met:

1. Fuel control is in the desired mode. The calibrator can choose between

purging during closed loop only or during both open loop and closed loop.

2. The EGO sensor has been warm at least 1 time or ECT indicates that the

engine is warm. Set PURECT to 254 to calibrate out ECT gate.

3. The not at closed throttle delay has been met.

4. The current value of the air mass modulator function, FN605A, is

non-zero.

The strategy includes features to prevent the rich surge which may occur on

initial purge turn-on and to prevent purge vapors from driving the Closed

Loop Fuel Control beyond its control limit. When purge is enabled, the

output is a 10HZ variable duty cycle, determined from the product of two fox

functions. FN600 determines the duty cycle (and purge flow) based on the

total accumulated time that purge has been enabled. This allows the purge

flow to be slowly introduced when the fuel vapor concentration may be high.

FN605A further modulates the output of FN600 versus total air flow. This

permits limiting the purge flow to a small percentage of total engine air

flow.

Certain adverse conditions, such as extended idles at elevated engine speed,

may cause the purge vapors to contribute a significant amount of the fuel

required to run the engine. When this condition, defined as LAMBSE at a

large value while in Closed Loop Fuel, is encountered, the timer input to

FN600(PRGTMR) is decremented to reduce purge flow and allow proper control of

the air/fuel ratio. PRGTMR is also decremented if the engine is above normal

operating temperature and is operating in Open Loop Fuel Control because of a

condition that can exist when the vehicle is stopped (i.e., WRMEGO = 0,

LESFLG = 1, OFMFLG = 1). This is to prevent the purge vapors from causing an

excessively rich condition in open loop. In order for the purge duty cycle

to be reduced immediately when PRGTMR begins decrementing, PRGTMR is clipped

to FULPRGTM as a maximum. FULPRGTM should be calibrated to the time when

output of FN600 equals 1.0 (i.e., the end of the ramp-in).

11-2

CANISTER PURGE STRATEGY, CANISTER PURGE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- ACT = Air charge temperature, deg. F.

- AM = Air mass flow, ppm.

- ECT = Engine coolant temperature, deg F.

- KAMREF = Adaptive fuel correction.

- LAMBSE = Air/fuel equivalence ratio.

- N = Engine RPM.

- NACTMR = Not at Closed Throttle timer, sec.

- PRGTMR = Purge ramp up/down timer, sec.

- PURG\_ADP\_SF = Adaptive learning safety factor; delta from minadp at which

time purge is disabled.

- PURGDC = Canister Purge Duty Cycle.

Bit Flags:

- ADT1FMFLG = Adaptive table 1 failure mode.

- CRKFLG = CRANK mode flag; 1 -> closed loop.

- LESFLG = Lack of EGO switching flag; 1 -> EGO not switching.

- OFMFLG = ETV solenoid shorted flag; 1 -> ETV solenoid circuit shorted to

ground.

- OLFLG = Open Loop Fuel Control flag; 1 -> Open Loop.

- PURGING = Purge enabled flag; 1 -> purge enabled.

- WRMEGO = Warm EGO flag; 1 -> EGO is currently warm.

11-3

CANISTER PURGE STRATEGY, CANISTER PURGE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- CANPHP = Canister purge hardware present switch; 1 -> EEC controlled

purge hardware present.

- EVTDOT = Minimum time not at Closed throttle to enable purge, sec. Set

to "zero" to purge at Closed Throttle.

- FN600(PRGTMR) = Purge duty cycle as a function of accumulated purge

enable time.

- FN603 = Maximum LAMBSE allowed before purge duty cycle is decremented.

- FN605A(AM) = Purge duty cycle modulator as a function of air mass.

- FULPRGTM = Maximum clip for PRGTMR, sec. Should be set to the time when

the output of FN600 first reaches its maximum.

- MINADP = Minimum allowable correction.

- NLMT = Maximum engine RPM.

- PRG\_DEC = PURGDC decrement value.

- PURECT = Minimum ECT to enable purge if WMEGOL is not set, deg F.

- PURECT1 = Minimum ECT to decrement PRGTMR when EGO is cold or not

switching, deg F.

- PURGSW = Calibration switch to enable purge in Open Loop.

OUTPUTS

Registers:

- PRGTMR = See above.

- PURGDC = See above.

Bit Flags:

- LIMIT\_PURGE = Flag which indicates Purge Duty Cycle is being limited due

to LAMBSE being clipped; 1 -> limited Purge.

- PURGING = See above.

11-4

CANISTER PURGE STRATEGY, CANISTER PURGE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CANP\_COM4

CANISTER PURGE CONTROL LOGIC

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

|

CANPHP = 1 ------------------------------|

|

NACTMR >= EVTDOT ------------------------|

|

OLFLG = 0 -------------------------| | (enable purge)

|OR --|AND -| PURGING = 1

PURGSW = 1 ------------------------| | | purgdc = FN600(PRGTMR)

| | \* FN605A(AM)

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

|OR --| |

ECT > PURECT ----------------------| | |

| |

FN605A(AM) > 0 --------------------------| |

| |

N < NLMT --------------------------------| |

| |

OFMFLG = 0 ------------------------------| |

| --- ELSE ---

|

| (disable purge)

| PURGING = 0

| purgdc = 0

| PURGDC = 0

11-5

CANISTER PURGE STRATEGY, CANISTER PURGE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PURGE DUTY CYCLE DECREMENT/INCREMENT LOGIC

LIMIT\_PURGE = 0 -------------------------------| PURGDC = purgdc

|

| --- ELSE ---

|

| Continue to Increment/

| Decrement with old

| value of PURGDC

The following logic allows the reduction of the purge duty cycle (PURGDC)

when conditions indicate that the fuel system may be failing. The purge is

backed out to prevent the continuous EGO TESTS and adaptive fuel test from

indicating failure due to purge overload. Also, the purge is backed out when

the engine temperature is extremely hot and the EGOs are not switching or are

not warmed-up yet. Once a failure has been indicated or control has been

restored for one of the areas indicated by the logic show below, purging is

resumed. If subsequently another area begins indicating failure, purging

will again be backed out until the appropriate failure is verified or until

the system comes back into full control.

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

(closed loop) |

|

LAMBSE => FN603(ACT) --------------|AND -|

(ego failure condition present) | |

| |

LESFLG = 0 ------------------------| |

(ego failure recognition not latched) |

|

KAMRF <= MINADP + 0.5 + |

PURG\_ADP\_SF ----| |

(adaptive limit imminent) |AND -|OR --| PURGDC = PURGDC -

| | | PRG\_DEC

ADT1FMFLG = 0 ---------------------| | | Clip to zero as a minimum

(adaptive failure not yet | | Clip to purgdc as a

recognized) | | maximum

| |

ECT > PURECT1 ---------------------| | |

(extreme hot temperatures) |AND -| |

| | |

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

(EGO not warm) | |

| |

LESFLG = 1 ------------------------------| |

(lack of EGO switching) |

| --- ELSE ---

|

| PURGDC = PURGDC +

| PRG\_DEC

| Clip to purgdc as a maximum

11-6

CANISTER PURGE STRATEGY, CANISTER PURGE - LHBH0

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purgdc > PURGDC -------------------------------| LIMIT\_PURGE = 1

| (purge is being limited

| due to LAMBSE being

| at its clip)

|

| --- ELSE ---

|

| LIMIT\_PURGE = 0

PRGTMR LOGIC

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

(CRANK mode) |

| --- ELSE ---

|

PURGING = 1 -----------------------------------| Increment PRGTMR

| (clip to FULPRGTM as

| a maximum)

|

| --- ELSE ---

|

| Freeze PRGTMR

11-7

CANISTER PURGE STRATEGY, CANISTER PURGE - LHBH0

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11-8

CHAPTER 12

THERMACTOR AIR STRATEGY

12-1

THERMACTOR AIR STRATEGY - LHBH0

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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 AM1 Solenoid AM2 Solenoid

Upstream on on

Downstream on off

Bypass off off

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.

NOTE: THRMHP must be set to 1 to enable the Thermactor Air logic.

12-2

THERMACTOR AIR STRATEGY - LHBH0

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DEFINITIONS

INPUTS

Registers:

- ACT = Air charge temperature deg. F.

- APT = Throttle mode indicator; -1 -> closed throttle, 0 -> part throttle,

1 -> wide open throttle.

- ATMR1 = Time since start, sec.

- ATMR2 = Time after coolant temperature exceeded TEMPBF, sec.

- AWOTMR = Time at wide open throttle, sec.

- BYPTMR = Thermactor bypass timer, sec.

- DFSO\_A\_TMR = Free running, down counting, TP based thermactor air shut

off timer.

- ECT = Engine coolant temperature, deg F.

- HMUTMR = High MAPPA upstream air timer, sec.

- HTPTMR = Heat protection timer (bankline timer), sec.

- LMBTMR = Low MAP bypass timer, sec.

- MAP = Manifold absolute pressure BIN 3.

- N = Engine speed RPM.

- TCSTRT = Temperature of engine coolant at startup, deg F.

- TP\_REL = Relative TP (TP - RATCH).

- WOTTMR = Time at wide open throttle.

Bit Flags:

- AFMFLG = ACT FMEM flag.

- CFMFLG = ECT FMEM flag.

- CRKFLG = Crank mode flag; 1 -> in crank mode.

- DFSFLG = Flag indicating status of Decel Fuel Shut-off; 0 -> Fuel not

shut-off for decel, 1 -> Fuel shut-off for decel.

- EGO1FMFLG = EGO #1 FMEM flag.

- HMUTMR\_FLG = High Mappa Upstream Air timer control flag.

- IMS = Inferred milage sensor flag; 0 -> low milage, 1 -> high milage.

12-3

THERMACTOR AIR STRATEGY - LHBH0

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- LESFLG = Lack of EGO switching flag.

- MFMFLG = MAP FHEM flag.

- MPGFLG = MPG mode flag.

- OLFLG = Open loop flag.

- OFMFLG = ETV overcurrent monitor failure flag; 0 -> ETV O.K., 1 -> ETV

failure mode.

- TAQ1 = Thermactor air latch flag (Based on ECT)

- TFMFLG = TP FMEM flag.

- TP\_AIR\_OFF\_F = flag to indicate state of FNTP\_AIR\_OFF Flip Flop (dump

thermactor air at low TP\_REL as a f'n of RPM)

Calibration Constants:

- BYPMAP = Minimum value of BYPTMR to bypass thermactor, sec.

- BYPWOT = Minumum time to wide open throttle to bypass air, sec.

- BYSTM1 = Maximum time to bypass thermactor after a high ECT startup, sec.

- BYSTM2 = Maximum time to bypass thermactor after an intermediate ECT

startup, sec.

- BYSTM3 = Maximum time to bypass thermactor after ECT > TEMPFB for a low

ECT startup, sec.

- BYSTM4 = Minimum time at closed throttle idle to bypass thermactor, sec.

- BYSTM8 = Minimum time at low MAP to bypass thermactor during decel, sec.

- CHKASW = Control switch for CHKAIR.

- CTBYS = Minimum coolant temperature to bypass thermactor air, deg F.

- CTBYSH = Hysteresis term for CTBYS, deg F.

- CTHIGH = Hot start minimum ECT, deg F.

- CTLOW = Cold start maximum ECT, deg F.

- DSFTSW = Control switch for thermactor air decel fuel.

- FNTP\_AIR\_OFF = TP\_REL at which to dump air below.

- SW\_MPD = Control switch for Thermactor air bypass MPG mode; 0 -> Do no

bypass in MPG Mode, 1 -> bypass in MPG mode.

- TP\_AIR\_OFF\_H = Hystersis for FNTP\_AIR\_OFF (bypass air at low TP\_REL as a

f'n of ROM)

- T70LSW = 7.0L thermactor application switch.

12-4

THERMACTOR AIR STRATEGY - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- T75LSW = Switch to dump air during closed loop for 7.5L applications.

- UPSMAP = Maximum time for upstream air at high MAPPA, sec.

- UPSTM1 = Maximum time for upstream air after a low milage, high ECT

startup, sec.

- UPSTM2 = Maximum time for upstream air after a low milage, intermediate

ECT startup, sec.

- UPSTM3 = Maximum time for upstream air after ECT > TEMPFB for a low

milage, low ECT startup, sec.

- UPSTM4 = Maximum time for upstream air after a high milage, high ECT

startup, sec.

- UPSTM5 = Maximum time for upstream air after a high milage, intermediate

ECT startup, sec.

- UPSTM6 = Maximum time for upstream air after ECT > TEMPFB for a high

milage, low ECT startup, sec.

- UPSWOT = Maximum time for upstream air at W.O.T., sec.

OUTPUTS

Bit Flags:

-

AM1 = Flag that controls the state of the AM1 output; 0 -> output off,

1 -> output on.

- AM2 = Flag that controls the state of the AM2 output; 0 -> output off,

1 -> output on.

- CHKAIR = Thermactor forced open loop flag; 1 -> not forced Open loop,

0 -> Force Open loop.

- TAQ1 = Thermactor air latch flag (Based on ECT)

- TP\_AIR\_OFF\_F = See above.

12-5

THERMACTOR AIR STRATEGY - LHBH0

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PROCESS

STRATEGY MODULE: THERM\_LH

THERMACTOR AIR CONTROL LOGIC

ECT > CTBYS -----------------------|S Q -| TAQ1

|

ECT < CTBYS - CTBYSH --------------|C

FNTP\_AIR\_OFF(N) = 0 ---------------|

(air dump not requested) |

|OR --| TP\_AIR\_OFF\_F = 0

TP\_REL >= FNTP\_AIR\_OFF(N) + | | (allow air)

TP\_AIR\_OFF\_H ---| |

(tp\_rel above hysterysis band) |

| --- ELSE ---

|

TP\_REL < FNTP\_AIR\_OFF(N) ----------------| TP\_AIR\_OFF\_F = 1

(dump air at low tp\_rel) | (dump air)

|

| --- ELSE ---

|

| no action

12-6

THERMACTOR AIR STRATEGY - LHBH0

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DFSO\_A\_TMR <> 0 -------------------------|

(turn or keep air off) |

|

EGO1FMFLG = 1 (EGO failure) -------------|

|

CRKFLG = 1 (in crank mode) --------------|

|

OFMFLG = 1 (ETV solenoid shorted) -------|

|

AFMFLG = 1 (ACT failure) ----------------|

|

CFMFLG = 1 (ECT failure) ----------------|

|

TFMFLG = 1 (TPS failure) ----------------|

|

MFMFLG = 1 (MAP failure) ----------------|

|

HTPTMR >= BYSTM4 ------------------------|

(Bankline timed out) |

|

LESFLG = 1 (EGO not switching) ----------|

|

"A" (See next page) ---------------------|

(startup bypass) |

|

TAQ1 = 1 --------------------------------|OR --| (bypass air)

(ECT meets CTBYS criteria) | | AM1 = 0

| | AM2 = 0

MPGFLG = 1 (MPG mode) -------------| | | CHKAIR = 1

|AND -| | (not forced O.L.)

SW\_MPD = 1 ------------------------| | |

| |

DFSFLG = 1 (in DFSO) --------------| | |

|AND -| |

DSFTSW = 1 ------------------------| | |

(select bypass if in DFSO) | | |

| |

APT = 1 (WOT) ---------------------| | |

|AND -| |

WOTTMR >= BYPWOT ------------------| | |

(WOT bypass) | |

| |

CHKASW = 1 (Calib. Sw) ------------| | |

|AND -| |

BYPTMR = BYPMAP -------------| | | |

(cruise bypass) |OR --| | |

| | |

LMBTMR >= BYSTM8 ------------| | |

(low MAP bypass) | |

| |

TP\_AIR\_OFF\_F = 1 ------------------------| |

(dump air at low tp\_rel) | |

| |

T75LSW = 1 ------------------------| | |

(7.5L application) |AND -| |

| |

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

(dump air during closed loop) |

| --- ELSE ---

12-7

THERMACTOR AIR STRATEGY - LHBH0

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(continued on next page)

12-8

THERMACTOR AIR STRATEGY - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

CHKASW = 0 (Calib. Sw) ------------------| |

|AND -| (bypass air)

BYPTMR = BYPMAP -------------------| | | AM1 = 0

(cruise bypass) |OR --| | AM2 = 0

| | CHKAIR = 0

LMBTMR >= BYSTM8 ------------------| | (forced O.L.)

(low MAP bypass) |

| --- ELSE ---

"B" (see next page) ---------------| |

(startup upstream) |AND -| |

| | |

IMS = 0 ---------------------------| | |

| |

"C" (see next page) ---------------| | |

(startup upstream) |AND -| |

| | |

IMS = 1 ---------------------------| | |

| |

AWOTMR < UPSWOT -------------------| | | (upstream air)

(WOT upstream time) |AND -|OR --| AM1 = 1

| | | AM2 = 1

APT = 1 (WOT) ---------------------| | | CHKAIR = 0

| | (force O.L.)

HMUTMR < UPSMAP -------------------| | |

(high load upstream time) |AND -| |

| | |

HMUTMR\_FLG = 1 --------------------| | |

| |

OLFLG = 1 -------------------------| | |

(open loop fuel) |AND -| |

| |

T70LSW = 1 ------------------------| |

(7.0L application) |

| --- ELSE ---

|

| (downstream air)

| AM1 = 1

| AM2 = 0

| CHKAIR = 1

| (not forced O.L.)

12-9

THERMACTOR AIR STRATEGY - LHBH0

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

|AND -|

ATMR1 < BYSTM1 --------------------------| |

|

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

|AND -|OR --| "A"

ATMR1 < BYSTM2 --------------------------| |

|

TCSTRT <= CTLOW -------------------------| |

|AND -|

ATMR2 < BYSTM3 --------------------------|

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

|AND -|

ATMR1 < UPSTM1 --------------------------| |

|

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

|AND -|OR --| "B"

ATMR1 < UPSTM2 --------------------------| |

|

TCSTRT <= CTLOW -------------------------| |

|AND -|

ATMR2 < UPSTM3 --------------------------|

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

|AND -|

ATMR1 < UPSTM4 --------------------------| |

|

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

|AND -|OR --| "C"

ATMR1 < UPSTM5 --------------------------| |

|

TCSTRT <= CTLOW -------------------------| |

|AND -|

ATMR2 < UPSTM6 --------------------------|

12-10

CHAPTER 13

DATA COMMUNICATIONS LINK

13-1

DATA COMMUNICATIONS LINK, OVERVIEW - LHBH0

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DATA COMMUNICATION LINK (DCL)

(LINK\_SW = 2, 3, 6 or 7)

OVERVIEW

The EEC communicates with other vehicle microcomputers through the 81C62

RAM/CART chip. The RAM/CART is a special microchip which contains a serial

I/O port. This port performs serial communications on the data communication

link (DCL). The communication link consists of a twisted pair (DATA+ and

DATA-). The EEC treats the RAM/CART as read/write memory. The RAM/CART is

identical to the 81C61 RAM-I/O chip, with exception of the serial port.

The RAM/CART chip may operate as an UART (Universal Asynchronous Receiver

Transmitter), or a CART (Custom Asynchronous Receiver Transmitter). In UART

mode, information is sent character by character, requiring large software

overhead. In CART mode, information is sent in frames with minimal software

intervention.

The strategy initializes to UART mode. Under most vehicle operating

conditions, there is no communication on the DCL and the strategy remains in

UART mode. Under these conditions, the EEC waits for a message from SBDS and

does not transmit. The SBDS can tell the EEC to either go permanently

off-line or to wake-up in CART mode to perform diagnostics.

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

| \_\_\_\_\_\_\_\_ |

| | | \_\_\_\_\_\_ | | \_\_\_\_\_\_

| | |<--->| |<----|---->|<--->| SBDS |

| | | | RAM/ | | | ------

| | EEC | | CART | | |

| | CPU | | | |

| | | |\_\_\_\_\_\_| |

| | | |

| |\_\_\_\_\_\_\_\_| |

| |

| EEC IV |

|\_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_|

13-2

DATA COMMUNICATIONS LINK, OVERVIEW - LHBH0

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DCL STATE DIAGRAM

(UART Mode Enabled)

(Link\_sw = 4,5,6 or 7)

Power-Up

|

|

V

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

| Standby |

Wake-up Message | |

from SBDS | - Configured as UART |

-----------------------| - No Link Master |

| | - EEC monitors Link for |

| | SBDS message |

| | - Link not active except|

V | for SBDS |

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

| Diagnostics | |

| | |

| - Configured as CART | |

| - EEC is Link Master | | Go off-line

| - EEC communicates with | | Message

| SBDS | | from SBDS

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

| |

| |

| V

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

| | Off-Line |

| | |

-----------------------> | - No communication |

Go off-line | - No return to other |

from SBDS | states |

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

13-3

DATA COMMUNICATIONS LINK, OVERVIEW - LHBH0

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DIAGNOSTIC MODE

The intent of the Data Communications Link (DCL) usage for diagnostics is to

provide on-board, Electronic Engine Control Module (EEC-IV) to off-board,

Service Bay Diagnostic System (SBDS), communications for enhanced diagnostic

capabilities. To accomplish this task, the SBDS will specify various tasks

which will be dependent on the level of diagnostics required.

If the strategy is in Standby (UART mode), the SBDS will send a message

instructing the EEC to enter Diagnostics (CART mode), then monitor the DPS

for further commands.

Once the EEC is in diagnostic mode, the SBDS designates the task by sending

commands in the DPS triggering the vehicle subsystems to perform the

appropriate actions. The diagnostic task specified by the contents of the

DPS takes effect at the start of the next block. All remaining link devices

will continue to monitor the DPS unless they have been sent off-line by the

SBDS. Non-active devices must refrain from transmitting or receiving

non-pertinent information until the DPS specifies a new diagnostic mode or

returns to the idle value.

13-4

DATA COMMUNICATIONS LINK, OVERVIEW - LHBH0

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DEFINITIONS

- Block = A group of sixteen sequential frames, transmitted in ascending

numerical order from 0 to 15.

- Byte = Eight bits of data.

- Cart\_Mode = Bit flag that indicates the current RAM/CART operating mode;

0 -> UART mode; 1 -> CART mode.

- DCLCT\_START = Flag to cause VIP to load continuous Self Test codes into a

RAM table for transmission over DCL, unitless.

- DCLST\_DONE = Handshaking flag which indicates VIP has finished loading

the RAM table, commands 25H and 26H.

- DCLST\_START = Handshaking flag which causes VIP to load the continuous

codes into a RAM table for subsequent transmission over DCL. Used in DCL

25H.

- DEFAULT\_LVF = Default value for the last valid frame in CART mode,

unitless.

- Diagnostic Parameter Slots = The diagnostic parameter slots are a

sequence of four information words, contained in the first four frames of

IS1, which define the diagnostic mode, beginning at the start of the next

block. The sequence is defined as IW1:F0, IW1:F1, IW1:F2, IW2:F3.

- Frame = A defined number of slots (1-16) preceded by an idle time. The

first slots are used for link control (sync and ID) and status

information, and the remaining slots are used for information transfer.

- ID Slot = The slot immediately following the sync slot, also referred to

as IW0, which contains the 4 bit frame identification number.

- Idle Slot = A slot where no message is transmitted (all logic ones

expected) (i.e. empty slot, blank slot)

- Information Slot = All slots except for sync slot and ID slot (IW1-IWE).

- Link Master = The control module which generates the sync sequence and ID

slot.

- Link\_sw = Hardware present switch for communication link configuration.

See EEC Overview Chapter.

- Message = A serial information flow consisting of two bytes of data. The

two bytes of data are also referred to as a word.

- Nibble = The upper or lower four bits of data in a byte.

- Slot = A dedicated time period relative to the sync sequence which is

used for transmission of a message.

- Sync Message = The message which contains the sync word 0000H (H denotes

hexadecimal).

13-5

DATA COMMUNICATIONS LINK, OVERVIEW - LHBH0

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- UART\_State = State counter for UART message check.

- Word = The 16 data bits of a message.

13-6

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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OVERVIEW

The intent of the Data Communications Link (DCL) usage for diagnostics is to

provide on-board, Electronic Engine Control Module (EEC-IV), to off-board,

Service Bay Diagnostic System (SBDS), communications for enhanced diagnostic

capabilities.

In order to accomplish this task, SBDS will provide various modes of

operation which will be dependent upon the level of diagnostics required.

The desired mode of operation will be determined by the SBDS and broadcast on

the DCL in the Diagnostic Parameter Slots, (DPS), which is defined to be

Information Word 1, Frames 0 through 3 inclusive. For normal (non-diagnostic

mode) operation, the Diagnostic Parameter Slots will be idle.

Once the SBDS is connected to the DCL, the operational mode may change at

which time the predetermined vehicle subsystems will recognize the change and

take the appropriate action.

The diagnostic mode specified by the contents of the Diagnostic Parameter

Slots will take effect at the start of the next Block, (ie., Frame 0 of the

next Block).

All remaining link devices will continue to monitor the DPS unless they have

been permanently disconnected by the SBDS. Non-active devices must refrain

from transmitting or receiving non-pertinent information until the DPS

specifies a new diagnostic mode or returns to the idle value.

13-7

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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DEFINED EEC-IV DIAGNOSTIC MODES

An eight (8) bit value is used to encode the various diagnostic modes for

each device. The following diagnostic modes are defined in this document:

DIAGMODE Value Function

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

00000001 1H clear DCL error/flag bits

00000010 2H clear Continuous Self Test codes

00000011 3H display status information only

00100001 21H transmit PID values

00100010 22H transmit DMR values

00100011 23H transmit PID map

00100100 24H transmit DMR map

00100101 25H run Self Test (K0E0 or K0ER)

00100110 26H transmit Continuous Self Test codes

00100111 27H transmit PID and DMR values

01000001 41H read Parameter Identification (PID) map

01000010 42H read Direct Memory Reference (DMR) map

01000011 43H read program/data bytes

01000101 45H read program execution vector

01000110 46H read A/D substitution values

In addition, one two diagnostic codes are reserved for all link devices.

DIAGMODE Value Function

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

10000000 80H go permanently offline, disable DCL function

10000001 81H Set DCL baud rate

These functions are described in the text below.

13-8

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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DCL DIAGNOSTIC STATUS INFORMATION

The EEC-IV Status Display

When the EEC-IV module has been selected with a DIAGMODE command in the range

00H through 7FH inclusive, the EEC will write the following status

information in Slot IW1, Frames 04H through 0FH inclusive:

Frame Description

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

4 Display the current diagnostic mode

5 Display the diagnostic mode for the next Block

6 DCL Error/Flag bits - Low byte

7 DCL Error/Flag bits - High byte

8 Direct Memory Reference (DMR) Base register - Low byte

9 Direct Memory Reference (DMR) Base register - High byte

A ROM Calibration ID - Low byte

B ROM Calibration ID - High byte

C Idle

D Idle

E Idle

F Idle

The DCL Error/Flag register, (16 bit), is used to maintain status information

regarding the actual DCL system. The SBDS will use this information to

insure error free DCL communications and the determination of system status.

The Error/Flag bits are assigned as follows:

Bit Function Condition

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

0 Read Bytes Load Address (low byte) Parity

1 Read Bytes Load Address (high byte) Bad Value

2 Read Bytes Data or Checksum Parity

3 Read Bytes Incorrect Checksum

4 Read A/D Values Parity Error

5 Read PID Map Parity Error

6 Read (DMR) Offset Parity Error

7 \*\*\* not used \*\*\*

8 \*\*\* not used \*\*\*

9 \*\*\* not used \*\*\*

10 Read Execute Vector Parity Error

11 Read Execute Vector Incorrect Checksum

12 DCL Mode Scheduler Bad Diagnostic Parameter Slot

13 EEC Reset Set if EEC Resets

14 Self Test Self Test Complete

15 Background Set to Disable Program\* Execution

\* Refers to execution of diagnostic programs downloaded into the EEC-IV by

the SBDS.

This error register is initialized to BC1FH on EEC power-up/initialize.

13-9

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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The Direct Memory Reference, (DMR), Base Register is a 16 bit value which is

used by the EEC-IV DCL software for information requested by address. The

SBDS will request data by sending 8-bit offset values which are added to the

base register to compute the absolute address of the parameters requested.

All parameters requested in this manner are to be returned as unscaled byte

values.

13-10

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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DCL DIAGNOSTIC MODE CHANGE PROTOCOL

All devices connected to the DCL will change operational modes based on the

contents of the Diagnostic Parameter Slots, (DPS), which are defined to be

Information Word 1, Frames 0 through 3 inclusive. Normal mode is indicated

by all Diagnostic Parameter Slots being Idle.

The Diagnostic Parameter Slots

The DPS may be divided into five (5) fields as follows:

Frame Bits Description

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

0 0-11 DCL Module Select Bit Map

1 0-11 DCL Module Offline Bit Map

2 0-7 DIAGMODE Command Code

2 8-11 Frame Length Specifier

3 0-11 DIAGMODE Command Qualifier

The Module Select Bit Map [IW:1 F:0 b:0-11]

The first field is the Module Select Bit Map which is defined as follows:

Bit Selected Module

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

0 Electronic Engine Control Module (EEC-IV)

1 Cluster Control Assembly (CCA)

2 Message Center Control Assembly (MCCA)

3-11 reserved for future expansion

If bit 0 is set (1), the EEC-IV should execute the specified DIAGMODE

command. If bit 0 is clear (0), the EEC-IV should ignore the DIAGMODE

command.

The Module Offline Bit Map [IW:1 F:1 b:0-11]

The second field is the Module Select Bit Map which is defined as follows:

Bit Selected Module

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

0 Electronic Engine Control Module (EEC-IV)

1 Cluster Control Assembly (CCA)

2 Message Center Control Assembly (MCCA)

3-11 reserved for future expansion

If bit 0 is set (1), the EEC-IV should not transmit or receive any normal map

information. If bit 0 is clear (0), the EEC-IV MUST transmit its normal map

information.

13-11

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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The DIAGMODE Command Code [IW:1 F:2 b:0-7]

The third field is the DIAGMODE Command Code. This is a byte value which

identifies the requested diagnostic mode. DIAGMODE codes in the range 00H

through 7FH inclusive are to be considered as specific, (or private),

diagnostic modes. DIAGMODE codes in the range 80H through FFH inclusive are

used to designate common diagnostic modes. Common diagnostic command codes

MUST NOT be assigned without approval by all link devices.

The Frame Length Specifier [IW:1 F:2 b:8-11]

The fourth field is the Frame Length Specifier for the next Block. This is a

four bit value in the range 1H through EH inclusive. This value specifies

the Frame Length as the last valid Slot number. Therefore, this value is one

(1) less than the value to be written to the CART Frame Length Register.

The DIAGMODE Command Qualifier [IW:1 F:3 b:0-11]

The fifth and last field is the DIAGMODE Command Qualifier. This is a 12-bit

value which may contain additional information required to process the

requested diagnostic procedure. Currently, only one defined EEC-IV

diagnostic mode uses this information, (see DIAGMODE CODE 80H, Go Permanently

Offline).

Diagnostic Parameter Slots Error Processing

Unless normal mode is specified, (ie., all DPS idle), all DPS fields MUST

contain valid information. That is to say, all DPS MUST not be idle and all

Slots MUST have the correct Vertical Parity value.

If any of the above conditions are not met, then the entire DPS is to be

considered in error and disregarded. Normal map information must then be

transmitted at the start of the next Block.

13-12

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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DCL DIAGNOSTIC MODE DESCRIPTIONS

The diagnostic modes used by the SBDS/EEC-IV interface may be divided into

the following categories:

I. Read information from the EEC-IV module

II. Parameter Substitution

III. Download programs/data

IV. Run Self Test (KOEO and KOER)

V. Housekeeping functions

Each of these functions are described, in detail, below.

Read Information from the EEC-IV Module

All diagnostic modes in this category are used by the SBDS to request

information from the EEC-IV module. Information may be requested in one of

two ways depending on the mode selected: by name, (PID index code), or by

address, (DMR offset).

Parameter Reference by Name

Certain key engine parameters will be referenced by a unique index code (ie.,

name). This mode is intended to provide a fast strategy independent means of

requesting parameter values which are considered to be vital to most

diagnostic procedures. It is our intent to keep this list as small as

possible to minimize the index table storage requirements.

The SBDS will specify these parameters in the following way:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 41H

Frame Length X

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the

next Block. All other link devices will go offline. Frame

length can vary from 2 to E slots.

II. The SBDS will then transmit the parameter reference index

codes in the selected Slots when mode 41H has taken effect.

These index codes are single byte values in the range 1

through 255 inclusive. An IDLE Slot or a Slot containing the

value 0 indicates that the EEC-IV should not transmit in

that Slot during the response phase, (mode 21H).

13-13

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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III. The EEC-IV will read these index codes and store them in a

RAM table for later usage. This table needs to be 208 bytes

in length, (16 Frames by 13 Slots; Slots IW0 and IW1 are

not represented in this table). This table will begin at

the end of reference by address table i.e.,

DCL\_RAM\_START + 208.

IV. While in mode 041H, the EEC-IV will transmit only the Sync

and ID Slots along with status information in the Diagnostic

Slot, (IW1).

After the Parameter Identification, (PID), map has been sent to the EEC-IV,

the SBDS will change modes to allow the EEC-IV to transmit the requested

parameters.

I. Once the table has been loaded by the SBDS, (a minimum of

one Block time), the SBDS will specify mode 21H by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 21H

Frame Length X

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the

next Block. All other link devices will go offline. Frame

length can vary from 2 to E slots.

When mode 21H takes effect, the EEC-IV will transmit the

requested parameter values in the same Slots that their index

codes were transmitted in by the SBDS in mode 41H. The

parameter values may be up to 12 bits in length and are to be

scaled appropriately. If an unused PID code is requested, a

value of zero will be returned in that slot.

The parameter names, indices (PIDs), and scaling factors are included towards

the end of this chapter.

13-14

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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Parameter Reference by Address Offset

In order to allow the SBDS to access any strategy parameter, another method

of requesting data will be provided by the EEC-IV module. In this mode, the

SBDS will request information by transmitting an 8 bit offset to a base

address. The sum of the base address value and offsets will form the

absolute addresses used to reference the required engine parameters.

The offset values are specified in the following way:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 42H

Frame Length X

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the

next Block. All other link devices will go offline.

13-15

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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II. At the start of the next Block, the SBDS will transmit the

the desired offset values in the appropriate Slots. The

EEC-IV must read these values and store them in a RAM table,

called the Direct Memory Reference (DMR) map, for future

use. The table must be 208 bytes in length, (16 Frames by

13 Slots; Slots IW0 and IW1 are not represented in this

table). This table space cannot be shared with the PID

RAM table as the SBDS may have loaded valid data into both

tables at the same time. This table is located at

DCL\_RAM\_START.

III. While in mode 42H, the EEC-IV will transmit only the Sync and

ID Slots along with the status information in the Diagnostic

Slot, IW1.

IV. Slots which are IDLE or contain the value 0 indicate that the

EEC-IV should not transmit any information in these Slots

during the response phase (mode 22H).

After the byte offset values have been loaded into the EEC-IV, the SBDS may

then command the requested information be returned as follows:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 22H

Frame Length X

DIAGMODE Qualifier XXXH

The EEC-IV will change to this mode at the start of the

next Block. All other link devices will go offline.

II. The base address is read from the command qualifier slot

and is normalized by shifting left 4 bit positions to

obtain a 16-bit address aligned on a 16-byte boundary in

memory. While mode 22H is in effect, the EEC-IV will

transmit the requested information in the specified Slots.

Each parameter to be returned is an unscaled byte value

whose address is obtained by adding the 8 bit offset to the

16 bit base address value (obtained as above, or the

default value of 0000H).

13-16

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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Parameter Reference by both PID MAP and Address Offset:

After both the PID Map and the DMR byte offset values have been loaded into

the EEC-IV, the SBDS may then command the requested information to be

returned using a combination of PID and DMR as follows:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 27H

Frame Length X

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the

next Block. All other link devices will go offline.

II. While mode 27H is in effect, the EEC-IV will transmit the

requested information in the specified Slots. The trans-

mission will be done via either PID or DMR, depending upon

whether PID codes or address offsets have been specified

by SBDS. If a conflict arises, where both a PID code and

an address offset have been specified for the same slot,

the PID transmission will have priority. The parameters

will be returned according to the descriptions in

commands 21H and 22H, above.

13-17

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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EEC-IV Transmission of Parameter Identification (PID) Map

The SBDS May request that the EEC-IV module transmit the current PID map to

verify the information which was previously requested. The PID map is

requested as follows:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 23H

Frame Length E

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the

next Block. All other link devices will go offline.

II. The EEC-IV will transmit a single byte value in all data

Slots (Slots IW2 through IWE). This value will be the

parameter index for that Slot. A value of 0 will indicate that

no request was made for that information slot.

III. The EEC-IV will also transmit the Sync and ID Slots as well

the status information in the Diagnostic Slot, IW1, as usual.

EEC-IV Transmission of Direct Memory Reference (DMR) Map

The SBDS May request that the EEC-IV module transmit the current base address

offset map to verify the information which was previously requested. The

base address offset map is requested as follows:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 24H

Frame Length E

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the

next Block. All other link devices will go offline.

II. The EEC-IV will transmit a single byte value in all data Slots

(Slots IW2 through IWE). This value will be the address offset

for that slot. A value of 0 will indicate that no request was

made for that information slot.

13-18

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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III. The EEC-IV will also transmit the Sync and ID Slots as well as

the status information in the Diagnostic Slot, IW1, as usual

Parameter Substitution

The only diagnostic mode of this type defined thus far is the substitution of

the A/D sensor values. The SBDS will transmit the values to be used in place

of the normal strategy values.

A/D Sensor Value Substitution

The instantaneous A/D sensor values will be substituted in the following way:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 46H

Frame Length E

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the next

Block. All other link devices will go offline.

II. When mode 46H has taken effect, the SBDS will write up to 13

A/D substitution values in Slot IW2, Frames 0 through C,

inclusive. These 10 bit binary 0 values will be substituted

for their respective A/D sensor values according to the

following table:

A/D Register Slot

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

ACH-0 IW2

ACH-1 IW3

ACH-2 IW4

ACH-3 IW5

ACH-4 IW6

ACH-5 IW7

ACH-6 IW8

ACH-7 IW9

ACH-8 IWA

ACH-9 IWB

ACH-10 IWC

ACH-11 IWD

ACH-12 IWE

III. The EEC-IV will transmit only the Sync and ID Slots and

the status information in the Diagnostic Slot, IW1, as usual.

13-19

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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IV. The values substitution should begin during the next

background loop and continue until changed later by the SBDS.

V. A/D parameter substitution is disabled for a particular A/D

channel when its associated Slot is left IDLE during mode 46H.

VI. When A/D parameter substitution is no longer requested all RAM

must be re-initialized.

VII. Before substituting A/D values all KAM must be read and stored

by the SBDC using parameter reference by address offset. At the

completion of the A/D substitutions the KAM data stored in the

SBDC must be read back to the EEC using data download.

Downloading Programs and Data

The next class of operations involves the transmission of data and diagnostic

programs from the SBDS to the EEC-IV module. Up to 10 bytes of data may be

transmitted during each Frame. An Exclusive-Or checksum is provided to

ensure data integrity.

Program / Data Download

There is no real difference between the transmission of data and programs.

In fact, the two may be transmitted at the same time. To keep processing to

a minimum, only 10 bytes may be transmitted in a given Frame in Slots IW2

through IWE inclusive. This information is downloaded as follows:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 43H

Frame Length E

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the next

Block. All other link devices will go offline.

II. The SBDS will then transmit the program/data using the following

format for each Frame in the Block:

13-20

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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Slot Contents

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

IW2 load address - low byte

IW3 load address - high byte

IW4 data byte 1

IW5 data byte 2

IW6 data byte 3

IW7 data byte 4

IW8 data byte 5

IW9 data byte 6

IWA data byte 7

IWB data byte 8

IWC data byte 9

IWD data byte 10

IWE Exclusive-Or checksum

III. If Slot IW2 is IDLE, the EEC-IV should ignore the rest of

the data in that Frame. If Slot IW2 contains the low byte of

the load address, then Slot IW3 MUST contain the load address

high byte. The data Slots may contain byte values or be IDLE.

An IDLE Slot indicates that no data should be written into the

address associated with that Slot. Data byte #1 will be loaded

into the address specified in Slots IW2 and IW3. Data byte #2

will be loaded into the next sequential address and so on. A

new load address is provided in every Frame. The load address

MUST be between 'DCL\_RAM\_START' and 'DCL\_RAM\_END', or

KAM\_START and KAM\_END. The only data written between

KAM\_START and KAM\_END is previously saved KAM data.

DCL\_RAM\_END is equal to DCL\_RAM\_START + 600.

IV. Slot IWE will contain an 8 bit Exclusive-Or checksum of Slots

IW2, IW3 and all data Slots which are not IDLE. This checksum

must be used by the EEC-IV to validate the received data bytes.

V. The EEC-IV will transmit only the Sync and ID Slots as well

as the status information in the Diagnostic Slot, IW1.

VI. This mode will remain in effect for as many Blocks as

necessary to transmit all of the required data/program bytes.

VII. Before downloading a program to execute all KAM must be read

and stored by the SBDC using Parameter Reference by Address

Offset. At the completion of running a downloaded program

the KAM data must be written back to the EEC using data

down load.

After a program has been downloaded, the SBDS may enable execution of this

program by sending the start address of the desired program. The requested

routine is to be executed once per background loop until the request is

revoked by the SBDS transmitting an execution address of 0000H, or when bit

15 of the DCL Error/Flag register is set, or when the EEC-IV is reset. When

the request is revoked all RAM must be re-initialized.

13-21

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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The program execution vector will be specified as follows:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 45H

Frame Length 4

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the next

Block. All other link devices will go offline.

II. As soon as this mode takes effect, the SBDS will transmit the

16 bit start address by writing the low byte in Slot IW2 and

the high byte in Slot IW3. An 8 bit checksum of the address

will be transmitted in Slot IW4, all in Frame 0.

III. The program should begin execution within the next background

loop time and be repeated during each background loop.

IV. The program execution must be inhibited if any of the associated

error bits in the DCL Error/Flag register are set (bits 0-3 and

bits 10-11). In addition, the program may disable itself by

setting bit 15 of the DCL Error/Flag register.

Running On Demand Self Test (Key-On-Engine-Off and Key-On-Engine-Running)

The next class of diagnostic operational modes are used to initiate on demand

self test and to return the fault (service) codes. A single DCL mode command

is used to initiate both Key-On-Engine-Off and Key-On-Engine- Running self

tests. The PIP signal will be used to determine which test sequence is

performed.

Continuous Self Test codes are not to be transmitted along with the on-demand

codes and must not be cleared during this time.

The EEC will set a flag DCLST\_START after receiving diagnostic mode code 25H.

This flag is continuously read by VIP to initiate self test.

DIAGMODE = 25H ---------------| DCLST\_START = 1

(SBDC request for VIP) | (initiate self test)

|

| --- ELSE ---

|

| DCLST\_START = 0

| (clear request for self test)

13-22

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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Key On Engine Off Self Test

One of these tests will be performed when the SBDS has requested on demand

Self Test. PIP is used to determine which Self Test is performed.

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 25H

Frame Length E

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the next

Block. All other link devices will go offline.

II. The EEC-IV will transmit only the Sync and ID Slots and the

status information in the Diagnostic Slot, IW1, while self test

is being run. All other link devices will be offline.

III. When the self test has completed, the EEC-IV will transmit the

service/fault codes in the last two slots. The codes will begin

in the last slot of frame 0, and continue in the last slot of

each successive frame up to frame 15. If there are more than

16 codes, the 17th code will be transmitted in slot (last

slot - 1) of frame 0. The rest will be transmitted in successive

frames, as above. The maximum number of codes is presently 20.

These codes are to be transmitted every Block until the

diagnostic mode has been changed by the SBDS. The EEC-IV will

inform the SBDS that all codes have been transmitted, at least

once, by setting bit 14 in the DCL Error/Flag register.

Key On Engine Running Self Test

This self test will be performed when the engine is running, (normal engine

running strategy) and the SBDS has requested on demand self test.

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 25H

Frame Length E

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the next

Block. All other link devices will go offline.

13-23

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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II. The EEC-IV will transmit only the Sync and ID Slots and the

status information in the Diagnostic Slot, IW1, while self test

is being run. All other link devices will be offline.

III. When the self test has completed, the EEC-IV will transmit the

service/fault codes in Slots IW2 through IWE, starting in Frame

0 and using as many Frames as necessary to transmit all of the

service code table. (In strategy MUN1, this table is called

SERV\_CODE\_TAB and is 20 bytes in length; therefore, only

Frames 0 and 1 are required to transmit all possible service/

fault codes). These codes are to be transmitted every Block

until the diagnostic mode has been changed by the SBDS. The

EEC-IV will inform the SBDS that all codes have been transmitted

at least once, by setting bit 14 in the DCL Error/Flag register.

Transmit Continuous Self Test Codes

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 26H

Frame Length X

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the next

block.

II. The EEC-IV will transmit only the Sync and ID Slots and the

status information in the Diagnostic Slot, IW1.

III. When the self test is complete, the EEC-IV will transmit

the service/fault codes in the last two slots. The codes

will begain in the last slot of frame 0, and continue in the

last slot of each successive frame up to frame 15. If there

are more than 16 codes, the 17th code will be transmitted

in slot (last slot - 1) of frame 0. The rest will be

transmitted in successive frames as above. The maximum

number of codes is presently 32 (2 slots in 16 frames).

Each time the codes are transmitted, the flag DCLST\_DONE

is cleared causing VIP to reload the RAM table with the

latest continuous codes. The latest codes will be transmitted

every block until the diagnostic mode has been changed by

the SBDS. If the diagnostic command remains 26H, and VIP

does not have time to load the RAM table before the next block

begins, that block will be idle. The EEC-IV will inform the

SBDS that a given block contains codes by setting bit 14 of

the DCL Error/Flag register.

13-24

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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Miscellaneous Housekeeping Functions

The following operational modes are used by the SBDS System to provide

housekeeping functions. Currently, three of these diagnostic modes have been

defined.

Clear DCL Error/Flag Register

This diagnostic mode is specified by the SBDS to clear the EEC-IV DCL

Error/Flag Register. The sequence of events proceeds as follows:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 01H

Frame Length 1

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the next

Block. All other link devices will go offline.

II. While this mode is in effect, the EEC-IV will clear all bits

except bit 12 of the DCL Error/Flag Register. Bit 12 will

remain at its previous value.

III. During this mode, the EEC-IV will continue to transmit the

Sync and ID Slots and the status information in the Diagnostic

Slot, IW1. All other link devices will be offline.

13-25

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Clear Continuous VIP Codes

This diagnostic mode is specified by the SBDS to clear the EEC-IV Continuous

Self Test Codes. The sequence of events proceeds as follows:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 02H

Frame Length 1

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the next

Block. All other link devices will go offline.

II. While this mode is in effect, the EEC-IV will clear the four

KAM bytes which hold the Continuous Self Test Codes.

III. During this mode, the EEC-IV will continue to transmit the

Sync and ID Slots and the status information in the Diagnostic

Slot, IW1. All other link devices will be offline.

Display DCL Status Information

This diagnostic mode is used by the SBDS to read the DCL status bytes which

are transmitted in the Diagnostic Slot, IW1, without having the EEC-IV

reading from or writing to any other Slots, (except the usual Slots in II

below). This mode may also be used by the SBDS for certain critical mode

timing change requirements. The sequence of events proceeds as follows:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 03H

Frame Length 1

DIAGMODE Qualifier 000H

The EEC-IV will change to this mode at the start of the next

Block. All other link devices will go offline.

II. During this mode, the EEC-IV will continue to transmit the

Sync and ID Slots and the status information in the Diagnostic

Slot, IW1. All other link devices will be offline.

13-26

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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COMMON DCL DIAGNOSTIC MODES

One diagnostic mode has been defined which is common to all link devices.

This mode is defined below.

All DCL Devices Go Offline

Permanent Device Disconnect

This mode is used by the SBDS to command all link devices to go offline.

This mode may be used to diagnose the link itself, or when external

diagnostic devices may be attached to the link.

This mode will be specified by the SBDS as follows:

I. The SBDS will specify this diagnostic mode by transmitting

the following DPS:

DPS Field Value

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

Module Select 001H

Module Offline FFFH

DIAGMODE Code 80H

Frame Length X

DIAGMODE Qualifier 07FH

The EEC-IV will change to this mode at the start of the next

Block. All other link devices will go offline.

II. The EEC-IV will completely disable all DCL functions. The

CART circuit should be placed into PAUSE mode. The EEC-IV

must not generate Sync Words in this mode.

III. This mode will remain in effect until the EEC-IV has been

reset, (ignition key OFF-ON).

Note that this mode makes use of the DIAGMODE Command Qualifier Field. The

EEC-IV MUST verify this command by taking the 1's complement of the DIAGMODE

Command Qualifier and comparing it to the DIAGMODE Code. If the comparison

fails, the EEC-IV MUST NOT go offline.

13-27

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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ERROR PROCESSING

I. Vertical Nibble Parity Error

In general, ignore data and retain previous valid data. Exceptions have been

noted in this chapter.

II. Non-EEC Diagnostic Codes

EEC-IV DCL is idle. No intervention until EEC-IV Diagnostic Modes or Normal

Mode are in effect. The EEC-IV will continue to transmit the Sync and ID

Slots. No status information should be transmitted in a non-EEC-IV

diagnostic mode.

13-28

DATA COMMUNICATIONS LINK, DIAGNOSIS MODE - LHBH0

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SET DATA COMMUNICATIONS LINK BAUD RATE

This diagnostic mode is used by the diagnostic computer system to command all

link devices to change baud rate. If any module is not capable of supporting

the new desired baud rate, it must first be placed permanently offline.

I. The diagnostic computer will specify this diagnostic

mode by transmitting the following DPS:

DPS Field Value Comment

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

Module Select FFFH Select all active modules

Module Offline XXXH as required, FFF in bay 0 on road

DIAGMODE Code 81H command code

Frame Length 2H minimum required frame length

DIAGMODE qualifier 000H ignored, 0 recommended

The EEC-IV will change to this mode at the start of the next

Block.

II. The diagnostic computer will then transmit the baud rate

specifier information in Frame F, IW2 according to the

following table:

Specifier Requested Baud Rate

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

00H 2400 baud

01H 4800 baud

02H 9600 baud

03H 19200 baud

III. The EEC-IV will set the new baud rate immediately upon

reading and verifying the baud rate specifier, (during

the CART service routine for receive frame F). Therefore,

the EEC-IV will use the new baud rate beginning at the

next Block.

IV. If the baud rate specifier is missing or invalid, the

default baud rate of 2400 will be used and the

corresponding error bit must be set. The error bit must

be clear before the baud rate can be set to any value

other than 2400 baud.

V. The EEC-IV will transmit the Sync and ID Slots during

mode OCOM. Status information should also be transmitted

in the Diagnostic Slot, IW1, as usual. Normal mode

information may also be transmitted depending upon

the state of the Module Offline Bit Mask.

A sample information map of this diagnostic mode is presented in Appendix P

of this document.

13-29

DATA COMMUNICATIONS LINK, PID TABLES AND BIMAP DEFINITIONS - LHBH0

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9.0 Parameter Identification (PID) Code Tables:

Parameter PID Data Output Output

Name Code Type Scaling Resolution

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

N 01 word bin -2 4 RPM

MAP 02 byte bin 3 0.125 "Hg

BP 03 byte bin 3 0.125 "Hg

SAFTOT 04 byte bin 2 0.25 degrees S.A.

IACT 05 word bin 0 1 A/D count

IECT 06 word bin 0 1 A/D count

IEGR 07 word bin 0 1 A/D count

IEGO1 08 word bin 0 1 A/D count

ITP 09 word bin 0 1 A/D count

\*\*\*NOT USED\*\*\* 0A

IVCAL 0B word bin 0 1 A/D count

FUELPW1 0C word bin -5 32 clock ticks

LAMBSE1 0D word bin 11 1/2048 unitless

APT 0E byte bin 0 -1,0,1 unitless

ACT 0F byte bin -1 2 degrees F

ECT 10 byte bin -1 2 degrees F

VBAT 11 byte bin 4 0.0625 volts

MAP\_FREQ 12 word bin 4 0.0625 Hz

EGRDC 13 word bin 11 1 EEC-IV count

\*\*\*NOT USED\*\*\* 14

ISCDTY 15 word bin 11 1 EEC-IV count

\*\*\*NOT USED\*\*\* 16

VSBAR 17 byte bin 1 0.5 MPH

VS 18 word bin 5 0.03125 MPH

\*\*\*NOT USED\*\*\* 19

BITMAP\_0 1A word N/A N/A (see def. below)

BITMAP\_1 1B word N/A N/A (see def. below)

\*\*\*NOT USED\*\*\* 1C

\*\*\*NOT USED\*\*\* 1D

SBDS01 1E byte bin 0 N/A

SBDS02 1F byte bin 0 N/A

SBDS03 20 byte bin 0 N/A

SBDS04 21 byte bin 0 N/A

SBDS05 22 byte bin 0 N/A

SBDS06 23 byte bin 0 N/A

13-30

DATA COMMUNICATIONS LINK, PID TABLES AND BIMAP DEFINITIONS - LHBH0

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9.0 Parameter Identification (PID) Code Tables (continued):

Parameter PID Data Output Output

Name Code Type Scaling Resolution

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

FMEM\_FLAGS 24 byte bin 0 N/A

FMEM\_FLAG2 25 byte bin 0 N/A

\*\*\*NOT USED\*\*\* 26

LOAD 27 word bin 11 0.0488% of standard air charge

KAMRF1 28 word bin 4 0.0625 A/F

\*\*\*NOT USED\*\*\* 29

DSDRPM 2A byte bin -4 16 r.p.m.

RATCH 2B word bin 2 0.25 count

\*\*\*NOT USED\*\*\* 2C

ATMR1 2D word bin 0 1 second

IOCC 2E word bin 0 1 A/D count

INDS 2F word bin 0 1 A/D count

BCSDC 30 word bin 11 0.0488% duty cycle on time

\*\*\*NOT USED\*\*\* 31

GR\_CM 32 byte bin 1 N/A

\*\*\*NOT USED\*\*\* 33

\*\*\*NOT USED\*\*\* 34

ETVOCM 35 word bin 2 0.25 volts

TV\_PRES 36 byte bin 1 0.5 p.s.i

ITOT 37 word bin 0 1 A/D count

PDL 38 byte bin 1 N/A

\*\*\*NOT USED\*\*\* 39

Where:

FLG\_LK\_CM = 1 ---------------| BCSDC = 1

|

| --- ELSE ---

|

| BCSDC = 0

13-31

DATA COMMUNICATIONS LINK, PID TABLES AND BIMAP DEFINITIONS - LHBH0

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BITMAP REGISTER DEFINITIONS

9.1 BITMAP\_0:

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

HIGH: | v | v | v | v | 3 | 2 | 1 | 0 |

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

0: \*\*\* not used \*\*\*, always 0.

1: \*\*\* not used \*\*\*, always 0.

2: 1 if canister purge has non-zero duty cycle.

3: 1 if A/C clutch is disengaged.

4-7: Vertical Nibble Parity (VNP)

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

LOW: | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

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

0: \*\*\* not used \*\*\*, always 0.

1: \*\*\* not used \*\*\*, always 0.

2: \*\*\* not used \*\*\*, always 0.

3: \*\*\* not used \*\*\*, always 0.

4: \*\*\* not used \*\*\*, always 0.

5: \*\*\* not used \*\*\*, always 0.

6: 1 if not in neutral or park.

7: 1 if fuel pump is on.

9.2 BITMAP\_1:

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

HIGH: | v | v | v | v | 3 | 2 | 1 | 0 |

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

0: 1 if alternate shift mode/overdrive cancel is selected.

1: \*\*\* not used \*\*\*, always 0.

2: \*\*\* not used \*\*\*, always 0.

3: \*\*\* not used \*\*\*, always 0.

4-7: Vertical Nibble Parity (VNP)

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

LOW: | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

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

0: 1 if in closed loop fuel control.

1: 1 if power sterring pressure switch is closed.

2: 1 if driver has selected A/C.

3: \*\*\* not used \*\*\*, always 0.

4: 1 if Ignition Diagnostic Monitor EEC module input is high.

5: 1 if output AM1 is on.

6: 1 if output AM2 is on.

7: \*\*\* not used \*\*\*, always 0.

13-32

DATA COMMUNICATIONS LINK, PID TABLES AND BIMAP DEFINITIONS - LHBH0

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PLEASE NOTE: If the hardware related to a certain BITMAP bit

is not present on a specific application then

that bit will always be zero for that application.

13-33

DATA COMMUNCATIONS LINK, UART MESSAGE CHECK - LHBH0

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UART MESSAGE CHECK

OVERVIEW

The message check logic first checks to see if the UART receive buffer is

full (bit 0 of CART\_STATUS = 1). If the buffer is not full, then reception

of data did not cause the interrupt. BYTE\_NUM and EEC\_CHKSUM are set to 0,

CART\_STATUS is set to 1818H and the message check logic is exited. If buffer

is full, then the new byte is read from UART receive buffer and following

logic is executed.

DEFINITIONS

INPUTS

Registers:

- BYTE\_NUM = Indicates which byte of UART message.

- CMD\_CODE = Command from SBDS.

- EEC\_CHKSUM = XOR checksum of bytes 6 thru 10 of UART message.

- SBDS\_CHKSUM = CHECKSUM computed by SBDS.

Bit Flags:

- MODULE\_ID = 1 -> EEC selected.

OUTPUTS Registers:

- BYTE\_NUM = See above.

- CART\_STATUS = CART status register.

- EEC\_CHKSUM = See above.

- NO\_OF\_STARTS = Number of starts using alternative calibration.

- NO\_START\_CHK = Number of starts, check byte.

- XDCL\_BAUD = Current DCL baud rate.

Bit Flags:

- CART\_MODE = 1 -> CART mode, 0 -> UART mode.

- XDCL\_ERR0 = Error/flag register 0.

13-34

DATA COMMUNCATIONS LINK, UART MESSAGE CHECK - LHBH0

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PROCESS

STRATEGY MODULE: DCL\_UART\_COM1

RECEIVE OVERRUN ERROR ---------------|

(bit 5 of CART\_STATUS = 1) |

|OR --| (bad sync sequence or ...

BYTE\_NUM < 5 ------------------| | | byte lost in transmission)

(5 zeros not received) |AND -| | CART\_STATUS = 1818H

| | BYTE\_NUM = 0

new byte <> 0 -----------------| | EEC\_CHKSUM = 0

(non-zero received) | Exit message check logic

|

| --- ELSE ---

BYTE\_NUM < 5 ------------------------| |

(5 zeros not received) |AND -| (normal sync sequence)

| | CART\_STATUS = 1818H

new byte = 0 ------------------------| | Increment BYTE\_NUM

(zero received) | EEC\_CHKSUM = 0

| Exit message check logic

|

| --- ELSE ---

BYTE\_NUM = 5 ------------------------| |

(5 zeros received) |AND -| (sync sequence complete)

| | CART\_STATUS = 1818H

new byte = 0 ------------------------| | EEC\_CHKSUM = 0

(zero received) | Exit message check logic

|

| --- ELSE ---

|

| (first non-zero received)

| Increment BYTE\_NUM

| Store new byte in uart\_msg

| DO SBDS COMMAND LOGIC

Byte numbers 6 through 11 of the message are stored in RAM as follows:

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

uart\_msg: 6 | MODULE\_ID | (1 -> EEC-IV selected)

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

7 | CMD\_CODE | (Command from SBDS)

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

8 | BYTE\_8 | (Not presently used)

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

9 | BYTE\_9 | (Not presently used)

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

10 | BYTE\_10 | (Not presently used)

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

11 | SBDS\_CHKSUM | (Checksum sent by SBDS)

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

13-35

DATA COMMUNCATIONS LINK, UART MESSAGE CHECK - LHBH0

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SBDS COMMAND LOGIC

BYTE\_NUM < 11 -----------------------------| CART\_STATUS = 1818H

| (update the check sum)

| EEC\_CHKSUM = EEC\_CHKSUM

| XOR new byte

| Exit message check logic

|

| --- ELSE ---

|

EEC\_CHKSUM <> SBDS\_CHKSUM -----------| | (ignore message)

(bad data in buffer) |OR --| CART\_STATUS = 1818H

| | BYTE\_NUM = 0

MODULE\_ID <> 01 ---------------------| | EEC\_CHKSUM = 0

(EEC not selected) | Exit message check logic

|

| --- ELSE ---

|

CMD\_CODE = 82H ----------------------------| (echo MODULE\_ID to SBDS)

(valid command) | CART\_STATUS = 1818H

| uart transmit buffer = MODULE\_ID

| BYTE\_NUM = 0

| EEC\_CHKSUM = 0

| Exit message check logic

|

| --- ELSE ---

|

CMD\_CODE = 80H ----------------------------| (go permanently off-line)

(valid command) | CART\_STATUS = 4040H

| BYTE\_NUM = 0

| EEC\_CHKSUM = 0

| Exit message check logic

|

| --- ELSE ---

|

CMD\_CODE = 04H ----------------------------| (go to CART Mode)

(valid command) | XDCL\_BAUD = 03H

| CART\_MODE = 1

| CART\_STATUS = 9292H

| XFRAME = 0FH

| XDCL\_ERRO = BC1FH

| BYTE\_NUM = 0

| EEC\_CHKSUM = 0

| Exit message check logic

|

| --- ELSE ---

|

(continued on next page)

13-36

DATA COMMUNCATIONS LINK, UART MESSAGE CHECK - LHBH0

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(continued from previous page)

CMD\_CODE = 05H ----------------------------| (load NO\_OF\_STARTS)

| NO\_OF\_STARTS = BYTE\_8

| NO\_START\_CHK = BYTE\_9

| CART\_STATUS = 1818H

| BYTE\_NUM = 0

| EEC\_CHKSUM = 0

| Exit message check logic

|

| --- ELSE ---

|

| (bad command)

| CART\_STATUS = 1818H

| BYTE\_NUM = 0

| EEC\_CHKSUM = 0

| Exit message check logic

13-37

DATA COMMUNCATIONS LINK, UART MESSAGE CHECK - LHBH0

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13-38

CHAPTER 14

DATA OUTPUT LINK

14-1

DATA OUTPUT LINK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DATA OUTPUT LINK

OVERVIEW

In this configuration, the DOL provides relative TP information to the stand

alone governor. DOL\_DUTY is a duty cycle with transfer function

FN500(TPREL). DOL\_DUTY is sent to the governor as a PWM signal with constant

frequency of 300 Hz (+/- 0.1%).

DEFINITIONS

INPUTS

Registers:

- RATCH = Lowest filtered throttle position (see SYSTEM EQUATIONS Chapter).

- TP = Throttle position, counts.

- TP\_REL = Relative TP (TP - RATCH).

Bit Flags:

- MFMFLG = Flag indicating MAP sensor failure; 1 -> failure.

- TFMFLG = Flag indicating a TP sensor failure; 1 -> failure.

Calibration Constants:

- GOVHP = Governor hardware present switch; 0 -> no governor, 1 -> governor

present.

- FN500 = Transfer function to convert TPREL counts to percent duty cycle

for transmission on the DOL.

OUTPUTS

Registers:

- DOL\_DUTY = Duty cycle to be output to the stand alone governor.

14-2

DATA OUTPUT LINK - LHBH0

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PROCESS

STRATEGY MODULE: DOL\_LH

GOVHP = 1 --------------|

|AND -|

TFMFLG = 0 -------------| |

(TP sensor ok) |

|OR --| DOL\_DUTY = FN500(TP\_REL)

GOVHP = 1 --------------| | | (GMAPDC is duty cycle)

| | | (output duty cycle DOL\_DUTY

TFMFLG = 1 -------------|AND -| | at 300 Hz on HSO-2)

(TP sensor failed) | |

| |

MFMFLG = 0 -------------| |

| --- ELSE ---

|

| No action

| Disable DOL outputs

NOTE:

- Should the TP sensor fail, TP is simulated from MAP and is output to the

governor. Should the MAP sensor also fail, no value for TP is output.

14-3

DATA OUTPUT LINK - LHBH0

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14-4

DATA OUTPUT LINK, PULSE CALCULATION - LHBH0

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PULSE CALCULATION

OVERVIEW

The Data Output Link (DOL) provides fuel consumption information to the

vehicle dashboard fuel economy display products (Tripminder or Message

Center). The output, in the form of pulses, represents the amount of fuel

used since the last update. This information is used in calculating fuel

economy and distance-to-empty for display to the driver.

The injector fuel flow (in lbmf/(injector/port)) is accumulated in the

register FUEL\_SUM every time an injector port is energized. Both normal and

AE pulses are accumulated in FUEL\_SUM. Once a background loop, FUEL\_SUM is

converted to the appropriate integer number of DOL pulses, and DOL\_COUNT is

updated according to the equation shown below. The amount of FUEL\_SUM which

cannot be converted to an integer count remains in FUEL\_SUM for the next

conversion. For some strategies, the injector fuel flow sum is stored in

ticks (register FUEL\_SUM\_TICKS) instead of lbmf. The ticks are then

converted to lbmf when the DOL pulses are calculated.

Approximately every two milliseconds, the value of DOL\_COUNT is checked. If

DOL\_COUNT is greater than 1.0, the DOL output is energized for about one

msec, and DOL\_COUNT is reduced by 1.0.

DEFINITIONS

INPUTS

Registers:

- A0COR = Corrected fuel flow rate of injectors, lb/sec.

- DOL\_COUNT = Number of pulses to be output to the Fuel Economy display

device.

- FUEL\_SUM\_TKS = Register for DOL summer, ticks.

- INJOUT = Number of injectors per output port, unitless.

- stcf = Seconds to clock ticks conversion factor, ticks/second.

Calibration Constants:

- PUL\_PER\_GAL = Number of DOL pulses to be issued for each gallon of fuel

used, pulse per gal.

NOTE: THE VALUE FOR PUL\_PER\_GAL MUST BE OBTAINED FROM EED/INSTRUMENT

SYSTEMS FOR EACH APPLICATION.

14-5

DATA OUTPUT LINK, PULSE CALCULATION - LHBH0

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OUTPUTS

Registers:

- DOL\_COUNT = See above.

- FUEL\_SUM\_TKS = See above.

14-6

DATA OUTPUT LINK, PULSE CALCULATION - LHBH0

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PROCESS

STRATEGY MODULE: DOL\_PULSE\_CALC\_COM3

Once per background loop execute the following:

bit 0 of LINK\_SW = 1 ----------| [pulses] = FUEL\_SUM\_TKS \* A0COR \*

| INJOUT \* PUL\_PER\_GAL

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

| 6.15 (lbm/gallon) \* stcf

|

| DOL\_COUNT = DOL\_COUNT + integer([pulses])

|

| FUEL\_SUM\_TKS = remainder([pulses]) \* stcf \*

| 6.15 (lbm/gallon) / ( A0COR \*

| INJOUT \* PUL\_PER\_GAL )

Once per millisecond execute the following:

bit 0 of LINK\_SW = 1 ----|

|AND -| Toggle DOL output

DOL\_COUNT > 0.5 ---------| |

| DOL\_COUNT = DOL\_COUNT - 1

|

| --- ELSE ---

|

bit 0 of LINK\_SW = 1 ----------| DOL\_COUNT = 0.5

14-7

DATA OUTPUT LINK, PULSE CALCULATION - LHBH0

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14-8

CHAPTER 15

ALTERNATIVE CALIBRATION

15-1

ALTERNATIVE CALIBRATION, CALIBRATION INITIALIZE LOGIC - LHBH0

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CALIBRATION INITIALIZE LOGIC

OVERVIEW

This module sets the flag which will invoke the alternate calibration. To do

this, it looks at the value of the parameter NO\_OF\_STARTS which may have been

downloaded in DCL, and it also checks the check byte which is the one's

complement of NO\_OF\_STARTS. The value of NO\_OF\_STARTS is subsequently

decremented. These checks are performed during the RAM initialization

process only.

DEFINITIONS

INPUTS

Registers:

- NO\_OF\_STARTS = Number of starts using alternative calibration.

- NO\_START\_CHK = Number of starts, check byte.

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

OUTPUTS

Registers:

- NO\_OF\_STARTS = See above.

- NO\_START\_CHK = See above.

Bit Flags:

- ALT\_CAL\_FLG = See above.

15-2

ALTERNATIVE CALIBRATION, CALIBRATION INITIALIZE LOGIC - LHBH0

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PROCESS

STRATEGY MODULE: ALTR\_CAL\_INIT\_COM1

Performed during RAM Initialization only.

NO\_OF\_STARTS > 0 ------------------|

|AND -| ALT\_CAL\_FLG = 1

NO\_START\_CHK = 255 - NO\_OF\_STARTS -| |

| --- ELSE ---

|

| ALT\_CAL\_FLG = 0

ALT\_CAL\_FLG = 1 -------------------------| Decrement NO\_OF\_STARTS

| Increment NO\_START\_CHK

|

| --- ELSE ---

|

| Do nothing

15-3

ALTERNATIVE CALIBRATION, CALIBRATION CLEAR LOGIC - LHBH0

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CALIBRATION CLEAR LOGIC

OVERVIEW

This module erases any remaining alternate calibration starts should the

vehicle travel further than ALT\_CAL\_DIST in any one journey. The value of

ALT\_CAL\_FLG is also set each background loop to reduce the effect of any

possible corruption of the register that may occur.

DEFINITIONS

INPUTS

Registers:

- BG\_TMR = Background loop timer.

- DISTANCE = Distance traveled since start, miles.

- NO\_OF\_STARTS = Number of starts using alternative calibration.

- NO\_START\_CHK = Number of starts, check byte.

- VSBAR = Filtered vehicle speed.

Calibration Constants:

- ALT\_CAL\_DIST = Distance traveled before alternate calibration is revoked,

miles.

OUTPUTS

Registers:

- DISTANCE = See above.

- NO\_OF\_STARTS = See above.

- NO\_START\_CHK = See above.

Bit Flags:

- ALT\_CAL\_FLG = Flag to indicate use of alternate calibration.

15-4

ALTERNATIVE CALIBRATION, CALIBRATION CLEAR LOGIC - LHBH0

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PROCESS

STRATEGY MODULE: ALTR\_CAL\_CLR\_COM1

DISTANCE = DISTANCE + (VSBAR \* BG\_TMR) / 3600

DISTANCE > ALT\_CAL\_DIST -----------------| NO\_OF\_STARTS = 0

| NO\_START\_CHK = 0

| ALT\_CAL\_FLG = 0

|

| --- ELSE ---

NO\_OF\_STARTS > 0 ------------------| |

|AND -| ALT\_CAL\_FLG = 1

NO\_START\_CHK = 255 - NO\_OF\_STARTS -| |

| --- ELSE ---

|

| ALT\_CAL\_FLG = 0

15-5

ALTERNATIVE CALIBRATION, CALIBRATION CLEAR LOGIC - LHBH0

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15-6

CHAPTER 16

SHIFT CONTROL

16-1

SHIFT CONTROL, E4OD TRANSMISSION STRATEGY OVERVIEW - LHBH0

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E4OD TRANSMISSION STRATEGY OVERVIEW

The E4OD strategy and software are comprised of a set of distinct,

independent modules, each with a specific function. The modules are designed

to minimize the software impact of different transmission hardware and can

thus be re-used in other future transmission strategies. The main modules

and subroutines are show on the following page. They are executed in the

order shown except for System Equations which is done immediately after input

conversion. Also shown are the main output parameters of the modules.

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

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

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

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

\*\*\* All references to "PDL", "PRNDL", or variations thereof \*\*\*

\*\*\* with respect to electronic transmission controls are \*\*\*

\*\*\* synonymous with "Manual Level Indicated Position" as deter- \*\*\*

\*\*\* mined from the manual lever position sensor. \*\*\*

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

\*\*\* All references to "TV", "ETV", or terms containing "TV" \*\*\*

\*\*\* with respect to electronic transmission controls are synon- \*\*\*

\*\*\* ymous with "Electronic Pressure Control", and are not \*\*\*

\*\*\* associated with any control function of the engine throttle.\*\*\*

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

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

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

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

16-2

SHIFT CONTROL, E4OD TRANSMISSION STRATEGY OVERVIEW - LHBH0

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STRUCTURE

MAIN ROUTINE

SUBROUTINES OUTPUT PARAMETERS

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

E4OD\_SYS\_EQU\_COM1 NEBART

E4OD\_INPUT\_PROCESSING\_COM1 VSBART

VSBART\_RT

NOBART

PDL

SPD\_RATIO

TP\_REL

FLG\_4X4L

FLG\_OCS

FLG\_PWR

TQ\_NET

DESRD\_GR\_DETR\_COM1 GR\_DS

FLG\_FRST\_DS

GR\_DS\_AUTO\_COM1 FLG\_SFT\_UP

VER\_AUTO\_SHFT\_COM1 FLG\_SFT\_DN

FLG\_SF\_AUTO

CM\_GR\_DETR\_COM1 GR\_CM

GR\_OLD

CM\_GR\_MAN1\_COM1 RT\_GR\_OLD

CM\_GR\_MAN2\_COM1 FLG\_FRST\_CM

CM\_GR\_AUTO\_DWN\_COM1

SHFT\_TIMER\_COM1 TM\_SFT\_IN

FLG\_SFT\_IN

FLG\_SFT\_MDN

SHFT\_SOL\_CTL\_COM1 FLG\_SS\_1

FLG\_SS\_2

RT\_GR\_CUR

GEAR\_CUR

SHIFT\_VALID\_COM1 SFT\_ERROR

CST\_CLTCH\_CTL\_COM1 FLG\_CS\_CM

FLG\_CS\_ENG

TV\_GUIDE\_COM1 TV\_PRES

TV\_STARTUP\_COM1 TV\_COUNTS

TV\_CST\_BOOST\_COM4 OFMFLG

TV\_ENGMT\_STALL\_COM1

TV\_NORM\_COM1 TV\_STAT

TV\_TQ\_IALPHA\_COM4 TQ\_IALPHA

TV\_DYNAMIC\_COM1 TV\_DYN

16-3

SHIFT CONTROL, E4OD TRANSMISSION STRATEGY OVERVIEW - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MAIN ROUTINE

SUBROUTINES OUTPUT PARAMETERS

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

ET\_EPC\_OFM\_COM2

ET\_TV\_VFS\_OUT\_COM2

CNVRTR\_CLUTCH\_CTL\_COM1 FLG\_LK\_CM

UNCOND\_UNLCK\_COM1 FLG\_UNC\_UNLK

SHFT\_UNLCK\_COM1 FLG\_SFT\_UNLK

INI\_DWN\_CNVR\_CLCH\_COM1 TM\_SFT\_CCO

DWN\_CNVR\_CLCH\_COM1

INI\_UP\_CNVR\_CLCH\_COM1

UP\_CNVR\_CLCH\_COM2

SCHLD\_LCK\_UP\_COM1 FLG\_CRV\_LK

WOT\_LCK\_UP\_COM2 FLG\_WOT\_LK

RT\_NOVS\_KAM\_CALC\_COM1 RT\_NOVS

CONV\_CLCH\_VALID\_COM1 CC\_ERROR

OD\_CANCEL\_SW\_COM1 FLG\_OCS

OCIL\_STATE\_COM1 OCIL\_STATE

OCILTMR

OCIL\_FLASH\_TMR

OCIL\_REPEAT\_COM1

CST\_OUT\_REPEAT\_COM1

CONVERTER\_CLUTCH\_REPEAT\_COM3

TV\_VFS\_OUT\_REPEAT\_COM1

16-4

SHIFT CONTROL, PRNDL BASED DESIRED GEAR DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PRNDL BASED DESIRED GEAR DETERMINATION

OVERVIEW

The desired transmission gear is calculated based on PRNDL position.

Possible gears are:

GR\_CM Transmission State GEAR\_CUR RT\_GR\_CUR

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

1 1ST 1 2.710

2 (PDL < 3) 2ND, interm. band ON 2 1.538

2 (PDL > 2) 2ND, interm. band OFF 2 1.538

3 3RD 3 1.0

4 4TH 4 0.742

In the normal Drive/Overdrive position, the desired gear is calculated based

on a maximum WOT RPM shift point or as a function of throttle position versus

vehicle speed. All shift points are adjusted for altitude. There are no

excluded shifts in automatic mode, that is 1 - 4 shifts or 3 - 1 shifts are

permitted if the calibration calls for it.

In manual 2 or 1, desired gear is set to the ultimate desired gear: 2 in

manual 2 and 1 in manual 1. Sequencing through the downshift routine is left

to the commanded gear routine.

The main outputs of the desired gear routine are:

- GR\_DS, the desired gear;

- FLG\_FRST\_DS, global flag to indicate a shift is desired this background

pass.

DEFINITIONS

INPUTS

Registers:

- GEAR\_CUR = Current transmission gear.

- GR\_DS = Desired transmission gear.

- GR\_DS\_LST = Desired gear in the last background pass

- GR\_DS\_TV = Desired gear used to compute TV pressure.

- GEAR\_OLD = Last commanded gear (global register).

- PDL = Current PRNDL position.

- PDL\_LST = Last PRNDL position.

16-5

SHIFT CONTROL, PRNDL BASED DESIRED GEAR DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TM\_DEL\_SFT = Time during which a shift is delayed.

OUTPUTS

Registers:

- GR\_DS = See above.

- GR\_DS\_LST = See above.

- GR\_DS\_TV = Desired gear used to compute TV pressure.

- TM\_DEL\_SFT = See above.

- TM\_SFT\_IN = Shift in progress timer.

Bit Flags:

- FLG\_DE\_DSGR = Delay desired gear 1st pass flag.

- FLG\_DEL\_MDN = Flag indicating a manual downshift is being delayed: 0 ->

no manual downshift is being delayed, 1 -> a manual downshift is being

delayed.

- FLG\_FRST\_DS = First time a shift is desired flag; 0 -> no shift desired,

1 -> shift desired this background pass.

- FLG\_SF\_AUTO = Automatic upshift/downshift flag; 1 -> automatic shift

(PRNDL = 3 or 4), 0 -> manual shift (PRNDL = 2 or 1).

- FLG\_SFT\_DN = Downshift flag; 1 -> indicates current or last shift is/was

a downshift.

- FLG\_SFT\_IN = Shift in progress flag; 1 -> shift in progress, 0 -> no

shift in progress.

- FLG\_SFT\_UP = Upshift flag; 1 -> indicates current or last shift is/was an

upshift.

16-6

SHIFT CONTROL, PRNDL BASED DESIRED GEAR DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_DESRD\_GR\_DETR\_COM1

PDL = 3 OR 4 ---------------------|

|AND -| TM\_SFT\_IN = 0

PDL\_LST <> 3 OR 4 ----------------| | FLG\_SFT\_IN = 0

always ---------------------------------| GR\_DS\_LST = GR\_DS

PDL = 1 --------------------------------| GR\_DS = 1

(PRNDL in manual 1) |

| --- ELSE ---

|

PDL = 2 --------------------------------| GR\_DS = 2

(PRNDL in manual 2) |

| --- ELSE ---

PDL = 3 --------------------------| |

(PRNDL in overdrive cancel) |OR --| Do "GR\_DS, PRNDL = 3 OR 4" Logic

| |

PDL = 4 --------------------------| |

(PRNDL in overdrive) |

| --- ELSE ---

PDL = 5 --------------------------| |

(PRNDL in neutral) | |

| |

PDL = 6 --------------------------|OR --| GR\_DS = 1

(PRNDL in reverse) |

|

PDL = 7 --------------------------|

(PRNDL in park)

always ---------------------------------| GR\_DS\_TV = GR\_DS

16-7

SHIFT CONTROL, PRNDL BASED DESIRED GEAR DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PDL <> 3 OR 4 --------------------|

(manual gear) |

|OR --| TM\_DEL\_SFT = 0

PDL\_LST <> 3 OR 4 ----------| | | FLG\_DE\_DSGR = 0

|AND -| | FLG\_SF\_AUTO = 0

PDL = 3 OR 4 ---------------| |

(man-to-auto shift) | --- ELSE ---

|

| Do "Delay Shift Logic"

TM\_DEL\_SFT = 0 -------------------------| FLG\_DEL\_MDN = 0

GR\_DS\_TV > GEAR\_CUR --------------|

(upshift is being verified or |

will be commanded this pass) |OR --| FLG\_SFT\_UP = 1

| | FLG\_SFT\_DN = 0

GR\_DS\_TV = GEAR\_CUR --------| | | (indicate upshift)

(no shift pending) |AND -| |

| |

GEAR\_CUR > GEAR\_OLD --------| | --- ELSE ---

(last shift was an upshift) |

| FLG\_SFT\_UP = 0

| FLG\_SFT\_DN = 1

| (indicate downshift)

GR\_DS <> GR\_DS\_LST ---------------------| FLG\_FRST\_DS = 1

(desired gear has changed) | (new desired gear for this

| program pass only)

|

| --- ELSE ---

|

| FLG\_FRST\_DS = 0

16-8

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

GR\_DS, PRNDL = 3 OR 4 LOGIC

OVERVIEW

This module handles the Desired Gear computation when PRNDL = 3 or 4.

DEFINITIONS

INPUTS

Registers:

- BP\_INTR = BP interpolation factor.

- CS\_SFT\_MULT = Cold start shift multiplier.

- GR\_DS = Desired transmission gear.

- GR\_DS\_LST = Desired gear, last background pass.

- GEAR\_CUR = Current transmission gear

- NEBART = Filtered engine RPM for transmission.

- PDL = Current PRNDL position.

- RT\_NOVS = Ratio of actual N/V to base N/V in KAM.

- TP\_REL = Relative throttle position, counts.

- TP\_REL\_H = Relative TP (TP - RATCH) high byte only.

- VS\_RATEPH = Vehicle accel rate for Powertrain Hunting.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission.

- VSCTR = Counter for unrealistic changes in vehicle speed.

Bit Flags:

- FLG\_4X4L = Flag indicating 4X4 low mode; 1 -> in 4X4 low mode.

- FLG\_SFT\_IN = Shift in progress flag; 1 -> shift in progress, 0 -> no

shift in progress.

- VSFMFLG = Vehicle speed sensor failure flag; 1 -> VSS failure, 0 -> no

VSS failure.

16-9

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- FN12A(TP\_REL\_H) = Vehicle speed for 1 - 2 upshift at altitude.

- FN12S(TP\_REL\_H) = Vehicle speed for 1 - 2 upshift at sea level.

- FN21A(TP\_REL\_H) = Vehicle speed for 2 - 1 downshift at altitude.

- FN21S(TP\_REL\_H) = Vehicle speed for 2 - 1 downshift at sea level.

- FN23A(TP\_REL\_H) = Vehicle speed for 2 - 3 upshift at altitude.

- FN23PPH(TP\_REL) = Min VS\_RATEPH to allow 2 - 3 upshift.

- FN23S(TP\_REL\_H) = Vehicle speed for 2 - 3 upshift at sea level.

- FN32A(TP\_REL\_H) = Vehicle speed for 3 - 2 downshift at altitude.

- FN32S(TP\_REL\_H) = Vehicle speed for 3 - 2 downshift at sea level.

- FN34A(TP\_REL\_H) = Vehicle speed for 3 - 4 upshift at altitude.

- FN34PPH(TP\_REL) = Minimum VS\_RATEPH to allow 3 - 4 upshift.

- FN34S(TP\_REL\_H) = Vehicle speed for 3 - 4 upshift at sea level.

- FN43A(TP\_REL\_H) = Vehicle speed for 4 - 3 downshift at altitude.

- FN43S(TP\_REL\_H) = Vehicle speed for 4 - 3 downshift at sea level.

- FN689D(TP\_REL) = Engine speed for downshifts during VSS failure.

- FN689U(TP\_REL) = Engine speed for upshifts during VSS failure.

- NE12A = WOT RPM 1 - 2 shift point, altitude.

- NE12S = WOT RPM 1 - 2 shift point, sea level.

- NE23A = WOT RPM 2 - 3 shift point, altitude.

- NE23S = WOT RPM 2 - 3 shift point, sea level.

- NE34A = WOT RPM 3 - 4 shift point, altitude.

- NE34S = WOT RPM 3 - 4 shift point, sea level.

16-10

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - LHBH0

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OUTPUTS

Registers:

- GR\_DS = See above.

Bit Flags:

-

FLG\_UP\_NE = WOT engine RPM upshift flag; 1 -> upshift due to WOT RPM,

0 -> upshift due to shift curves.

16-11

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_GR\_DS\_AUTO\_COM1

Always ---------------------------------------| FLG\_UP\_NE = 0

| (Start fresh every time)

VSFMFLG = 0 ----------------------------|

(VS sensor OK) |AND -| Do "VEHICLE SPEED SENSOR

| | OK SHIFT LOGIC"

VSCTR = 0 ------------------------------| |

(stable VS values) |

| --- ELSE ---

|

| Do "VEHICLE SPEED SENSOR

| FAILURE SHIFT LOGIC"

GR\_DS > GR\_DS\_LST ----------------------|

|AND -| GR\_DS = GR\_DS\_LST

FLG\_SFT\_IN = 1 -------------------------| | (Do not allow an upshift

| if a previous shift is

| still in progress)

| FLG\_UP\_NE = 0

16-12

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

VEHICLE SPEED SENSOR OK SHIFT LOGIC

GEAR\_CUR = 1 ---------------------------|

|

NEBART > NE12S + [BP\_INTR \* NE12A] -----|AND -| GR\_DS = 2

(1-2 WOT RPM upshift) | | FLG\_UP\_NE = 1

| |

FLG\_4X4L = 0 ---------------------------| |

(not in 4X4 low) |

| --- ELSE ---

GEAR\_CUR = 2 ---------------------------| |

| |

NEBART > NE23S + [BP\_INTR \* NE23A] -----|AND -| GR\_DS = 3

(2-3 WOT RPM upshift) | | FLG\_UP\_NE = 1

| |

FLG\_4X4L = 0 ---------------------------| |

(not in 4X4 low) |

| --- ELSE ---

GEAR\_CUR >= 3 --------------------------| |

| |

NEBART > NE34S + [BP\_INTR \* NE34A] -----| |

|AND -| GR\_DS = 4

PDL = 4 --------------------------------| | FLG\_UP\_NE = 1

(3-4 WOT RPM upshift, if PRNDL = 4) | |

| |

FLG\_4X4L = 0 ---------------------------| |

(not in 4X4 low) |

| --- ELSE ---

GEAR\_CUR < 4 ---------------------------| |

| |

VSBART\_RT > [FN34S + (BP\_INTR \* | |

FN34A)] \* CS\_SFT\_MULT ----------------| |

|AND -| GR\_DS = 4

PDL = 4 --------------------------------| |

(VS vs. TP\_REL upshift to 4th gear, | |

if PRNDL = 4) | |

| |

VS\_RATEPH > FN34PPH \* RT\_NOVS ----------| |

(VS\_RATEPH vs. TP\_REL upshift to 4th gear, |

if minimum accel rate is satisfied) |

| --- ELSE ---

GEAR\_CUR < 3 ---------------------------| |

| |

VSBART\_RT > [FN23S + (BP\_INTR \* | |

FN23A)] \* CS\_SFT\_MULT ----------------|AND -| GR\_DS = 3

(VS vs. TP\_REL upshift to 3rd gear) | |

| |

VS\_RATEPH > FN23PPH \* RT\_NOVS ----------| |

(VS\_RATEPH vs. TP\_REL upshift to 3rd gear, |

if minimum accel rate is satisfied) |

| --- ELSE ---

|

(continued on next page)

16-13

SHIFT CONTROL, GR\_DS, PRNDL = 3 OR 4 LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

GEAR\_CUR < 2 ---------------------------| |

|AND -| GR\_DS = 2

VSBART\_RT > [FN12S + (BP\_INTR \* | |

FN12A)] \* CS\_SFT\_MULT ----------------| |

(VS vs. TP\_REL upshift to 2nd gear) |

| --- ELSE ---

GEAR\_CUR > 1 ---------------------------| |

|AND -| GR\_DS = 1

VSBART\_RT < [FN21S + (BP\_INTR \* | |

FN21A)] \* CS\_SFT\_MULT ----------------| |

(VS vs. TP\_REL downshift to 1st gear) |

| --- ELSE ---

GEAR\_CUR > 2 ---------------------------| |

|AND -| GR\_DS = 2

VSBART\_RT < [FN32S + (BP\_INTR \* | |

FN32A)] \* CS\_SFT\_MULT ----------------| |

(VS vs. TP\_REL downshift to 2nd gear) |

| ---ELSE ---

GEAR\_CUR > 3 ---------------------| |

|AND -| |

VSBART\_RT < [FN43S + (BP\_INTR \* | | |

FN43A)] \* CS\_SFT\_MULT ----------| | |

(VS vs. TP\_REL downshift to 3rd gear) |OR --| GR\_DS = 3

| |

GEAR\_CUR > 3 ---------------------| | |

|AND -| |

PDL = 3 --------------------------| |

(manual 4-3 downshift) |

| --- ELSE ---

|

| GR\_DS = GEAR\_CUR

VEHICLE SPEED SENSOR FAILURE SHIFT LOGIC

NEBART > FN689U(TP\_REL) ----------------|

|AND -| GR\_DS = GEAR\_CUR + 1

GEAR\_CUR <> 4 --------------------------| |

| --- ELSE ---

NEBART < FN689D(TP\_REL) ----------------| |

| |

GEAR\_CUR <> 1 --------------------------|AND -| GR\_DS = GEAR\_CUR - 1

|

FLG\_SFT\_IN = 0 -------------------------|

GR\_DS = 4 ------------------------------|

|AND -| GR\_DS = 3

PDL = 3 --------------------------------|

16-14

SHIFT CONTROL, DELAY/VERIFY SHIFT LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DELAY/VERIFY SHIFT LOGIC

OVERVIEW

This logic delays the commanding of the desired gears a calibratable amount

of time to:

- allow for the TV pressure to ramp-up prior to commanding the shift. TV

is increased tremendously during a shift. It is necessary to start

commanding the extra TV prior to the shift to overcome the delays

associated with the time constant of the TV solenoid.

- allow the RPM to decrease before commanding a tip-out upshift.

Commanding an upshift immediately after a tip-out feels harsh, since the

clutches will be used to slow the engine down. Waiting a period of time

before commanding this shift, smoothes the shift significantly.

- verify a shift is absolutely necessary. Noise perturbations may result

in incorrect gears being desired for one or two background loops.

Delaying the shift, verifies that a gear is truly desired, and that it is

not just noise.

Entering into this logic is the parameter, GR\_DS, the desired gear. The

logic first transfers this gear value into another parameter, GR\_DS\_TV, which

is used to calculate the additional amount of TV required for the upcoming

shift. The delay logic then proceeds to delay the shift by setting the GR\_DS

to its previous value until the delay timer runs out. When the timer

expires, the GR\_DS is no longer set to its previous value, but is allowed to

pass through to the Commanded Gear Determination logic and Shift Solenoid

logic which actually processes the GR\_DS into shift solenoid commands; i.e.,

the shift is commanded.

By the time the shift is commanded, the necessary TV required for the shift

will have been commanded, the engine RPM will have slowed some to make the

tip-out upshifts feel smooth, and the shift will have been verified.

If the GR\_DS changes prior to the timer expiring, the timer continues to

count down. The timer does not affect the amount of TV which is commanded,

because GR\_DS\_TV will always be set to the latest desired gear, and the TV

will be commanded based on that value. Worst case, the TV pressure will be

unnecessarily increased for a short period of time if the GR\_DS/GR\_DS\_TV

fluctuates due to a noise spike. When the timer becomes zero, the latest

GR\_DS is passed through.

NOTES:

The delay timer is set to one of three values. These are:

- delay to allow TV to ramp up for an upshift, and/or the delay to verify a

gear; TM\_DEL\_UP

- delay to allow TV to ramp up for a downshift, and/or the delay to verify

a gear; TM\_DEL\_DOWN

- delay for a tip-out upshift to allow the RPM decrease, TM\_DEL\_TO\_UP

16-15

SHIFT CONTROL, DELAY/VERIFY SHIFT LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- GEAR\_CUR = Current transmission gear.

- GR\_DS = Desired transmission gear.

- GR\_DS\_LST = Desired gear in last background pass.

- PDL = PRNDL position.

- TM\_DEL\_SFT = Time to delay automatic desired shift.

- TP\_RATE = Throttle rate = TP - TBART.

Bit Flags:

- FLG\_DE\_DSGR = Delay desired gear first pass flag; 0 -> First pass through

DELAY DESIRED GEAR, 1 -> Delay desired gear in process.

Calibration Constants:

- TM\_DEL\_DOWN = Time to delay/verify a downshift.

- TM\_DEL\_TO\_UP = Time to delay a tip-out upshift.

- TM\_DEL\_UP = Time to delay/verify an upshift.

- TO\_TP\_RATE = TP\_RATE required to recognize a tip-out.

OUTPUTS

Registers:

- GR\_DS = See above.

- GR\_DS\_TV = Desired gear used to compute TV pressure.

- TM\_DEL\_SFT = See above.

Bit Flags:

- FLG\_DE\_DSGR = See above.

- FLG\_DEL\_MDN = Flag indicating a manual downshift is being delayed: 0 ->

no manual downshift is being delayed; 1 -> a manual downshift is being

delayed.

- FLG\_SF\_AUTO = Automatic upshift/downshift flag: 1 -> Automatic shift

(PRNDL = 3 or 4); 0 -> Manual shift (PRNDL = 1,2,5,6 or 7).

- FLG\_TIP\_OUT = Flag which indicates a tip-out upshift in progress: 0 ->

no tip-out upshift in progress; 1 -> a tip-out upshift in progress.

16-16

SHIFT CONTROL, DELAY/VERIFY SHIFT LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_VER\_AUTO\_SHFT\_COM1

GR\_DS <> GR\_DS\_LST -----------|

(shift is desired) |

|

FLG\_DE\_DSGR = 1 --------------|AND -| GR\_DS = GR\_DS\_LST

(delay in process) | | (hold original desired gear until

| | new desired gear is verified)

TM\_DEL\_SFT > 0 ---------------| |

(timer not expired) | --- ELSE ---

|

GR\_DS <> GR\_DS\_LST -----------| |

(shift is desired) | |

| |

FLG\_DE\_DSGR = 1 --------------|AND -| FLG\_DE\_DSGR = 0

(delay in process) | | (new desired gear is delayed,

| | allow it to pass thru to

TM\_DEL\_SFT = 0 ---------------| | commanded gear module)

(timer expired) | FLG\_SF\_AUTO = 1

| (this is an automatic shift,

| cleared in converted clutch)

|

| --- ELSE ---

GR\_DS > GR\_DS\_LST ------------| |

(upshift is desired) |AND -| FLG\_DE\_DSGR = 1

| | (set first pass flag)

FLG\_DE\_DSGR = 0 --------------| | DO "LOAD TM\_DEL\_SFT FOR UPSHIFTS"

(first pass thru) | (load timer)

| GR\_DS = GR\_DS\_LST

| (hold original desired gear until

| new desired gear is delayed)

| FLG\_SF\_AUTO = 0

| (clear auto shift flag)

|

GR\_DS < GR\_DS\_LST ------------| | --- ELSE ---

(downshift is desired) | |

|AND -| FLG\_DE\_DSGR = 1

FLG\_DE\_DSGR = 0 --------------| | (set first pass flag)

(first pass through) | TM\_DEL\_SFT = TM\_DEL\_DOWN

| (load timer)

| DO "MANUAL DOWNSHIFT DETERMINATION"

| GR\_DS = GR\_DS\_LST

| (hold original desired gear until

| new desired gear is delayed)

| FLG\_SF\_AUTO = 0

| (clear auto shift flag)

| FLG\_TIP\_OUT = 0

|

| --- ELSE ---

|

| FLG\_DE\_DSGR = 0

| (clear first pass flag)

16-17

SHIFT CONTROL, DELAY/VERIFY SHIFT LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PDL = 3 ----------------------|

|AND -| FLG\_SF\_AUTO = 0

GEAR\_CUR = 4 -----------------| | (clear auto shift flag for a

(driver did manual 4-3) | manual 4 - 3 downshift. All

| subsequent downshifts will be

| considered automatic downshifts.

| Also clear shift flag for manual

| PRNDL positions)

MANUAL DOWNSHIFT DETERMINATION

PDL = 3 ----------------------------|

|AND -| FLG\_DEL\_MDN = 1

GEAR\_CUR = 4 -----------------------| |

(driver did manual 4-3) | --- ELSE ---

|

| FLG\_DEL\_MDN = 0

LOAD TM\_DEL\_SFT FOR UPSHIFTS LOGIC

TP\_RATE < TO\_TP\_RATE ---------------------| TM\_DEL\_SFT = TM\_DEL\_TO\_UP

| FLG\_TIP\_OUT = 1

|

| --- ELSE ---

|

| TM\_DEL\_SFT = TM\_DEL\_UP

| FLG\_TIP\_OUT = 0

16-18

SHIFT CONTROL, PRNDL BASED COMMANDED GEAR DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PRNDL BASED COMMANDED GEAR DETERMINATION

OVERVIEW

The commanded transmission gear is calculated based on PRNDL position. The

logic looks at the current gear and the desired gear to determine if an

upshift or a downshift is required and then commands the next appropriate

gear in the sequence.

In the drive or overdrive position, there are no restrictions on shifts. The

commanded gear routine, therefore does not have to sequence through any

particular pattern. The only restriction is that downshifts are done only

after the converter clutch has unlocked.

In neutral, first gear is commanded, unless a calibratible vehicle speed is

reached. At this point, the gear commanded is calibratible (GR\_NEU). This

feature is provided to protect the direct clutch from rotating at very high

speeds in neutral. In the case of a vehicle speed sensor failure, GR\_NEU

will be commanded.

In the manual 2 or 1 position, the downshift sequence is as follows:

1. Unlock the converter clutch and command 3rd gear (This is because

commanded 4th gear in a manual low range results in 2nd intermediate band

on, based on both shift solenoids being off).

2. Apply the coast clutch in 3rd gear to absorb some inertia torque.

3. When the coast clutch has engaged and the converter clutch has unlocked

command second gear, intermediate band off.

4. Delay the application of the intermediate band for a calibratable period

of time.

5. Command first gear if PRNDL = 1 and below the 2 - 1 pull-in speed.

The main outputs of the commanded gear routine are:

- GR\_CM, commanded gear which reflects the actual shift solenoid states.

- GR\_OLD, GEAR\_OLD, RT\_GR\_OLD, last gear the transmission was in.

- FLG\_FRST\_CM, global flag to indicate a shift is commanded this background

pass.

16-19

SHIFT CONTROL, PRNDL BASED COMMANDED GEAR DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- GEAR\_CUR = Current transmission gear (global register).

- GR\_CM = Commanded gear for shift solenoids.

- GR\_CM\_LST = Commanded gear in last background pass.

- GR\_DS = Desired transmission gear.

- PDL = Current PRNDL position.

- RT\_GR\_CUR = Current transmission gear ratio.

- TP\_REL = Relative throttle position, counts.

- VSBART\_RT = Vehicle Speed, corrected for N/V, MPH.

Bit Flags:

- FLG\_FRST\_DS = First time a shift is desired flag; 0 -> no shift desired,

1 -> shift desired this background pass.

- VSFMFLG = Vehicle speed sensor FMEM flag; 1 -> sensor failed.

Calibration Constants:

- FN624(TP\_REL) = Time to delay downshift to unlock converter.

- GRMSFT = Gear commanded for manual shifting.

- GR\_NEU = Gear commmanded in neutral at a vehicle speed above VS\_NEU.

- SW\_MSF = Switch to select GR\_CM manually; 1 -> manual gear selection, <>

1 -> automatic gear selection.

- VS\_NEU = Vehicle speed above which an alternate gear is commanded in

neutral.

16-20

SHIFT CONTROL, PRNDL BASED COMMANDED GEAR DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- DNUN\_TM = FN624(TP\_REL) = Time to delay downshift for converter to

unlock.

- GEAR\_OLD = Last commanded transmission gear (global register).

- GR\_CM = See above.

- GR\_CM\_LST = See above.

- GR\_OLD = Last commanded gear.

- RT\_GR\_OLD = Last gear transmission gear ratio.

Bit Flags:

- FLG\_FRST\_CM = First time a shift is commanded flag; 1 -> shift commanded

this background pass, 0 -> no shift commanded this background pass.

16-21

SHIFT CONTROL, PRNDL BASED COMMANDED GEAR DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_CM\_GR\_DETR\_COM1

Always ----------------------------| GR\_CM\_LST = GR\_CM

| (Update last pass current gear)

FLG\_FRST\_DS = 1 -------------------| DNUN\_TM = FN624(TP\_REL)

(new desired gear) | (time to delay downshift to unlock

| converter)

SW\_MSF = 1 ------------------------| GR\_CM = GRMSFT

(Manual shift selection) |

| --- ELSE ---

|

PDL = 1 ---------------------------| DO "GR\_CM, PRNDL = 1" LOGIC

|

| --- ELSE ---

|

PDL = 2 ---------------------------| DO "GR\_CM, PRNDL = 2" LOGIC

|

| --- ELSE ---

PDL = 3 OR 4 ----------------| |

|AND -| GR\_CM = GR\_DS

GR\_DS > GR\_CM ---------------| |

| --- ELSE ---

PDL = 3 OR 4 ----------------| |

|AND -| DO "GR\_CM, PRNDL = 3 OR 4 DOWNSHIFT"

GR\_DS < GR\_CM ---------------| | LOGIC

| --- ELSE ---

PDL = 5 ---------------------| |

(Neutral) | |

|AND -| GR\_CM = GR\_NEU

VSBART\_RT > VS\_NEU ----| | |

(Vehicle at high | | |

speed) |OR --| |

| |

VSFMFLG = 1 -----------| |

(Vehicle Speed |

sensor failure) |

| --- ELSE ---

PDL = 5 ---------------------| |

(Neutral) | |

| |

PDL = 6 ---------------------|OR --| GR\_CM = 1

(Reverse) |

|

PDL = 7 ---------------------|

(Park)

16-22

SHIFT CONTROL, PRNDL BASED COMMANDED GEAR DETERMINATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

GR\_CM\_LST <> GR\_CM ----------------| FLG\_FRST\_CM = 1

(A shift has been commanded) | (New commanded gear for this

| program pass only)

| GR\_OLD = GR\_CM\_LST

| (Update old gear)

| GEAR\_OLD = GEAR\_CUR

| RT\_GR\_OLD = RT\_GR\_CUR

|

| --- ELSE ---

|

| FLG\_FRST\_CM = 0

| (No shift this program pass)

16-23

SHIFT CONTROL, GR\_CM, PRNDL = 1 LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

GR\_CM, PRNDL = 1 LOGIC

OVERVIEW

This logic determines the commanded gear when PRNDL = 1.

DEFINITIONS

INPUTS

Registers:

- DNUN\_TM = FN624(TP\_REL) = Time to delay downshift for converter to

unlock.

- GR\_CM = Commanded gear for shift solenoids.

- PDL\_LST = Manual lever position previous background pass.

- TM\_UNLK\_CONV = Time since converter was commanded to unlock, sec.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission.

Bit Flags:

- FLG\_CS\_ENG = Coast clutch state of engagement: 1 -> coast clutch

inferred to be on; 0 -> coast clutch not engaged.

- VSFMFLG = Vehicle speed sensor failure flag: 1 -> VSS failure; 0 -> no

VSS failure.

Calibration Constants:

- VS21PI = Maximum vehicle speed for 2 - 1 pull in.

OUTPUTS

Registers:

- GR\_CM = See above.

16-24

SHIFT CONTROL, GR\_CM, PRNDL = 1 LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_CM\_GR\_MAN1\_COM1

GR\_CM = 4 -------------------------------------| GR\_CM = 3

| (always do a 4-3,

| otherwise 2nd will

| result if no action

| is taken)

PDL\_LST = 5 -----------------------| |

| |

GR\_GM = 2 -------------| | |

|OR --| |OR --| | --- ELSE ---

GR\_CM = 3 -------------| | | | |

| | | |

TM\_UNLK\_CONV >= DNUN\_TM -----|AND -| | |

(converter clutch unlocked) | | |

| | |

FLG\_GC\_ENG = 1 --------------| |AND -| GR\_CM = 2

(coast clutch engaged) | |

| |

VSFMFLG = 1 -----------------------| | |

|OR --| |

VSBART\_RT > VS21PI ----------------| |

(above 1st gear pull-in) |

| --- ELSE ---

TM\_UNLK\_CONV >= DNUN\_TM -----------------| |

(converter clutch unlocked) | |

| |

FLG\_CS\_ENG = 1 --------------------------|AND -| GR\_CM = 1

(coast clutch engaged) |

|

VSFMFLG = 0 -----------------------------|

|

VSBART\_RT <= VS21PI ---------------------|

(below 1st gear pull-in)

16-25

SHIFT CONTROL, GR\_CM, PRNDL = 2 LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

GR\_CM, PRNDL = 2 LOGIC

OVERVIEW

This module determines the commanded gear when PRNDL = 2.

DEFINITIONS

INPUTS

Registers:

- DNUN\_TM = FN624(TP\_REL) = Time to delay downshift for converter to

unlock.

- GR\_CM = Commanded gear for shift solenoid.

- PDL\_LST = PRNDL position last background pass.

- TM\_SFT\_12MN = Manual 1-2 delay timer.

- TM\_UNLK\_CONV = Time since converter was commanded to unlock.

Bit Flags:

- FLG\_CS\_ENG = Coast clutch state of engagement; 1 -> coast clutch inferred

to be on, 0 -> coast clutch not engaged.

- FLG\_PWR = Power mode flag; 1 -> power on mode, 0 -> power off mode.

Calibration Constants:

- TM12MN = Time to remain in 1st gear on a manual 1-2 to allow

first/reverse clutch to release.

OUTPUTS

Registers:

- GR\_CM = See above.

- TM\_SFT\_12MN = See above.

16-26

SHIFT CONTROL, GR\_CM, PRNDL = 2 LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_CM\_GR\_MAN2\_COM1

PDL\_LST = 1 -----------------|

(manual 1-2) |

|

GR\_CM = 1 -------------------|AND -| TM\_SFT\_12MN = TM12MN

(current gear is first) | | (load timer to retain

| | first gear until the

| | low/reverse clutch

FLG\_PWR = 0 -----------------| | released)

(power off) | GR\_CM = 1

|

| --- ELSE ---

|

TM\_SFT\_12MN > 0 -------------------| GR\_CM = 1

(timer not expired) |

| --- ELSE ---

|

GR\_CM = 4 -------------------------| GR\_CM = 3

| (always do a 4-3, otherwise

| 2nd will result if no

| action is taken)

|

TM\_UNLK\_CONV >= DNUN\_TM -----| | --- ELSE ---

(converter clutch unlocked) | |

|AND -| GR\_CM = 2

FLG\_CS\_ENG = 1 --------------|

(coast clutch engaged)

16-27

SHIFT CONTROL, GR\_CM, PRNDL = 3 OR 4, DOWNSHIFT LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

GR\_CM, PRNDL = 3 OR 4, DOWNSHIFT LOGIC

OVERVIEW

This module determines the commanded gear on a downshift when PRNDL = 3 or 4.

DEFINITIONS

INPUTS

Registers:

- DNUN\_TM = FN624(TP\_REL) = Time to delay downshift for converter to

unlock.

- GR\_DS = Desired transmission gear.

- TM\_SFT\_CCO = Time since converter clutch commanded on or off during a

shift, sec.

Bit Flags:

- FLG\_LK\_CM = Converter clutch commanded state: 1 -> command converter

clutch lockup; 0 -> command converter clutch unlock.

OUTPUTS

Registers:

- GR\_CM = Commanded gear for shift solenoids.

PROCESS

STRATEGY MODULE: SC\_CM\_GR\_AUTO\_DWN\_COM1

FLG\_LK\_CM = 0 -----------------------|

(converter is unlocked already, or |

will be due to desired downshift) |AND -| GR\_CM = GR\_DS

| | (command downshift)

TM\_SFT\_CCO >= DNUN\_TM ---------------|

(converter has physically unlocked)

16-28

SHIFT CONTROL, LOAD SHIFT IN PROGRESS TIMER - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

LOAD SHIFT IN PROGRESS TIMER

OVERVIEW

The shift in progress timer (TM\_SFT\_IN) is a down-counting timer which is

used in many places in the strategy to determine that a shift is currently

taking place. When the timer has a value of 0, no shift is taking place.

Since the E4OD transmission has no turbine speed sensor, there is no absolute

way to determine the completion of a shift. A worst case time is loaded into

the timer at the start of a shift. The only exception is a power-off manual

downshift. In this special case, speed ratio can be monitored to infer

completion of the shift. Different default values are provided for upshifts,

downshifts, power on, and power off.

DEFINITIONS

INPUTS

Registers:

- GR\_CM = Current transmission gear.

- GR\_OLD = Last commanded gear.

- TM\_DEL\_SFT = Time during which a shift is delayed.

- TM\_SFT\_IN = Time during which shift is in progress.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission.

Bit Flags:

- FLG\_4X4L = Flag indicating 4X4 low mode; 1 -> in 4X4 low mode.

- FLG\_FRST\_CM = First time a shift is commanded flag; 1 -> shift commanded

this background pass, 0 -> no shift commanded this background pass.

- FLG\_PWR = Power mode flag; 1 -> power on mode, 0 -> power off mode.

- FLG\_SF\_AUTO = Automatic upshift/downshift flag; 1 -> automatic shift

(PRNDL = 3 or 4), 0 -> manual shift (PRNDL = 2 or 1).

- FLG\_SFT\_IN = Shift in progress flag; 1 -> shift in progress, 0 -> no

shift in progress.

- FLG\_SFT\_MDN = Power off manual downshift flag; 1 -> power off manual

downshift in progress, 0 -> power off manual downshift not in progress.

Calibration Constants:

- TCDHMF = Time delay to infer coast clutch engagement on manual downshifts

at high vehicle speed, sec.

- TCDLMF = Time delay to infer coast clutch engagement on manual downshifts

at low vehicle speeds, sec.

16-29

SHIFT CONTROL, LOAD SHIFT IN PROGRESS TIMER - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TCDNAF = Time to complete auto downshift, power off.

- TCDNON = Time to complete downshift, power on.

- TCUPOF = Time to complete upshift, power off.

- TCUPON = Time to complete upshift, power on.

- TCUPON4L = Time to complete upshift, power on, in 4X4L mode.

- VSDNMF = Maximum vehicle speed to use TCDLMF, MPH.

OUTPUTS

Registers:

- TM\_SFT\_IN = See above.

Bit Flags:

- FLG\_SFT\_MDN = See above.

- FLG\_TIP\_OUT = 0 -> no tip-out upshift in progress; 1 -> a tip-out upshift

in progress.

- FLG\_SFT\_IN = See above.

16-30

SHIFT CONTROL, LOAD SHIFT IN PROGRESS TIMER - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_TIMER\_COM1

FLG\_FRST\_CM = 1 --------------------|

(shift has been commanded) |

|

GR\_CM > GR\_OLD ---------------------|

(upshift) |AND -| TM\_SFT\_IN = TCUPON

| | (time to complete upshift,

FLG\_PWR = 1 ------------------------| | power on)

(power on) | | FLG\_SFT\_MDN = 0

| | (not power off manual downshift)

FLG\_4X4L = 0 -----------------------| |

(not in 4X4 low) |

| --- ELSE ---

FLG\_FRST\_CM = 1 --------------------| |

(shift has been commanded) | |

| |

GR\_CM > GR\_OLD ---------------------| |

(upshift) |AND -| TM\_SFT\_IN = TCUPON4L

| | (time to complete upshift,

FLG\_PWR = 1 ------------------------| | power on, in 4X4 low)

(power on) | | FLG\_SFT\_MDN = 0

| | (not power off manual downshift)

FLG\_4X4L = 1 -----------------------| |

(in 4X4 low) |

| --- ELSE ---

FLG\_FRST\_CM = 1 --------------------| |

(shift has been commanded) | |

| |

GR\_CM > GR\_OLD ---------------------| |

(upshift) |AND -| TM\_SFT\_IN = TCUPOF

| | (time to complete

FLG\_PWR = 0 ------------------------| | upshift, power off)

(power off) | FLG\_SFT\_MDN = 0

|

FLG\_FRST\_CM = 1 --------------------| |

(shift has been commanded) | | --- ELSE ---

| |

GR\_CM < GR\_OLD ---------------------|AND -| TM\_SFT\_IN = TCDNON

(downshift) | | (time to complete downshift,

| | power on)

FLG\_PWR = 1 ------------------------| |

(power on) | FLG\_SFT\_MDN = 0

|

FLG\_FRST\_CM = 1 --------------------| |

(shift has been commanded) | |

| | --- ELSE ---

GR\_CM < GR\_OLD ---------------------| |

(downshift) | | TM\_SFT\_IN = TCDNAF

|AND -| (time to complete downshift,

FLG\_PWR = 0 ------------------------| | auto, power off)

(power off) | |

| | FLG\_SFT\_MDN = 0

FLG\_SF\_AUTO = 1 --------------------| |

(automatic shift) | --- ELSE ---

(continued on next page)

16-31

SHIFT CONTROL, LOAD SHIFT IN PROGRESS TIMER - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

FLG\_FRST\_CM = 1 --------------------| |

(shift has been commanded) | |

| |

GR\_CM < GR\_OLD ---------------------| |

(downshift) | |

|AND -| TM\_SFT\_IN = TCDHMF

FLG\_PWR = 0 ------------------------| | (time to complete downshift,

(power off) | | manual, power off, high vehicle

| | speed)

FLG\_SF\_AUTO = 0 --------------------| | FLG\_SFT\_MDN = 1

(manual shift) | | (manual power off downshift

| | in progress)

VSBART\_RT > VSDNMF -----------------| |

| --- ELSE ---

FLG\_FRST\_CM = 1 --------------------| |

| |

GR\_CM < GR\_OLD ---------------------| |

| |

FLG\_PWR = 0 ------------------------|AND -| TM\_SFT\_IN = TCDLMF

| | (time to complete downshift,

FLG\_SF\_AUTO = 0 --------------------| | manual, power off, low vehicle

| | speed)

VSBART\_RT <= VSDNMF ----------------| | FLG\_SFT\_MDN = 1

| (manual power off downshift

| in progress)

FLG\_SFT\_MDN = 1 --------------------|

(manual power off downshift |

in progress) |AND -| TM\_SFT\_IN = TCDNON

| | (reset timer to power on value

FLG\_PWR = 1 ------------------------| | if power mode changes in the

(suddenly becomes power on) | middle of a downshift)

| FLG\_SFT\_MDN = 0

| (clear manual downshift flag)

TM\_SFT\_IN = 0 ----------------------------| FLG\_SFT\_MDN = 0

(timer expired) | (manual downshift

| is complete)

| FLG\_SFT\_IN = 0

| (no shift in progress)

|

| --- ELSE ---

|

| FLG\_SFT\_IN = 1

| (shift in progress)

FLG\_SFT\_IN = 0 ---------------------|

(no shift in progress) |AND -| FLG\_TIP\_OUT = 0

| | (reset tip-out flag)

TM\_DEL\_SFT = 0 ---------------------|

(no delay shift in progress)

16-32

SHIFT CONTROL, DETERMINE SHIFT SOLENOID STATES - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DETERMINE SHIFT SOLENOID STATES

OVERVIEW

The shift solenoid state logic configures the shift solenoid output states

based on the commanded gear (GR\_CM). Most of the time, this is very

straightforward. Although the solenoids have different reaction rates (SS2

takes longer to move than SS1) shifts are normally made by moving only one

solenoid at a time. The exception is when PRNDL moves from 1 or 2 while

GR\_CM = 2 to PRNDL 3 or 4 and 2nd gear is still commanded. This requires

both solenoids to go from off to on. The timer TM\_SS1\_GR2 takes care of this

by moving SS2 early so that they both switch at the same time.

The main outputs of the shift solenoid routine, besides the shift solenoid

states are:

- GEAR\_CUR, global gear indicator which reflects only the transmission gear

ratio, not any transmission specific combination of engine braking bands

or clutches;

- RT\_GR\_CUR, current transmission gear ratio.

DEFINITIONS

INPUTS

Registers:

- CYCCTR = Cold shift solenoid cycling counter.

- GR\_CM = Commanded gear for shift solenoids.

- NEBART = Filtered engine RPM for transmission.

- NOBART = Filtered output shaft speed.

- PDL = Current PRNDL position.

- RT\_GR\_CUR = Current transmission gear ratio.

- TM\_SS1\_GR2 = Time delay for SS1 on manual to auto 2nd gear shift.

Bit Flags:

- FLG\_FRST\_CM = First time a shift is commanded flag; 1 -> shift commanded

this background pass, 0 -> no shift commanded this background pass.

- FLG\_FRST\_TV = Start-up TV pressure flag; 0 -> do start-up TV logic, 1 ->

do not do start-up TV logic.

- FLG\_TVENG\_CD = Flag which indicates cold temperature for engagement TV; 0

-> don't use TVEMAX in engagement TV, 1 -> use TVEMAX in engagement TV.

16-33

SHIFT CONTROL, DETERMINE SHIFT SOLENOID STATES - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_TVENG\_MD = Flag which indicates moderate temperature for engagement

TV; 0 -> don't use TVEMOD in engagement TV, 1 -> use TVEMOD in engagement

TV.

- UNDSP = Flag indicating engine mode; 1 -> cranking or underspeed, 0 ->

run mode.

Calibration Constants:

- CLDCTM = Cold shift solenoid cycle period (in background loops).

- GRRAT1 = First gear ratio.

- GRRAT2 = Second gear ratio.

- GRRAT3 = Third gear ratio.

- GRRAT4 = Fourth gear ratio.

- TMS1G2 = Time to delay SS1 on manual to auto 2nd gear shift.

OUTPUTS

Registers:

- CCYCTR = See above.

- GEAR\_CUR = Current transmission gear (global register).

- RT\_GR\_CUR = See above.

- SPD\_RT\_STRT = Speed ratio at start of shift.

- TM\_SS1\_GR2 = See above.

Bit Flags:

- FLG\_SS\_1 = Shift solenoid 1 output state; 1 -> SS1 energized, 0 -> SS1

de-energized.

- FLG\_SS\_2 = Shift solenoid 2 output state; 1 -> SS2 energized, 0 -> SS2

de-energized.

16-34

SHIFT CONTROL, DETERMINE SHIFT SOLENOID STATES - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_SOL\_CTL\_COM1

always ---------------------------------------| Increment CYCCTR

CYCCTR >= CLDCTM -----------------------------| CYCCTR = 0

FLG\_FRST\_TV = 0 -----------------------|

(no engagement yet) |

|

CYCCTR > CLDCTM/2 ---------------------|

(cycle shift solenoids) |

|

FLG\_TVENG\_MD = 1 ----------------| |

|OR --|

FLG\_TVENG\_CD = 1 ----------------| |AND -| FLG\_SS\_1 = 0

(moderately cold) | | FLG\_SS\_2 = 1

| | RT\_GR\_CUR = GRRAT1

UNDSP = 0 -----------------------------| | GEAR\_CUR = 1

(RUN mode) | | (do cold shift solenoid

| | cycling strategy)

GR\_CM = 1 -----------------------------| |

| --- ELSE ---

|

GR\_CM = 1 -----------------------------------| FLG\_SS\_1 = 1

(1st gear) | FLG\_SS\_2 = 0

| RT\_GR\_CUR = GRRAT1

| GEAR\_CUR = 1

|

| --- ELSE ---

|

GR\_CM = 2 -----------------------------| |

|AND -| FLG\_SS\_1 = 0

PDL <= 2 ------------------------------| | FLG\_SS\_2 = 0

(2nd gear, intermediate band on) | TM\_SS1\_GR2 = TMS1G2

| (load timer in case 2nd gear

| is commanded in PDL 3 or 4)

| RT\_GR\_CUR = GRRAT2

| GEAR\_CUR = 2

|

| --- ELSE ---

GR\_CM = 2 -----------------------------| |

|AND -| FLG\_SS\_1 = 0

TM\_SS1\_GR2 > 0 ------------------------| | FLG\_SS\_2 = 1

| (2nd gear has been commanded

| in PDL 3 or 4. Move SS2

| early due to its longer

| response time)

| RT\_GR\_CUR = GRRAT2

| GEAR\_CUR = 2

|

| --- ELSE ---

(continued on next page)

16-35

SHIFT CONTROL, DETERMINE SHIFT SOLENOID STATES - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

GR\_CM = 2 -----------------------------------| FLG\_SS\_1 = 1

(2nd gear, intermediate | FLG\_SS\_2 = 1

band OFF, PRNDL position | RT\_GR\_CUR = GRRAT2

in 3 or 4) | GEAR\_CUR = 2

|

| --- ELSE ---

|

GR\_CM = 3 -----------------------------------| FLG\_SS\_1 = 0

(3rd gear) | FLG\_SS\_2 = 1

| RT\_GR\_CUR = GRRAT3

| GEAR\_CUR = 3

|

| --- ELSE ---

|

GR\_CM = 4 -----------------------------------| FLG\_SS\_1 = 0

(4th gear if PRNDL is in | FLG\_SS\_2 = 0

4, 2nd gear if PRNDL is | RT\_GR\_CUR = GRRAT4

in 1 or 2) | GEAR\_CUR = 4

NOBART

FLG\_FRST\_CM = 1 -----------| SPD\_RT\_STRT = ------ \* RT\_GR\_CUR

NEBART

16-36

SHIFT CONTROL, SHIFT VALIDATION LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SHIFT VALIDATION LOGIC

OVERVIEW

The Shift Validation logic verifies that a shift has taken place after it is

commanded. This logic is only capable of verifying automatic upshifts which

take place during a steady, off idle, throttle position.

The logic works as follows: if the transmission control has just commanded

an automatic upshift, and throttle position and vehicle speed are high

enough, the shift is considered verifiable and the current converter clutch

state, throttle position, vehicle speed and engine rpm are recorded. The

logic then waits until the shift is complete; FLG\_SFT\_IN = 0. At that time,

the logic verifies that the throttle position and the vehicle speed have not

varied significantly, and the converter clutch has not changed from a locked

to unlocked state. If all conditions are met, then the engine speed should

decrease if a shift actually took place.

If a shift error is detected, failure mode action will be performed for a

calibratable number of warm up cycles.

DEFINITIONS

INPUTS

Registers:

- C617CNT = 1-2 shift error warm up counter.

- C617FIL = 1-2 miss shift fault filter.

- C617\_KAM\_BIT = 1-2 shift error detected.

- C618CNT = 2-3 shift error warm up counter.

- C618FIL = 2-3 miss shift fault filter.

- C618\_KAM\_BIT = 2-3 shift error detected.

- C619CNT = 3-4 shift error warm up counter.

- C619FIL = 3-4 miss shift fault filter.

- C619\_KAM\_BIT = 3-4 shift error detected.

- GEAR\_CUR = Current commanded gear.

- GEAR\_OLD = Last commanded gear.

- NEBART = Filtered engine speed.

- NEV\_STRT\_SFT = Engine speed at start of the shift.

- SFT\_STEADY = Number of steady shifts since power-up.

16-37

SHIFT CONTROL, SHIFT VALIDATION LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SFT\_TOTAL = Total shifts commanded since power-up.

- TP\_REL = Relative throttle position; TP - RATCH.

- TPV\_STRT\_SFT = Throttle position at start of the shift.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission.

- VSCTR = Count vehicle speed sensor errors.

- VSV\_STRT\_SFT = Vehicle speed at start of the shift.

Bit Flags:

- CCV\_STRT\_SFT = Converter clutch position at start of shift.

- FLG\_FRST\_CM = New commanded gear this pass flag.

- FLG\_LK\_CM = Converter clutch commanded flag.

- FLG\_NOV\_KAM = Flag indicating at least one update of RT\_NOVS\_KAM.

- FLG\_SF\_AUTO = Automatic shift flag.

- FLG\_SFT\_IN = Shift in progress flag: 1 -> shift in progress.

- FLG\_SFT\_VAL = Shift validity flag: 0 -> Shift cannot be verified; 1 ->

Shift may be verified.

- PDL\_ERROR = PRNDL sensor failure; 0 -> no PRNDL sensor failure, 1 ->

PRNDL sensor failure.

- TFMFLG = Throttle position FMEM flag; 1 -> throttle position failure

detected.

- VSFMFLG = Vehicle speed sensor FMEM flag; 1 -> vehicle speed sensor

failure detected.

Calibration Constants:

- S\_VAL\_NESUB = Tolerance on NE to verify an engine speed drop (negative

direction) during the shift validation.

- S\_VAL\_TPADD = Tolerance on TP to verify steady TP (positive direction)

during the shift validation.

- S\_VAL\_TPSUB = Tolerance on TP to verify steady TP (negative direction)

during the shift validation.

- S\_VAL\_VSADD = Tolerance on VS to verify steady vehicle speed (positive

direction) during the shift validation.

- S\_VAL\_VSSUB = Tolerance on VS to verify steady vehicle speed (negative

direction) during the shift validation.

- SFT\_FM\_LVL = Total number of warm up cycles that failure mode action will

be executed after a shift error is detected.

16-38

SHIFT CONTROL, SHIFT VALIDATION LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TP\_SH\_VALID = Minimum TP to validate a shift.

- VS\_SH\_VAL2 = Minimum vehicle speed to validate an upshift to 2nd gear.

- VS\_SH\_VAL3 = Minimum vehicle speed to validate an upshift to 3rd gear.

- VS\_SH\_VAL4 = Minimum vehicle speed to validate an upshift to 4th gear.

OUTPUTS

Registers:

- NEV\_STRT\_SFT = Engine speed at start of the shift.

- SFT\_STEADY = See above.

- TPV\_STRT\_SFT = See above.

- VSV\_STRT\_SFT = See above.

Bit Flags:

- CCV\_STRT\_SFT = See above.

- FLG\_SFT\_VAL = See above.

- SFT\_ERROR = Shift error flag: 0 -> No shift error; 1 -> Shift error.

- SFT\_FM\_FLG = Shift error failure mode flag; 0 -> no failure mode action,

1 -> shift error failure mode action will be executed.

16-39

SHIFT CONTROL, SHIFT VALIDATION LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SC\_VALID\_COM1

PDL\_ERROR = 0 --------------------------|

(MLPS ok) |

|

FLG\_FRST\_CM = 1 ------------------------|

(new commanded gear this pass) |

|

FLG\_SF\_AUTO = 1 ------------------------|

(automatic shift) |

|

GEAR\_CUR > GEAR\_OLD --------------------|

(upshift) |

|

TP\_REL > TP\_SH\_VALID -------------------|

(off idle) |

|

GEAR\_CUR = 2 ---------------| |AND -| CCV\_STRT\_SFT = FLG\_LK\_CM

|AND -| | | (record CC state at

VSBART\_RT > VS\_SH\_VAL2 -----| | | | start of shift)

| | | TPV\_STRT\_SFT = TP\_REL

GEAR\_CUR = 3 ---------------| | | | (record TP at start of

|AND -|OR --| | shift)

VSBART\_RT > VS\_SH\_VAL3 -----| | | | NEV\_STRT\_SFT = NEBART

| | | (record filtered engine

GEAR\_CUR = 4 ---------------| | | | speed at start of shift)

|AND -| | | VSV\_STRT\_SFT = VSBART\_RT

VSBART\_RT > VS\_SH\_VAL4 -----| | | (record filtered vehicle

| | speed at start of shift)

FLG\_NOV\_KAM = 1 ------------------------| | FLG\_SFT\_VAL = 1

(RT\_NOVS\_KAM learned) | | (shift may be checked

| | for validity)

TFMFLG = 0 -----------------------------| |

| |

VSCTR = 0 ------------------------------| |

| |

VSFMFLG = 0 ----------------------------| |

| --- ELSE ---

|

FLG\_FRST\_CM = 1 ------------------------------| FLG\_SFT\_VAL = 0

FLG\_FRST\_CM = 1 ------------------------------| SFT\_TOTAL = SFT\_TOTAL + 1

FLG\_SFT\_IN = 0 -------------------------------| DO "SHIFT VERIFICATION LOGIC"

(shift complete, may be verified) |

| --- ELSE ---

|

| EXIT "SHIFT VALIDATION"

| MODULE

16-40

SHIFT CONTROL, SHIFT VALIDATION LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SHIFT VERIFICATION LOGIC (Part 1)

FLG\_SFT\_VAL = 1 ------------------------|

(shift can be verified) |

|

VSBART\_RT > VSV\_STRT\_SFT - S\_VAL\_VSSUB -|

(steady vehicle speed) |

|

VSBART\_RT < VSV\_STRT\_SFT + S\_VAL\_VSADD -|AND -| (steady conditions during

(steady vehicle speed) | | entire shift)

| | SFT\_STEADY =

TP\_REL < TPV\_STRT\_SFT + S\_VAL\_TPADD ----| | SFT\_STEADY + 1

(steady TP) | | FLG\_SFT\_VAL = 0

| | (reset valid shift flag)

TP\_REL > TPV\_STRT\_SFT - S\_VAL\_TPSUB ----| | Do "Part 2" and "Shift

(steady TP) | | Error Flag Logic"

| |

FLG\_LK\_CM >= CCV\_STRT\_SFT --------------| |

(CC has not moved from a locked | --- ELSE ---

to an unlocked state during |

validation) |

| (unsteady conditions)

| FLG\_SFT\_VAL = 0

| (reset valid shift flag)

| Exit "Shift Validation"

| Module

16-41

SHIFT CONTROL, SHIFT VALIDATION LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SHIFT VERIFICATION LOGIC (Part 2)

GEAR\_CUR = 2 ---------------------------|

|AND -| error\_detected = 1

NEBART > NEV\_STRT\_SFT - S\_VAL\_NESUB ----| | (missed 1-2 shift)

| DO: FAULT FILTER for code

| 617 procedure

|

| --- ELSE ---

|

GEAR\_CUR = 2 ---------------------------------| (1-2 shift occurred)

| DO: FAULT FILTER for code

| 617 procedure

|

| --- ELSE ---

GEAR\_CUR = 3 ---------------------------| |

|AND -| error\_detected = 1

NEBART > NEV\_STRT\_SFT - S\_VAL\_NESUB ----| | (missed 2-3 shift)

| DO: FAULT FILTER for code

| 618 procedure

|

| --- ELSE ---

|

GEAR\_CUR = 3 ---------------------------------| (2-3 shift occurred)

| DO: FAULT FILTER for code

| 618 procedure

|

| --- ELSE ---

GEAR\_CUR = 4 ---------------------------| |

|AND -| error\_detected =1

NEBART > NEV\_STRT\_SFT - S\_VAL\_NESUB ----| | (missed 3-4 shift)

| DO: FAULT FILTER for code

| 619 procedure

|

| --- ELSE ---

|

GEAR\_CUR = 4 ---------------------------------| (3-4 shift occurred)

| DO: FAULT FILTER for code

| 619 procedure

16-42

SHIFT CONTROL, SHIFT VALIDATION LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

C617FIL > 0 ----------------------------|

|

C618FIL > 0 ----------------------------|OR --| SFT\_ERROR = 1

| |

C619FIL > 0 ----------------------------| | --- ELSE ---

|

| SFT\_ERROR = 0

C617\_KAM\_BIT = 1 -----------------|

(1-2 shift error detected) |

|AND -|

C617CNT < SFT\_FM\_LVL -------------| |

(not enough warm up cycles have |

passed since failure detection) |

|

C618\_KAM\_BIT = 1 -----------------| |

(2-3 shift error detected) | |

|AND -|OR --| SFT\_FM\_FLG = 1

C618CNT < SFT\_FM\_LVL -------------| | | (a shift error has been

(not enough warm up cycles have | | detected, perform failure

passed since failure detection) | | mode action for SFT\_FM\_LVL

| | warm up cycles since the

C619\_KAM\_BIT = 1 -----------------| | | last failure detection)

(3-4 shift error detected) | | |

|AND -| | --- ELSE ---

C619CNT < SFT\_FM\_LVL -------------| |

(not enough warm up cycles have | SFT\_FM\_FLG = 0

passed since failure detection)

16-43

SHIFT CONTROL, SHIFT VALIDATION LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

16-44

CHAPTER 17

ELECTRONIC PRESSURE CONTROL

17-1

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ELECTRONIC PRESSURE CONTROL GUIDE

OVERVIEW

EPC pressure is regulated by a variable force solenoid which is under EEC-IV

control. The purpose of EPC pressure is to modulate the hydraulic pressure

used to apply, release, and hold the various clutches and bands in the

transmission. The higher the pressure, the more torque the transmission can

transmit. This input torque in a conventional transmission has been

approximated by either a mechanical linkage connected to the throttle plates,

or a vacuum diaphragm which sees manifold vacuum. The electronic EPC

strategy looks up engine torque from a table and varies the EPC pressure to

contain the static capacity requirement of the transmission.

In general, EPC pressure is calculated as follows:

- Static Capacity - This is the EPC required to hold the weakest friction

element due to combustion torque (TQ\_NET) and inertia torque (TQ\_IALPHA)

during a shift. Inertia torque is 0 when a shift is not taking place.

The sum of the combustion torque and inertia torque values is multiplied

by the torque converter torque ratio to determine the total torque the

transmission must transmit (TQ\_STAT\_CAP). This in turn determines the

static EPC capacity requirement (TV\_STAT).

- Dynamic EPC - This is EPC required to obtain acceptable shift feel and is

the powertrain developers' main calibration tool. A switch is provided

(SW\_DYN) to allow the developer to either freeze RPM at a the start of a

shift, or to allow dynamic EPC pressure to follow RPM during the shift

(TV\_DYN). The combustion torque always updates, even during the shift.

- AETV - Additional EPC provided on quick tip-ins to counteract the lag in

EEC-IV updates to torque and to compensate for hydraulic lag times in the

VFS/EPC hydraulic system.

- Total EPC - (TV\_PRES) is simply the sum of static, dynamic and AETV

requirements.

- Additional features -

- Cold Starts - additional EPC can be requested to counteract the

viscous effect of cold transmission oil on engagements

- Rock cycling and high speed engagements - additional EPC can be

requested to protect the transmission capacity during severe

engagement conditions

- Tip-out from stall capacity hold - delay the release of stall EPC

pressure during a quick tip-out to contain powertrain wind-up

- Stall EPC - at low speed ratio and vehicle speed stall EPC is

computed as a function of throttle position

- Coast boost - coast boost on a manual downshift is computed as a

function of output shaft speed

- Start-up - additional EPC can be requested once per start-up to

"charge" the EPC system in extremely cold ambients.

- When sensors critical to determining the correct EPC pressure have

failed, or a shift error is detected, EPC is either set to the

maximum value or clipped to TVFMMN as a minimum to protect the

transmission. See the logic diagrams for specifics.

- EPC is always clipped to TVPMIN as a minimum to prevent fluid

drain-back.

17-2

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- CS\_SFT\_MULT = Cold start shift multiplier.

- GEAR\_CUR = Global bear indicator, reflects only.

- GR\_DS\_TV = Desired gear used to compute EPC pressure.

- N = RPM.

- NEBART = Filtered engine RPM for transmission, rpm.

- NEU\_RES\_TMR = Neutral residency timer.

- PDL = Current MLIP position.

- PDL\_LST = MLIP position last background pass.

- SPD\_RATIO = Speed ratio across torque converter.

- TM\_DEL\_SFT = Timer to verify automatic desired shift, sec.

- TM\_ENG\_TV = Engagement EPC pressure ramp timer, sec.

- TOT = Transmission oil temperature, deg F.

- TP = Throttle Position, counts.

- TSFETMR = Time Since first transmission engagement (sec)

- TV\_COUNTS = FN620(TV\_PRES) + FN622(TOT) = Requested EPC counts based

transfer function and temperature compensation, counts.

- TV\_PRES = EPC pressure, psi.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS, mph. end list

- VSCTR = Count of mph sensor errors.

Bit Flags:

- CC\_FM\_FLG = Converter Clutch Failure Mode flag.

- DRV2NEU\_FLG = Forward prior to neutral flag.

- ETV\_TEST = Flag indicating that the ETV open/short test is in progress; 1

-> test in progress.

- FLG\_DEL\_MDN = Flag indicating a manual downshift is being delayed; 0 ->

no manual downshift is being delayed, 1 -> a manual downshift is being

delayed.

- FLG\_DRV\_REV = Forward gear to reverse gear engagement flag; 1 -> most

recent engagement was forward to reverse.

17-3

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_ENG\_IN = Engagement in progress flag; 1 -> engagement in progress.

- FLG\_ENG\_TV = Engagement EPC pressure flag; 1 -> do engagement logic, 0 ->

do not do engagement logic.

- FLG\_FRST\_DS = First time a shift is desired flag; 0 -> no shift desired,

1 -> shift desired this background pass.

- FLG\_FWD\_REV = Forward to reverse or reverse to forward engagement in

progress flag: 1 -> "rock cycling" engagement in progress.

- FLG\_NEU\_DRV = Neutral gear to forward gear engagement flag; 1 -> most

recent engagement was neutral to forward.

- FLG\_NEU\_REV = Neutral gear to reverse gear engagement flag; 1 -> most

recent engagement was neutral to reverse.

- FLG\_PWR = Power mode flag; 1 -> power on mode, 0 -> power off mode.

- FLG\_REV\_DRV = Reverse gear to forward gear engagement flag; 1 -> most

recent engagement was reverse to forward.

- FLG\_SFT\_IN = Shift in progress flag; 1 -> shift in progress.

- FLG\_SFT\_MDN = Power off manual downshift flag; 1 -> power off manual

downshift in progress, 0 -> power off manual downshift not in progress.

- FLG\_TVENG\_MD = Flag which indicates moderate temperature for engagement

EPC; 0 -> Don't use TVEMOD in engagement EPC, 1 -> Use TVEMAX in

engagement EPC.

- MFMFLG = Flag indicating MAP sensor failure; 1 -> failure.

- OTMP\_EPC\_FLG = Flag indicating RPM is high enough to raise EPC pressure

due to transmission overtemperature.

- OTEMP\_FM\_FLG = Transmission overtemperature FMEM flag; 1 -> Transmission

is overtemperature.

- PDL\_ERROR = Flag indicating a MLIP sensor failure; 1 -> failure.

- REV2NEU\_FLG = Reverse prior to neutral flag.

- SFT\_FM\_FLG = Shift error failure mode flag; 0 -> no failure mode action,

1 -> failure mode action will be executed.

- TFMFLG = Flag indicating a TP sensor failure; 1 -> failure.

- VSFMFLG = Flag indicating a vehicle speed sensor failure; 1 -> failure.

Calibration Constants:

- CSDYN12 = Dynamic EPC multiplier for 1-2 shifts.

- CSDYN23 = Dynamic EPC multiplier for 2-3 shifts.

- CSDYN34 = Dynamic EPC multiplier for 3-4 shifts.

17-4

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- EPC\_OTEMP = EPC adder for transmission overtemperature.

- FN12T(TOT) = TV\_PRES multiplier versus TOT for upshift to 2nd gear.

- FN21T(TOT) = TV\_PRES multiplier versus TOT for downshift to 2nd gear.

- FN23T(TOT) = TV\_PRES multiplier versus TOT for upshift to 3nd gear.

- FN32T(TOT) = TV\_PRES multiplier versus TOT for downshift to 3nd gear.

- FN34T(TOT) = TV\_PRES multiplier versus TOT for upshift to 4nd gear.

- FN43T(TOT) = TV\_PRES multiplier versus TOT for downshift to 4nd gear.

- FN620(TV\_PRES) = EPC VFS transfer function.

- FN622(TOT) = EPC VFS transfer function modifier as a function

transmission oil temperature, counts.

- FN622A(TOT) = TV\_PRES multiplier for TOT.

- NE\_OTEMP\_MAX = Engine speed above which EPC pressure is raised for

tranmission overtemperature.

- NE\_OTEMP\_MIN = Engine speed below which EPC returns to normal while

tranmission is overtemperature.

- NEUTIM = Minimum time in neutral to use neutral to in-gear engagement EPC

functions.

- NRUN = Minimum engine speed to exit crank mode.

- RTSTAL = Maximum SPD\_RATIO to do stall epc.

- TM46BLP = Time after a forward to reverse engagement to use FN46B for EPC

pressure, sec.

- TM54BLP = Time after a neutral to forward engagement to use FN54B for EPC

pressure, sec.

- TM56BLP = Time after a neutral to reverse engagement to use FN56B for EPC

pressure, sec.

- TM64BLP = Time after a reverse to forward engagement to use FN64B for EPC

pressure, sec.

- TMDRVREV = Time to complete a forward to reverse engagement, sec.

- TMNEUDRV = Time to complete a neutral to forward engagement, sec.

- TMNEUREV = Time to complete a neutral to reverse engagement, sec.

- TMREVDRV = Time to complete a reverse to forward engagement, sec.

- TVASOF = EPC pressure for power off automatic shift, psi.

- TVFMMN = Minimum EPC clip for VS, PRNDL or RPM sensor failures, psi.

17-5

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TVPMIN = Global minimum TV\_PRES clip, psi.

- TVPMN1 = Minimum EPC clip, PDL = 1, GEAR = 1, psi.

- TVPMN2 = Minimum EPC clip, PDL = 1, GEAR = 2, psi.

- TVPMN3 = Minimum EPC clip, PDL = 1, GEAR = 3, psi.

- TVPMX1 = Maximum EPC clip, PDL = 1, GEAR = 1, psi.

- TVPMX2 = Maximum EPC clip, PDL = 1, GEAR = 2, psi.

- TVPMX3 = Maximum EPC clip, PDL = 1, GEAR = 3, psi.

- VSSTAL = Maximum vehicle speed to do stall EPC.

17-6

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- NEU\_RES\_TMR = See above.

- TM\_BLP\_TV = Engagement EPC pressure blip timer, sec.

- TM\_ENG\_TV = See above.

- TSFETMR = See above.

- TV\_COUNT\_LST = EPC Pressure counts last update.

- TV\_COUNTS = See above.

- TV\_PRES = See above.

Bit Flags:

- DRV2NEU\_FLG = See above.

- FLG\_DRV\_REV = See above.

- FLG\_ENG\_IN = See above.

- FLG\_ENG\_TV = See above.

- FLG\_FRST\_TV = Start-up EPC pressure flag; 0 -> do start-up EPC logic, 1

-> do not do start-up EPC logic.

- FLG\_FWD\_REV = See above.

- FLG\_NEU\_DRV = See above.

- FLG\_NEU\_REV = See above.

- FLG\_REV\_DRV = See above.

- OTMP\_EPC\_FLG = See above.

- REV2NEU\_FLG = See above.

17-7

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EPC\_GUIDE\_COM1

N > NRUN -------------------|

|AND -|

PDL <= 4 -------------------| |

(in fwd) |OR --| FLG\_FRST\_TV = 1

| | (stop charging EPC circuit

N > NRUN -------------------| | | after the 1st engagement)

|AND -|

PDL = 6 --------------------|

(in rev)

FLG\_FRST\_TV = 0 ------------------| TSFETMR = 0

|

| --- ELSE ---

|

| Increment TSFETMR (every 1 sec)

ENGAGEMENT FLAGS/TIMERS

PDL = 5 --------------------|

(in neutral) |OR --|

| |

PDL = 7 --------------------| |AND -| NEU\_RES\_TMR = NEUTIM

(in park) | | (load neutral timer)

| | DRV2NEU\_FLG = 1

PDL\_LST <= 4 ---------------------| | REV2NEU\_FLG = 0

(fwd last pass) | (indicate fwd prior to neu)

|

| --- ELSE ---

PDL = 5 --------------------| |

(in neutral) |OR --| |

| | |

PDL = 7 --------------------| |AND -| NEU\_RES\_TMR = NEUTIM

(in park) | | (load neutral timer)

| | DRV2NEU\_FLG = 0

PDL\_LST = 6 ----------------------| | REV2NEU\_FLG = 1

(rev last pass) | (indicate rev prior to neu)

|

| --- ELSE ---

|

| NO ACTION

17-8

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PDL = 6 --------------------------|

(in rev) |

|

PDL\_LST = 5 ----------------| |

(neu last pass) |OR --| | (neutral to reverse)

| |AND -| TM\_ENG\_TV = TMNEUREV + TM56BLP

PDL\_LST = 7 ----------------| | | TM\_BLP\_TV = TM56BLP

(park last pass) | | FLG\_DRV\_REV = 0

| | FLG\_NEU\_DRV = 0

NEU\_RES\_TMR = 0 ------------| | | FLG\_NEU\_REV = 1

(in neu long enough) |OR --| | FLG\_REV\_DRV = 0

| |

DRV2NEU\_FLG = 0 ------------| |

(not fwd prior to neu) |

| --- ELSE ---

|

PDL = 6 --------------------------| | (drive to reverse)

(in rev) |AND -| TM\_ENG\_TV = TMDRVREV + TM46BLP

| | TM\_BLP\_TV = TM46BLP

PDL\_LST <> 6 ---------------------| | FLG\_DRV\_REV = 1

(fwd to rev or | FLG\_NEU\_DRV = 0

fwd to neu to rev with | FLG\_NEU\_REV = 0

short time in neu) | FLG\_REV\_DRV = 0

|

| --- ELSE ---

PDL <= 4 -------------------------| |

(in fwd) | |

| |

PDL\_LST = 5 ----------------| | |

(neu last pass) |OR --| | (neutral to drive)

| |AND -| TM\_ENG\_TV = TMNEUDRV + TM54BLP

PDL\_LST = 7 ----------------| | | TM\_BLP\_TV = TM54BLP

(park last pass) | | FLG\_DRV\_REV = 0

| | FLG\_NEU\_DRV = 1

NEU\_RES\_TMR = 0 ------------| | | FLG\_NEU\_REV = 0

(in neu long enough) |OR --| | FLG REV\_DRV = 0

| |

REV2NEU\_FLG = 0 ------------| |

(not rev prior to neu) |

| --- ELSE ---

|

PDL = <= 4 -----------------------| | (reverse to drive)

(in fwd) |AND -| TM\_ENG\_TV = TMREVDRV + TM64BLP

| | TM\_BLP\_TV = TM64BLP

PDL\_LST > 4 ----------------------| | FLG\_DRV\_REV = 0

(rev to fwd or | FLG\_NEU\_DRV = 0

rev to neu to fwd | FLG\_NEU\_REV = 0

with short time in neu) | FLG\_REV\_DRV = 1

17-9

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TM\_ENG\_TV > 0 --------------------------| FLG\_ENG\_IN = 1

| (engagement in progress)

|

| --- ELSE ---

|

| FLG\_ENG\_IN = 0

| (no engagement in progress)

FLG\_ENG\_IN = 1 -------------------|

(engagement in progress) |

|

FLG\_DRV\_REV = 1 ------------| |

(fwd to rev) | |

| |AND -| FLG\_FWD\_REV = 1

FLG\_REV\_DRV = 1 ------------| | | DRV2NEU\_FLG = 0

(rev to fwd) | | | REV2NEU\_FLG = 0

| | | (set direction change flag

FLG\_NEU\_REV = 1 ------| |OR --| | and clear "prior to neutral"

(neu to rev) |AND -| | flags)

| | |

DRV2NEU\_FLG = 1 ------| | |

(fwd prior to neu) | |

| |

FLG\_NEU\_DRV = 1 ------| | |

(neu to fwd) |AND -| |

| |

REV2NEU\_FLG = 1 ------| |

(rev prior to neu) |

| --- ELSE ---

|

FLG\_ENG\_IN = 0 -------------------------| FLG\_FWD\_REV = 0

(no engagement in progress) | (clear direction change flag)

|

| --- ELSE ---

|

| NO ACTION

17-10

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_FWD\_REV = 1 ------------------|

(direction change) |

|

PDL >= 5 ------------------------|OR --| FLG\_ENG\_TV = 1

(not in forward gear) | | (perform engagement/stall TV)

| |

GR\_DS\_TV = GEAR\_CUR --------| | |

(no verify in progress) |AND -| |

| |

FLG\_ENG\_IN = 1 -------------| |

(engagement in progress) |

| --- ELSE ---

GR\_DS\_TV <> GEAR\_CUR -------------| |

(desired shift being verified) | |

| |

FLG\_FRST\_DS = 1 ------------------|OR --| FLG\_ENG\_TV = 0

(shift is desired) | | (Stop doing engagement/stall TV;

| | forward engagement is over and

PDL <= 4 -------------------| | | trans is warm or a shift is

(forward gear) |AND -| | pending)

| |

FLG\_TVENG\_MD = 0 -----------| |

(transmission warm) |

| --- ELSE ---

|

| NO ACTION

17-11

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PDL = 5 OR 7 ---------------------------| Do: "START-UP EPC" LOGIC

|

| --- ELSE ---

FLG\_ENG\_TV = 1 -------------------| |

(no shift yet after engagement) | |

| |

SPD\_RATIO <= RTSTAL --------| |OR --| Do: "ENGAGEMENT/STALL EPC" LOGIC

(Low speed ratio) | | |

| | |

VSBART\_RT <= VSSTAL --------|AND -| |

(Low vehicle speed) | |

| |

FLG\_SFT\_IN = 0 -------------| |

(No shift in progress) |

| --- ELSE ---

FLG\_PWR = 0 ----------------------| |

(Power off) | |

| |

FLG\_SFT\_MDN = 1 ------------| | |

(Manual downshift) | |AND -| Do: "COAST BOOST" LOGIC

| | |

TM\_DEL\_SFT > 0 -------| | | |

(Verify/delay in |AND -| | |

progress) | | | |

| | | |

FLG\_DEL\_MDN = 1 ------| |OR --| |

(Manual downshift is | |

being verified/delayed) | |

| |

PDL <= 3 -------------| | |

(Drive, Manual1, or | | |

Manual2) | | |

|AND -| |

FLG\_SFT\_IN = 0 -------| |

(No shift in | |

progress) | |

| |

TM\_DEL\_SFT = 0 -------| |

(No delay in progress) |

| --- ELSE ---

FLG\_PWR = 0 ----------------------| |

(Power off) | |

|AND -| TV\_PRES = TVASOF

FLG\_SFT\_IN = 1 -------------| | |

(Auto shift in progress) | | |

|OR --| |

TM\_DEL\_SFT > 0 -------------| |

(Delay in progress) |

| --- ELSE ---

|

| Do: "NORMAL EPC CALCULATION"

17-12

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Determine Transmission Overtemperature FMEM action:

NEBART > NE\_OTEMP\_MAX ------------|S Q -| OTMP\_EPC\_FLG

|

NEBART < NE\_OTEMP\_MIN ------------|C

OTEMP\_FM\_FLG = 1 -----------------|

(Transmission Overtemperature) |AND -| TV\_PRES = TV\_PRES + EPC\_OTEMP

|

OTMP\_EPC\_FLG = 1 -----------------|

Clip TV\_PRES as necessary:

TFMFLG = 1 -----------------------|

(TP failed) |

|

MFMFLG = 1 -----------------------|OR --| TV\_PRES = 127.5 (Maximum)

(MAP failed) | |

| |

ETV\_TEST = 1 ---------------------| |

| --- ELSE ---

VSFMFLG = 1 ----------------------| |

(VS failed) | |

| |

VSCTR > 0 ------------------------| |

| |

SFT\_FM\_FLG = 1 -------------------|OR --| Clip TV\_PRES to TVFMMN as a minimum

(shift error detected) | |

| |

CC\_FM\_FLG = 1 --------------------| |

(conv clutch error detected) | |

| |

PDL\_ERROR = 1 --------------------| |

(MLPS failed) |

| --- ELSE ---

PDL = 1 --------------------------| |

|AND -| Clip TV\_PRES to TVPMX1 as a maximum

GEAR\_CUR = 1 ---------------------| | Clip TV\_PRES to TVPMN1 as a minimum

|

| --- ELSE ---

PDL = 1 --------------------------| |

|AND -| Clip TV\_PRES to TVPMX2 as a maximum

GEAR\_CUR = 2 ---------------------| | Clip TV\_PRES to TVPMN2 as a minimum

|

(continued on next page)

17-13

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

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(continued from previous page)

| --- ELSE ---

PDL = 1 --------------------------| |

|AND -| Clip TV\_PRES to TVPMX3 as a maximum

GEAR\_CUR = 3 ---------------------| | Clip TV\_PRES to TVPMN3 as a minimum

|

| --- ELSE ---

FLG\_SFT\_IN = 0 -------------------| |

|AND -| NO ACTION

GR\_DS\_TV = GEAR\_CUR --------------| | (do not adjust TV\_PRES for

| transmission oil temperature

| unless shifting)

|

| --- ELSE ---

|

GR\_DS\_TV = 1 ---------------------------| TV\_PRES = TV\_PRES \* FN21T(TOT)

|

| --- ELSE --

GR\_DS\_TV = 2 ---------------------| |

| |

FLG\_SFT\_UP = 1 -------------------|AND -| TV\_PRES = TV\_PRES \* FN12T(TOT) \*

| | CSDYN12

CS\_SFT\_MULT <> 1 -----------------| |

| --- ELSE ---

GR\_DS\_TV = 2 ---------------------| |

|AND -| TV\_PRES = TV\_PRES \* FN12T(TOT)

FLG\_SFT\_UP = 1 -------------------| |

| --- ELSE --

|

GR\_DS\_TV = 2 ---------------------------| TV\_PRES = TV\_PRES \* FN32T(TOT)

|

| --- ELSE --

GR\_DS\_TV = 3 ---------------------| |

| |

FLG\_SFT\_UP = 1 -------------------|AND -| TV\_PRES = TV\_PRES \* FN23T(TOT) \*

| | CSDYN23

CS\_SFT\_MULT <> 1 -----------------| |

| --- ELSE ---

GR\_DS\_TV = 3 ---------------------| |

|AND -| TV\_PRES = TV\_PRES \* FN23T(TOT)

FLG\_SFT\_UP = 1 -------------------| |

| --- ELSE --

|

GR\_DS\_TV = 3 ---------------------------| TV\_PRES = TV\_PRES \* FN43T(TOT)

|

(continued on next page)

17-14

ELECTRONIC PRESSURE CONTROL, ELECTRONIC PRESSURE CONTROL GUIDE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

| --- ELSE --

GR\_DS\_TV = 4 ---------------------| |

|AND -| TV\_PRES = TV\_PRES \* FN34T(TOT) \*

CS\_SFT\_MULT <> 1 -----------------| | CSDYN34

|

| --- ELSE ---

|

GR\_DS\_TV = 4 ---------------------------| TV\_PRES = TV\_PRES \* FN34T(TOT)

always ---------------------------------| TV\_PRES = max (TV\_PRES,TVPMIN)

| TV\_COUNT\_LST = TV\_COUNTS

ETV\_TEST = 0 ---------------------------| tv\_comp = TV\_PRES \* FN622A(TOT)

| TV\_COUNTS = max (FN620(tv\_comp) +

| FN622(TOT), 0)

|

| --- ELSE ---

|

| TV\_COUNTS = 0

always ---------------------------------| Do "TV VFS OUTPUT ROUTINE"

| (set VFS\_OUT\_FLG = 1 for

| repeater)

17-15

ELECTRONIC PRESSURE CONTROL, START-UP TV LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

START-UP TV LOGIC

OVERVIEW

DEFINITIONS

INPUTS

Registers:

- RATCH = Closed throttle position, counts.

- TP = Throttle position sensor.

- TP\_REL = Relative TP = TP - RATCH, counts.

- TP\_REL\_H = Relative TP (TP - RATCH) high byte only.

Bit Flags:

- FLG\_FRST\_TV = Start-up TV pressure flag; 0 -> do start-up TV logic,

1 -> do not do start-up TV logic.

- FLG\_TVSTR\_CD = Flag which indicates cold temperature for start-up EPC;

0 ->

Don't use TVCHRG in start-up EPC, 1 -> Use TVCHRG in start-up EPC.

Calibration Constants:

- FN616(TP\_REL\_H) = Stall EPC pressure, psi.

- TVCHRG = EPC charge pressure for first start-up, psi.

OUTPUTS

Registers:

- TV\_PRES = EPC pressure, psi.

PROCESS

STRATEGY MODULE: EPC\_STARTUP\_COM1

FLG\_TVSTR\_CD = 1 -|

(cold engine) |AND -| TV\_PRES = TVCHRG

| | (charge TV circuit, first start-up only)

FLG\_FRST\_TV = 0 --| |

(first start-up) | --- ELSE ---

|

| TV\_PRES = FN616(TP\_REL)

17-16

ELECTRONIC PRESSURE CONTROL, COAST BOOST LOGIC - GAAI0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

COAST BOOST LOGIC

OVERVIEW

Coast boost TV is supplied during manual downshifts and in manual gear

positions when in power off mode only.

DEFINITIONS

INPUTS

Registers:

- GEAR\_CUR = Current transmission gear.

- RT\_NOVS = Ratio of actual N/V to base N/V in KAM.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission,

mph.

Calibration Constants:

- FN1CB(VSBART\_RT) = First gear coast boost TV pressure.

- FN2CB(VSBART\_RT) = Second gear coast boost TV pressure.

- FN3CB(VSBART\_RT) = Third gear coast boost TV pressure.

OUTPUTS

Registers:

- TV\_PRES = TV pressure.

17-17

ELECTRONIC PRESSURE CONTROL, COAST BOOST LOGIC - GAAI0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: TV\_CST\_BOOST\_COM4

GEAR\_CUR = 1 -----| TV\_PRES = FN1CB(VSBART\_RT)

|

| --- ELSE ---

|

GEAR\_CUR = 2 -----| TV\_PRES = FN2CB(VSBART\_RT)

|

| --- ELSE ---

|

GEAR\_CUR >= 3 ----| TV\_PRES = FN3CB(VSBART\_RT)

NOTE: In the case of a vehicle speed sensor failure, VSBART\_RT = 0. FN1CB,

FN2CB, and FN3CB should be calibrated at zero vehicle speed to provide enough

coast boost to cover the worst case manual downshift. These functions should

therefore be calibrated as a step function from VSBART\_RT 0 to 1 mph and

revert to normal coast boost TV from 1 mph and higher. This will provide

proper VSS failure mode protection.

17-18

ELECTRONIC PRESSURE CONTROL, ENGAGEMENT/STALL TV LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGAGEMENT/STALL TV LOGIC

DEFINITIONS

INPUTS

Registers:

- NEBART = Filtered engine RPM for transmission.

- PDL = Current PRNDL position.

- TOT = Transmission oil tempterature, degrees F.

- TP\_REL = Relative Throttle position, counts.

- TP\_REL\_H = Relative TP (TP - RATCH) high byte only.

- TPBARTV = Filtered TP for TV strategy.

- TM\_ENG\_TV = Engagament EPC pressure ramp timer.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission,

mph.

Bit Flags:

- FLG\_DRV\_REV = Forward to reverse engagement flag.

- FLG\_ENG\_IN = Engagement in progress flag.

- FLG\_ENG\_TV = Engagement TV pressure flag; 0 -> do engagement logic, 1 ->

do not do engagement logic.

- FLG\_FWD\_REV = Rock cycling engagement in progress flag.

- FLG\_NEU\_DRV = Neutral to drive engagement flag.

- FLG\_NEU\_REV = Neutral to reverse engagement flag.

- FLG\_TVENG\_MD = Moderate temperature for TV engagement flag.

17-19

ELECTRONIC PRESSURE CONTROL, ENGAGEMENT/STALL TV LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- FN46B\_T = Engagement EPC for first TM46BLP seconds of forward to reverse

engagement, psi; function of TOT.

- FN46F\_T = Engagement EPC at finish of engagement ramp for a forward to

reverse

engagement, psi; function of TOT.

- FN46S\_T = Engagement EPC at start of engagement ramp for a forward to

reverse

engagement, psi; function of TOT.

- FN46\_NE = Multiplier for FN46S\_T and FN46F\_T; function of NEBART.

- FN54B\_T = Engagement EPC for first TM54BLP seconds of neutral to forward

engagement, psi; function of TOT.

- FN54F\_T = Engagement EPC at finish of engagement ramp for a neutral to

forward

engagement, psi; function of TOT.

- FN54S\_T = Engagement EPC at start of engagement ramp for a neutral to

forward

engagement, psi; function of TOT.

- FN54\_NE = Multiplier for FN54S\_T and FN54F\_T; function of NEBART.

- FN56B\_T = Engagement EPC for first TM56BLP seconds of neutral to reverse

engagement, psi; function of TOT.

- FN56F\_T = Engagement EPC at finish of engagement ramp for a neutral to

reverse

engagement, psi; function of TOT.

- FN56S\_T = Engagement EPC at start of engagement ramp for a neutral to

reverse

engagement, psi; function of TOT.

- FN56\_NE = Multiplier for FN56S\_T and FN56F\_T; function of NEBART.

- FN616(TP\_REL\_H) = Stall TV pressure.

- FN64B\_T = Engagement EPC for first TM64BLP seconds of reverse to forward

engagement, psi; function of TOT.

- FN64F\_T = Engagement EPC at finish of engagement ramp for a reverse to

forward

engagement, psi; function of TOT.

- FN64S\_T = Engagement EPC at start of engagement ramp for a reverse to

forward

engagement, psi; function of TOT.

- FN64\_NE = Multiplier for FN64S\_T and FN64F\_T; function of NEBART.

- NETVMN = Minimum RPM to use TVEMOD engagement TV.

17-20

ELECTRONIC PRESSURE CONTROL, ENGAGEMENT/STALL TV LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- NETVMX = Minimum RPM to use TVEMAX engagement TV.

- REV\_ENG\_ADD = Reverse Engagement Adder.

- STALLTV\_SW = Calibration switch to select FN616 during engagement; 0 ->

select FN616, 1 -> do not select FN616.

- TMDRVREV = Time to complete a forward to reverse engagement, sec.

- TMNEUDRV = Time to complete a neutral to forward engagement, sec.

- TMREVDRV = Time to complete a revolution to forward engagement, sec.

- TOTVTP = Tip-out TP cahnge to hold stall Tv.

- TPTVMN = Minimum TP\_REL to use TVEMOD engagement TV.

- TPTVMX = Minimum TP\_REL to use TVEMAX engagement TV.

- TVEMAX = TV for worst case engagement.

- VSTVMN = Minimum vehicle speed to use TVEMOD engagement TV.

- VSTVMX = Minimum vehicle speed to use TVEMAX engagement TV.

17-21

ELECTRONIC PRESSURE CONTROL, ENGAGEMENT/STALL TV LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EPC\_ENGMT\_STALL\_COM1

ENGAGEMENT/STALL TV LOGIC

STALLTV\_SW = 1 -----------------------|

(FN616 selection switch) |AND -| tempreg1 = 0

| | (do not consider FN616

FLG\_ENG\_IN = 1 -----------------------| | during engagement)

(engagement in progress) |

| --- ELSE ---

|

| tempreg1 = FN616(TP\_REL\_H)

| (determine stall TV)

17-22

ELECTRONIC PRESSURE CONTROL, ENGAGEMENT/STALL TV LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

VSBART\_RT >= VSTVMX ------------|

(high vehicle speed) |AND -|

| |

FLG\_FWD\_REV = 1 ----------------| |

(fwd/rev or rev/fwd) |

|OR --| tempreg2 = TVEMAX

FLG\_ENG\_TV = 1 -----------------| | | (set maximum TV engagement

(no shift yet) | | | pressure)

| | | Do "REVERSE ENGAGEMENT ADDER"

TP\_REL >= TPTVMX ---------| |AND -| | logic

(high TP) | | |

| | |

NEBART >= NETVMX ---------|OR --| |

(high engine speed) | |

| |

FLG\_TVENG\_CD = 1 ---------| |

(cold temperature) |

| --- ELSE ---

VSTVMN < VSBART\_RT < VSTVMX ----| |

(moderate vehicle speed) |AND -| |

| | |

FLG\_FWD\_REV = 1 ----------------| | |

(fwd/rev or rev/fwd) | |

|OR --| tempreg2 = TVEMOD

FLG\_ENG\_TV = 1 -----------------| | | (set moderate TV engagement

(no shift yet) | | | pressure)

| | | Do "REVERSE ENGAGEMENT ADDER"

TPTVMN < TP\_REL < TPTVMX -| |AND -| | logic

(moderate TP) | | |

| | |

NETVMN < NEBART < NETVMX -|OR --| |

(moderate engine speed) | |

| |

FLG\_TVENG\_MD = 1 ---------| |

(moderate temperature) |

| --- ELSE ---

|

FLG\_ENG\_IN = 1 -----------------------------| Do "DRIVE/REVERSE ENGAGEMNENT"

| logic

|

| --- ELSE ---

|

| tempreg2 = 0

17-23

ELECTRONIC PRESSURE CONTROL, ENGAGEMENT/STALL TV LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

tempreg2 > tempreg1 ------------------------| tempreg1 = tempreg2

(choose the larger of the stall

or engagement EPC pressure)

(TPVARTV - TP) >= TOTVTP -------------|

(high tip-out rate) |AND -| No change to TV\_PRES

| | (use last pass value to hold

TV\_PRES > tempreg1 -------------------| | TV pressure on tip-out)

(last pass value has enough capacity) |

| --- ELSE ---

|

| TV\_PRES = tempreg1

| (use the higher of stall TV

| or engagement TV)

REVERSE ENGAGEMENT ADDER LOGIC

PDL = 6 ------------------------------------| tempreg2 =

tempreg2 + REV\_ENG\_ADD

17-24

ELECTRONIC PRESSURE CONTROL, ENGAGEMENT/STALL TV LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DRIVE/REVERSE ENGAGEMENT LOGIC

FLG\_DRV\_REV = 1 -----------------|

|AND -| tempreg2 = FN46B\_T(TOT)

TM\_BLP\_TV > 0 -------------------| |

|

| --- ELSE ---

|

FLG\_DRV\_REV = 1 -----------------------| temp\_ne = FN46\_NE(NEBART)

| tempreg2 = FN46S\_T(TOT) \* temp\_ne +

| [FN46F\_T(TOT) - FN46S\_T(TOT)] \*

| [1 - TM\_ENG\_TV / TMDRVREV] \*

| [temp\_ne]

|

| --- ELSE ---

FLG\_NEU\_DRV = 1 -----------------| |

|AND -| tempreg2 = FN54B\_T(TOT)

TM\_BLP\_TV > 0 -------------------| |

|

| --- ELSE ---

|

FLG\_NEU\_DRV = 1 -----------------------| temp\_ne = FN54\_NE(NEBART)

| tempreg2 = FN54S\_T(TOT) \* temp\_ne +

| [FN54F\_T(TOT) - FN54S\_T(TOT)] \*

| [1 - TM\_ENG\_TV / TMNEUDRV] \*

| [temp\_ne]

|

| --- ELSE ---

FLG\_NEU\_REV = 1 -----------------| |

|AND -| tempreg2 = FN56B\_T(TOT)

TM\_BLP\_TV > 0 -------------------| |

|

| --- ELSE ---

|

FLG\_NEU\_REV = 1 -----------------------| temp\_ne = FN56\_NE(NEBART)

| tempreg2 = FN56S\_T(TOT) \* temp\_ne +

| [FN56F\_T(TOT) - FN56S\_T(TOT)] \*

| [1 - TM\_ENG\_TV / TMNEUREV] \*

| [temp\_ne]

|

| --- ELSE ---

FLG\_REV\_DRV = 1 -----------------| |

|AND -| tempreg2 = FN64B\_T(TOT)

TM\_BLP\_TV > 0 -------------------| |

|

| --- ELSE ---

|

FLG\_REV\_DRV = 1 -----------------------| temp\_ne = FN64\_NE(NEBART)

| tempreg2 = FN64S\_T(TOT) \* temp\_ne +

| [FN56F\_T(TOT) - FN64S\_T(TOT) \*

| [1 - TM\_ENG\_TV / TMREVDRV] \*

| [temp\_ne]

17-25

ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

NORMAL TV CALCULATION

OVERVIEW

Normal TV computes the TV pressure required to maintain static capacity,

that is, the capacity required when no shift is in progress.

DEFINITIONS

INPUTS

Registers:

- EPC\_TQ\_CONV = Torque converter static capacity EPC pressure requirement.

- GR\_CM = Current transmission gear.

- GR\_DS\_TV = Desired gear used to compute EPC pressure.

- NEBART = Filtered engine RPM for transmission.

- RATCH = Closed throttle position, counts.

- SPD\_RATIO = Speed ratio across the torque converter.

- TP = Throttle Position, counts.

- TPBARTV = Filtered TP for TV strategy. This filtered throttle position

is calculated using the ROLAV subroutine, but with a different time

constant then the values used in the TPBART and TPBARTC calculation.

TPBARTV is used in the TV routine to determine a tip-in condition.

During a tip-in condition in the TV routine, extra TV is added.

- TP\_REL = Relative Throttle Position, TP - RATCH.

- TP\_STRT\_SFT = TP\_REL at the start of a shift, counts.

- TQ\_IALPHA = I-ALPHA torque due to ratio change.

- TQ\_NET = Net torque into torque converter.

- TQ\_STAT\_CAP = Static Capacity Torque of transmission.

- TR\_STRT\_SFT = Torque ratio at the start of a shift.

- TV\_DYN = TV pressure required for dynamic shift control.

- TV\_PRES = TV pressure.

- TV\_STAT = TV pressure required for static capacity.

- TV\_ST\_SFT = Static TV pressure while shifting.

17-26

ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- FLG\_4X4L = 4X4L flag; 0 -> not in 4X4 L, 1 -> in 4X4 L.

- FLG\_DYN\_CD = Flag which indicates that it is necessary to add dynamic TV

due to cold transmission conditions.

- FLG\_FRST\_CM = Flag indicating a shift was commanded this background loop.

- FLG\_LK\_CM = Converter clutch lock-up commanded flag.

- FLG\_SFT\_IN = Shift in progress flag.

Calibration Constants:

- AETV = Anticipatory TV adder for heavy tip-ins.

- AETVTP = Minimum throttle change to include AETV in TV\_STAT.

- EPC\_TQMAX = Maximum clip on torque converter static capacity EPC pressure

requirement.

- FN617(SPD\_RATIO) = Torque converter torque ratio.

- MUSLP = Torque converter coefficient of friction temperature

compensation; slope.

- MUINT = Torque converter coefficient of friction temperature

compensation; intercept.

- SCINT1 = Static capacity TV intercept, first gear.

- SCINT2 = Static capacity TV intercept, second gear.

- SCINT3 = Static capacity TV intercept, third gear.

- SCINT4 = Static capacity TV intercept, fourth gear.

- SCSLP1 = Static capacity TV slope, first gear.

- SCSLP1SD = Static capacity TV slope, downshift to first gear.

- SCSLP2 = Static capacity TV slope, second gear.

- SCSLP2SD = Static capacity TV slope, downshift to second gear.

- SCSLP2SU = Static capacity TV slope, upshift to second gear.

- SCSLP3 = Static capacity TV slope, third gear.

- SCSLP3SD = Static capacity TV slope, downshift to third gear.

- SCSLP3SU = Static capacity TV slope, upshift to third gear.

- SCSLP4 = Static capacity TV slope, fourth gear.

- SCSLP4SU = Static capacity TV slope, upshift to fourth gear.

17-27

ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TQCONVINT = Static capacity EPC intercept for the torque converter.

- TQCONVSLP = Static capacity EPC slope for the torque converter.

OUTPUTS

Registers:

- EPC\_TQ\_CONV = See above.

- NE\_STRT\_SFT = Engine RPM at start of a shift.

- TQ\_STAT\_CAP = See above.

- TP\_STRT\_SFT = See above.

- TV\_DYN = See above.

- TV\_PRES = See above.

17-28

ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EPC\_NORM\_COM7

FLG\_FRST\_CM = 1 -------------------| NE\_STRT\_SFT = NEBART

(start of shift) | TR\_STRT\_SFT = FN617(SPD\_RATIO)

| TP\_STRT\_SFT = TP\_REL

| (capture engine speed, torque

| ratio and throttle position at

| start of shift)

| DO "TQ\_IALPHA CALCULATION"

Now calculate the minimum static capacity.

FLG\_SFT\_IN = 1 --------------------| TQ\_STAT\_CAP = (TQ\_NET + TQ\_IALPHA) \*

(shift in progress, | TR\_STRT\_SFT

use IALPHA term) | (calculate static torque capacity

| required)

|

| --- ELSE ---

|

FLG\_SFT\_IN = 0 --------------------| TQ\_IALPHA = 0

(shift done, use steady torque | TQ\_STAT\_CAP = TQ\_NET \* FN617(SPD\_RATIO)

requirement) | (calculate steady state input torque

| through torque converter ratio)

Calculate steady state pressure for current gear.

FLG\_SFT\_IN = 0 --------------------| DO "NON-SHIFTING STATIC TV

| CALCULATION"

FLG\_SFT\_IN = 0 --------------|

|AND -| DO "TORQUE CONVERTER STATIC TV

FLG\_LK\_CM = 1 ---------------| | CALCULATION"

Select larger of TV\_STAT and EPC\_TQ\_CONV.

FLG\_SFT\_IN = 0 --------------|

|AND -| TV\_STAT = EPC\_TQ\_CONV

TV\_STAT < EPC\_TQ\_CONV -------|

17-29

ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calculate pressure for shift using shifting slopes and Dynamic TV.

FLG\_SFT\_IN = 1 ----------------|

|

GR\_DS\_TV <> GR\_CM -------------|

|OR --| DO "SHIFTING STATIC TV CALCULATION"

FLG\_DYN\_CD = 1 ----------------| | DO "DYNAMIC TV CALCULATION"

|

FLG\_4X4L = 1 ------------------|

Select proper value for TV\_PRES.

FLG\_SFT\_IN = 0 ----------------|

|

GR\_DS\_TV = GR\_CM --| |

| |AND -| TV\_PRES = TV\_STAT

FLG\_4X4L = 0 ------|AND -| | |

| | | |

FLG\_DYN\_CD = 0 ----| |OR --| |

| |

TV\_STAT > TV\_ST\_SFT | |

+ TV\_DYN -----| |

| --- ELSE ---

|

| TV\_PRES = TV\_ST\_SFT + TV\_DYN

| (Clip TV\_PRES to zero minimum)

Now add anticipatory TV value for a tip-in.

FLG\_SFT\_IN = 0 ----------------|

|AND -| TV\_PRES = TV\_PRES + AETV

(TP - TPBARTV) >= AETVTP ------| | (adjust TV pressure for heavy

| tip-in to compensate for all

| system delays)

17-30

ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

NON-SHIFTING STATIC TV CALCULATION

GR\_CM = 1 ---------------------------| TV\_STAT = (TQ\_STAT\_CAP \* SCSLP1) +

| SCINT1

|

| --- ELSE ---

|

GR\_CM = 2 ---------------------------| TV\_STAT = (TQ\_STAT\_CAP \* SCSLP2) +

| SCINT2

|

| --- ELSE ---

|

GR\_CM = 3 ---------------------------| TV\_STAT = (TQ\_STAT\_CAP \* SCSLP3) +

| SCINT3

|

| --- ELSE ---

|

| TV\_STAT = (TQ\_STAT\_CAP \* SCSLP4) +

| SCINT4

SHIFTING STATIC TV CALCULATION

GR\_DS\_TV = 1 ------------------------| TV\_ST\_SFT = (TQ\_STAT\_CAP \* SCSLP1SD) +

| SCINT1

|

| --- ELSE ---

GR\_DS\_TV = 2 ------------------| |

|AND -| TV\_ST\_SFT = (TQ\_STAT\_CAP \* SCSLP2SU) +

FLG\_SFT\_UP = 1 ----------------| | SCINT2

|

| --- ELSE ---

|

GR\_DS\_TV = 2 ------------------------| TV\_ST\_SFT = (TQ\_STAT\_CAP \* SCSLP2SD) +

| SCINT2

|

| --- ELSE ---

GR\_DS\_TV = 3 ------------------| |

|AND -| TV\_ST\_SFT = (TQ\_STAT\_CAP \* SCSLP3SU) +

FLG\_SFT\_UP = 1 ----------------| | SCINT3

|

| --- ELSE ---

|

GR\_DS\_TV = 3 ------------------------| TV\_ST\_SFT = (TQ\_STAT\_CAP \* SCSLP3SD) +

| SCINT3

|

| --- ELSE ---

|

| TV\_ST\_SFT = (TQ\_STAT\_CAP \* SCSLP4SU) +

| SCINT4

17-31

ELECTRONIC PRESSURE CONTROL, NORMAL TV CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TORQUE CONVERTER STATIC TV CALCULATION

FLG\_SFT\_IN = 0 --------------|

|AND -| mu\_temp = (TOT \* MUSLP) +

FLG\_LK\_CM = 1 ---------------| | MUINT

| EPC\_TQ\_CONV =

| (TQ\_STAT\_CAP \* TQCONVSLP/mu\_temp) +

| TQCONVINT

|

| --- ELSE ---

|

| EPC\_TQ\_CONV = 0

always-----------------------------| EPC\_TQ\_CONV =

min(EPC\_TQ\_CONV, EPC\_TQMAX)

17-32

ELECTRONIC PRESSURE CONTROL, TQ\_IALPHA CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TQ\_IALPHA CALCULATION

OVERVIEW

The I-ALPHA torque calculation determines the torque that results from a

transmission upshift or downshift.

DEFINITIONS

INPUTS

Registers:

- GEAR\_CUR = Current transmission gear.

- GEAR\_OLD = Last commanded gear.

- NE\_STRT\_SFT = Engine RPM at start of a shift.

- RT\_GR\_CUR = Current transmission gear ratio.

- RT\_GR\_OLD = Last gear transmission gear ratio.

Calibration Constants:

- TQIA12 = I-ALPHA torque constant for 1 - 2.

- TQIA21 = I-ALPHA torque constant for 2 - 1.

- TQIA23 = I-ALPHA torque constant for 2 - 3.

- TQIA32 = I-ALPHA torque constant for 3 - 2.

- TQIA34 = I-ALPHA torque constant for 3 - 4.

- TQIA43 = I-ALPHA torque constant for 4 - 3.

OUTPUTS

Registers:

- TQ\_IALPHA = I-ALPHA torque due to ratio change.

17-33

ELECTRONIC PRESSURE CONTROL, TQ\_IALPHA CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EPC\_TQ\_IALPHA\_COM4

GEAR\_CUR = 2 ----------------|

|AND -| TQ\_IALPHA = NE\_STRT\_SFT \* TQIA12 \*

GEAR\_OLD = 1 ----------------| | [1 - (RT\_GR\_CUR/RT\_GR\_OLD)]

|

| --- ELSE ---

GEAR\_CUR = 1 ----------------| |

|AND -| TQ\_IALPHA = NE\_STRT\_SFT \* TQIA21 \*

GEAR\_OLD > 1 ----------------| | [1 - (RT\_GR\_CUR/RT\_GR\_OLD)]

|

| --- ELSE ---

GEAR\_CUR = 3 ----------------| |

|AND -| TQ\_IALPHA = NE\_STRT\_SFT \* TQIA23 \*

GEAR\_OLD < 3 ----------------| | [1 - (RT\_GR\_CUR/RT\_GR\_OLD)]

|

| --- ELSE ---

GEAR\_CUR = 2 ----------------| |

|AND -| TQ\_IALPHA = NE\_STRT\_SFT \* TQIA32 \*

GEAR\_OLD > 2 ----------------| | [1 - (RT\_GR\_CUR/RT\_GR\_OLD)]

|

| --- ELSE ---

GEAR\_CUR = 4 ----------------| |

|AND -| TQ\_IALPHA = NE\_STRT\_SFT \* TQIA34 \*

GEAR\_OLD < 4 ----------------| | [1 - (RT\_GR\_CUR/RT\_GR\_OLD)]

|

| --- ELSE ---

GEAR\_CUR = 3 ----------------| |

|AND -| TQ\_IALPHA = NE\_STRT\_SFT \* TQIA43 \*

GEAR\_OLD = 4 ----------------| | [1 - (RT\_GR\_CUR/RT\_GR\_OLD)]

17-34

ELECTRONIC PRESSURE CONTROL, DYNAMIC TV CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DYNAMIC TV CALCULATION

DEFINITIONS

INPUTS

Registers:

- GEAR\_CUR = Global Gear Indicator, reflects only.

- GR\_DS\_TV = Commanded gear for TV.

- TOT = Transmission oil temperature, deg F.

- TP\_REL\_H = Relative TP (TP - RATCH) high byte only.

- TP\_STRT\_SFT = TP at start of shift.

- TSLSFT = Time since last shift timer.

Bit Flags:

- FLG\_4X4L = 4x4 low flag.

- FLG\_FRST\_CM = First time a shift is commanded flag; 0 -> no shift

commanded.

- FLG\_SFT\_DN = Downshift flag.

- FLG\_SFT\_IN = Shift in progress flag.

- FLG\_SFT\_UP = Upshift flag.

Calibration Constants:

- FN12CA = Time dependent Dynamic EPC pressure adder for 1-2 shift, psi.

- FN12\_DC = Dynamic TV pressure for 1-2 shift.

- FN21\_DC = Dynamic TV pressure for 2-1 shift.

- FN23CA = Time dependent Dynamic EPC pressure adder for 1-2 shift, psi.

- FN23\_DC = Dynamic TV pressure for 2-3 shift.

- FN32\_DC = Dynamic TV pressure for 3-2 shift.

- FN34CA = Time dependent Dynamic EPC pressure adder for 3-4 shift, psi.

- FN34\_DC = Dynamic TV pressure for 3-4 shift.

- FN43\_DC = Dynamic TV pressure for 4-3 shift.

- SW\_DYN = Software switch for dynamic TV; 0 -> allow shift dynamics to

vary with rpm, 1 -> use rpm at start of shift.

17-35

ELECTRONIC PRESSURE CONTROL, DYNAMIC TV CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TMTVRMP\_12 = TV ramp time for 1-2 shift.

- TMTVRMP\_23 = TV ramp time for 2-3 shift.

- TMTVRMP\_34 = TV ramp time for 3-4 shift.

- TOTTV5 = Maximum TOT to adjust TV\_DYN for cold accum.

- TV\_4L\_12 = Dynamic TV adder for 1-2 shift in 4x4L.

- TV\_4L\_21 = Dynamic TV adder for 2-1 shift in 4x4L.

- TV\_4L\_23 = Dynamic TV adder for 2-3 shift in 4x4L.

- TV\_4L\_32 = Dynamic TV adder for 3-2 shift in 4x4L.

- TV\_4L\_34 = Dynamic TV adder for 3-4 shift in 4x4L.

- TV\_4L\_43 = Dynamic TV adder for 4-3 shift in 4x4L.

- TVRMP\_12 = TV adder during 1-2 upshift.

- TVRMP\_23 = TV adder during 2-3 upshift.

- TVRMP\_34 = TV adder during 3-4 upshift.

OUTPUTS

Registers:

- TSLSFT = See above.

- TV\_DYN = TV pressure required for dynamic shift control.

- TV\_RAMP = TV value added during upshift.

- TV\_RAMP\_TMR = TV adder during upshift control timer.

- TVRMPTM = TV Ramp Timer initail value for upshifts.

17-36

ELECTRONIC PRESSURE CONTROL, DYNAMIC TV CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EPC\_DYNAMIC\_COM1

SW\_DYN = 1 --------------|

|AND -| tempreg = TP\_STRT\_SFT

FLG\_SFT\_IN = 1 ----------| | (Do not allow shift

| dynamics to vary)

|

| --- ELSE ---

|

| tempreg = TP\_REL\_H

| (Allow shift dynamics to vary)

FLG\_FRST\_CM = 1 ---------------| TSLSFT = 0

|

| --- ELSE ---

|

| Increment TSLSFT

GR\_DS\_TV = 1 ------------------| TV\_DYN = FN21\_DC(tempreg)

|

| --- ELSE ---

GR\_DS\_TV = 2 ------------| |

|AND -| TV\_DYN = FN12\_DC(tempreg)

FLG\_SFT\_UP = 1 ----------| |

| --- ELSE ---

GR\_DS\_TV = 2 ------------| |

|AND -| TV\_DYN = FN32\_DC(tempreg)

FLG\_SFT\_DN = 1 ----------| |

| --- ELSE ---

GR\_DS\_TV = 3 ------------| |

|AND -| TV\_DYN = FN23\_DC(tempreg)

FLG\_SFT\_UP = 1 ----------| |

| --- ELSE ---

GR\_DS\_TV = 3 ------------| |

|AND -| TV\_DYN = FN43\_DC(tempreg)

FLG\_SFT\_DN = 1 ----------| |

| --- ELSE ---

|

GR\_DS\_TV = 4 ------------------| TV\_DYN = FN34\_DC(tempreg)

17-37

ELECTRONIC PRESSURE CONTROL, DYNAMIC TV CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

COLD ACCUMULATOR DYNAMIC TV COMPENSATION

TOT >= TOTTV5 -----------|

|OR --| Do not adjust TV\_DYN for a cold accumulator

FLG\_SFT\_UP = 0 ----------| |

| --- ELSE ---

|

GEAR\_CUR = 1 ------------| |

|OR --| TV\_DYN = TV\_DYN + FN12CA(TSLSFT)

GEAR\_CUR = 2 ------------| |

|

| --- ELSE ---

|

GEAR\_CUR = 3 ------------------| TV\_DYN = TV\_DYN + FN23CA(TSLSFT)

|

| --- ELSE ---

|

GEAR\_CUR = 4 ------------------| TV\_DYN = TV\_DYN + FN34CA(TSLSFT)

4X4L DYNAMIC TV COMPENSATION

FLG\_4X4L = 0 ------------------| Do not adjust TV\_DYN for 4X4L mode.

|

| --- ELSE ---

|

GEAR\_CUR = 1 ------------------| TV\_DYN = TV\_DYN + TV\_4L\_21

|

| --- ELSE ---

GEAR\_CUR = 2 ------------| |

|AND -| TV\_DYN = TV\_DYN + TV\_4L\_12

FLG\_SFT\_UP = 1 ----------| |

| --- ELSE ---

GEAR\_CUR = 2 ------------| |

|AND -| TV\_DYN = TV\_DYN + TV\_4L\_32

FLG\_SFT\_DN = 1 ----------| |

| --- ELSE ---

GEAR\_CUR = 3 ------------| |

|AND -| TV\_DYN = TV\_DYN + TV\_4L\_23

FLG\_SFT\_UP = 1 ----------| |

| --- ELSE ---

GEAR\_CUR = 3 ------------| |

|AND -| TV\_DYN = TV\_DYN + TV\_4L\_43

FLG\_SFT\_DN = 1 ----------| |

| --- ELSE ---

|

GEAR\_CUR = 4 ------------------| TV\_DYN = TV\_DYN + TV\_4L\_34

17-38

ELECTRONIC PRESSURE CONTROL, DYNAMIC TV CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_FRST\_CM = 1 ---------|

|

FLG\_SFT\_UP = 1 ----------|AND -| TVRMPTM = TMTVRMP\_12

| | TV\_RAMP\_TMR = TMTVRMP\_12

GR\_DS\_TV = 2 ------------| | TV\_RAMP = TVRMP\_12

|

| --- ELSE ---

FLG\_FRST\_CM = 1 ---------| |

| |

FLG\_SFT\_UP = 1 ----------|AND -| TVRMPTM = TMTVRMP\_23

| | TV\_RAMP\_TMR = TMTVRMP\_23

GR\_DS\_TV = 3 ------------| | TV\_RAMP = TVRMP\_23

|

| --- ELSE ---

FLG\_FRST\_CM = 1 ---------| |

| |

FLG\_SFT\_UP = 1 ----------|AND -| TVRMPTM = TMTVRMP\_34

| | TV\_RAMP\_TMR = TMTVRMP\_34

GR\_DS\_TV = 4 ------------| | TV\_RAMP = TVRMP\_34

|

| --- ELSE ---

|

FLG\_FRST\_CM = 1 ---------| |

|AND -| TVRMPTM = 1

FLG\_SFT\_DN = 1 ----------| | TV\_RAMP\_TMR = 1

| TV\_RAMP = 0

FLG\_SFT\_IN = 1 ----------------| TV\_DYN = TV\_DYN + TV\_RAMP \* [(TVRMPTM -

| TV\_RAMP\_TMR) / TVRMPTM]

|

| --- ELSE ---

|

| No action

| (shift is being verified; do not apply

| the upshift TV\_RAMP to TV\_DYN)

17-39

ELECTRONIC PRESSURE CONTROL, OFMFLG LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OFMFLG LOGIC

OVERVIEW

The Electronic Pressure Control VFS is a current control device with a 0 to 1

amp control range. One amp produces the lowest line pressure (handles idle

torque capacity). The ETV Overcurrent Circuit Monitor, ETVOCM, is a voltage

representative of the current in the ETV solenoid. This voltage is read by

the EEC-IV through the A/D.

The monitor is checked once per background loop after ETV current has had

time to stabilize to verify that the solenoid is operating within

specification. The expected monitor voltage is a function of battery voltage

and solenoid current. Measured voltage decreases with increasing current or

decreasing battery voltage.

If the measured voltage is less than the allowable minimum (ETV\_OCM\_MIN), the

ETV solenoid failure flag, ETV\_ERROR, is set and an "ETV Test" sequence is

initiated. This sequence commands zero TV\_COUNTS and then rechecks the

voltage to differentiate an open from a short. Through the use of a

"pull-up" circuit connected to the ETV output, at zero TV\_COUNTS, a short

will result in low voltage on ETVOCM, while an open will show a near-normal

voltage. If a short is detected, the torque truncation/failure mode routine

is enabled by setting the OFMFLG to 1. If an open is detected, the

EPC\_OPEN\_FLG is set to 1. If either the OFMFLG or the EPC\_OPEN\_FLG and the

EPC\_ERR\_SW is set, the TCIL will flash.

DEFINITIONS

INPUTS

Registers:

- ETVOCM = Actual ETV monitor voltage, counts.

- ETV\_OCM\_MIN = Minimum acceptable ETVOCM, counts.

- TM\_TV\_SS = ETV current settling timer, sec.

- TV\_COUNTS = Commanded ETV current, counts.

- UNDSP = In Underspeed mode flag; 1 -> in Underspeed or Crank, 0 -> in run

mode.

- VBAT = Battery Voltage, volts.

Bit Flags:

- ETV\_TEST = Flag indicating that the ETV open/short test is in progress; 1

-> test in progress.

17-40

ELECTRONIC PRESSURE CONTROL, OFMFLG LOGIC - LHBH0

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Calibration Constants:

- ETV\_BIAS = ETVOCM voltage at 10 volts VBAT and 0 counts commanded ETV,

counts.

- ETV\_GAIN = ETVOCM gain per one count of commanded ETV, counts/count.

- ETV\_GAIN\_BAT = ETVOCM count gain per one battery volt, counts/volt.

- TV\_SLT\_TM = Minimum time after a significant change in TV\_COUNTS before

performing the current monitor test. Used to allow ETV current to

stabilize before measurement, sec.

- TVCDLT = Minimum change in TV\_COUNTS from previous value to reset

TM\_TV\_SS, counts.

OUTPUTS

Registers:

- TM\_TV\_SS = See above.

Bit Flags:

- EPC\_OPEN\_FLG = Indicates EPC open circuit; 1 -> EPC open circuit

detected.

- ETV\_ERROR = ETV Solenoid error.

- ETV\_TEST = See above.

- OFMFLG = ETV Overcurrent Monitor Failure flag.

17-41

ELECTRONIC PRESSURE CONTROL, OFMFLG LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EPC\_OFM\_COM2

|Previous TV\_COUNTS - TV\_COUNTS|> TVCDLT ----| TM\_TV\_SS = 0

|

| --- ELSE ---

|

| Increment TM\_TV\_SS

VBAT >= 10.0 --------------------------|

|

UNDSP = 0 -----------------------------|AND -| Do "ETV Current

| | Monitor Test"

TM\_TV\_SS >= TV\_SLT\_TM -----------------| |

| --- ELSE ---

|

| Exit Routine

ETV CURRENT MONITOR TEST

Calculate ETV\_OCM\_MIN:

ETV\_OCM\_MIN = (ETV\_BIAS - (ETV\_GAIN \* TV\_COUNTS)) +

(Clip to zero)

((VBAT - 10.0) \* ETV\_GAIN\_BAT)

(Clip to zero)

17-42

ELECTRONIC PRESSURE CONTROL, OFMFLG LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

| (Initiate Open/Short Test)

ETVOCM < ETV\_OCM\_MIN ------------| |

|AND -| ETV\_ERROR = 1

ETV\_TEST = 0 --------------------| | OFMFLG = 0

| EPC\_OPEN\_FLG = 0

| ETV\_TEST = 1

| TM\_TV\_SS = 0

|

| --- ELSE ---

|

| (Over Current/Short Circuit)

ETVOCM < ETV\_OCM\_MIN ------------| |

|AND -| ETV\_ERROR = 1

ETV\_TEST = 1 --------------------| | OFMFLG = 1

| EPC\_OPEN\_FLG = 0

| ETV\_TEST = 1

|

| --- ELSE ---

|

| (Under Current/Open Circuit)

ETVOCM >= ETV\_OCM\_MIN -----------| |

|AND -| ETV\_ERROR = 1

ETV\_TEST = 1 --------------------| | OFMFLG = 0

| EPC\_OPEN\_FLG = 1

| ETV\_TEST = 0

| TM\_TV\_SS = 0

|

| --- ELSE ---

|

| (No Error)

|

| ETV\_ERROR = 0

| OFMFLG = 0

| EPC\_OPEN\_FLG = 0

| ETV\_TEST = 0

17-43

ELECTRONIC PRESSURE CONTROL, TV VFS OUTPUT ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TV VFS OUTPUT ROUTINE

OVERVIEW

TV pressure is controlled by a variable force solenoid in the transmission.

Current to the VFS ranges from 0 to 1 amp\_. and is controlled by a custom

integrated circuit which converts an 8 bit binary value to a proportional

current using the following relationship:

I ave. = requested counts/255

This 8 bit word is clocked into the IC via two low speed output lines from

the EEC-IV called data and clock. The following conventions must be

observed:

1) Both data and clock lines shall be held high between data words

2) Holding the data line low during a falling edge of the clock initiates an

input sequence at any point in time (even in the middle of a data

sequence). The LSB (Least Significant Bit) is assumed to follow next,

bit 7

3) A rising edge of the clock shifts the current state of the data line into

the IC buffer.

4) The eighth rising edge indicates that the MSB (Most Significant Bit), bit

0, has been shifted in. This latches the new 8 bit word in the IC and

forces the output current to the commanded level.

DEFINITIONS

INPUTS

Registers:

- TV\_COUNTS = FN620(TV\_PRES) = Requested TV counts based on transfer

function.

OUTPUTS

Bit Flags:

- FLG\_TV\_CLK = TV VFS clock line.

- FLG\_TV\_DATA = TV VFS data line.

17-44

ELECTRONIC PRESSURE CONTROL, TV VFS OUTPUT ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EPC\_VFS\_OUT\_COM2

One time --------------------------| FLG\_TV\_DATA = 0

| PAUSE

| FLG\_TV\_CLK = 0

| PAUSE

| (initiate input sequence)

Repeat eight times ----------------| FLG\_TV\_DATA = TV\_COUNTS, bit 0

| PAUSE

| FLG\_TV\_CLK = 1

| PAUSE

| (Latch data bit)

| FLG\_TV\_DATA = 1

| PAUSE

| FLG\_TV\_CLK = 0

| PAUSE

| (set up for next bit)

| Shift TV\_COUNTS right, 1 bit

one time --------------------------| FLG\_TV\_DATA = 1

| FLG\_TV\_CLK = 1

| (return output to rest state)

17-45

ELECTRONIC PRESSURE CONTROL, TRANSMISSION OVERTEMPERATURE TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TRANSMISSION OVERTEMPERATURE TEST

OVERVIEW

At very high temperatures, the torque capacity of the transmission is

decreased, which can impact its durabilty. When a high transmission oil

temperature is reached, the fault filter for the Transmission overtemperature

code will count up. Once the KAM bit is set, the OTEMP\_FM\_FLG is set. The

OTEMP\_FM\_FLG is used throughout the strategy for FMEM action. The

OTEMP\_FM\_FLG will remain set until the transmission drops below the

overtemperature threshold minus the hysteresis.

DEFINITIONS

INPUTS

Registers:

- TOT = Transmission oil temperature, deg F.

Calibration Constants:

- C657LVL = Threshold for Transmission overtemperature fault.

- C657UP = Transmission overtemperature fault up-count.

- TOT\_OTEMP = Temperature above which the Transmission overtemperature

fault filter is called.

- HYS\_OTEMP = Delta Temperature below which the Transmission is considered

no the be overtemperature.

OUTPUTS

Bit Flags:

- OTEMP\_FM\_FLG = Transmission overtemperature FMEM flag; 1 -> Transmission

is overtemperature.

17-46

ELECTRONIC PRESSURE CONTROL, TRANSMISSION OVERTEMPERATURE TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EPC\_OTEMP\_TEST\_COM2

TOT > TOT\_OTEMP ---------------------------| error\_detected = 1

(Transmission oil temperature above | Call fault filter for

overtemperature threshold) | Code 657

| OTEMP\_FM\_FLG = 1

| (Execute Transmission

| overtemperature failure

| mode action)

|

| --- ELSE ---

|

TOT <= TOT\_OTEMP - HYS\_OTEMP --------------| error\_detected = 0

| Call fault filter for

| Code 657

| OTEMP\_FM\_FLG = 0

17-47

ELECTRONIC PRESSURE CONTROL, TRANSMISSION OVERTEMPERATURE TEST - LHBH0

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17-48

CHAPTER 18

CONVERTER CLUTCH CONTROL

18-1

CONVERTER CLUTCH CONTROL, CONVERTER CLUTCH CONTROL - LHBH0

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CONVERTER CLUTCH CONTROL

OVERVIEW

The converter clutch is an electronically controlled wet clutch which

essentially bypasses the torque converter when actuated. This eliminates

torque converter slippage and excess heat generation leading to fuel economy

and vehicle performance benefits. The converter clutch is also used during

transmission gear changes to minimize the customer perceived engine RPM

change during upshifts and downshifts. Hydraulically, the converter clutch

circuit is a two pass (two circuit) system. This allows only on/off control

of the application of the clutch.

The converter clutch strategy is broken down into four basic parts:

1) Unconditional Unlock Logic - The converter clutch is unconditionally

released under a number of conditions such as closed throttle, brake

applied, high tip-in or tip-out rates, etc. A timer is then loaded to

allow re-application of the converter clutch after the condition is no

longer true. All times are independent such that the longest converter

clutch release time for multiple release conditions controls

re-application of the clutch.

There are two versions of the E4OD control logic; one for diesel engine

applications and one for gasoline engine applications. To minimize

software/strategy workload, the majority of the logic is kept generic, so

that it may be used for both versions.

In the converter clutch routine, it is desired to unconditionally unlock

the converter clutch during closed throttle. The means by which closed

throttle is determined is different in the two versions. Therefore, a

dummy variable, DD\_UNC\_UNL, is created. This variable is loaded with

TP\_REL in the gasoline version. The entire converter clutch routine

would then be generic between the two strategies.

2) Shift Unlock Logic - Shift unlock logic is used to control the converter

clutch during upshifts and downshifts. For power on upshifts, speed

ratio is monitored after the gear change begins and is used to release

the converter clutch. In this way, the drop in RPM caused by the ratio

change is offset by an RPM rise due to the release of the converter

clutch. After the converter clutch is released, speed ratio is monitored

again to reapply the converter clutch. The end result is that the RPM

change during the shift has been minimized and converter clutch control

has been imperceptible to the driver. If speed ratio conditions are not

met a default timer controls the converter clutch. The speed ratio

check, due to the accuracy required for proper control, is done during

the 1 msec. interrupt. Power off upshifts and all downshifts are

controlled by the default timer due to the lower required timing

accuracy. Downshifts are all performed on an open converter to aid shift

quality.

18-2

CONVERTER CLUTCH CONTROL, CONVERTER CLUTCH CONTROL - LHBH0

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3) Scheduled Lock/Unlock Logic - When there are no unconditional releases in

effect and the converter clutch is not being controlled during shifts,

converter clutch applies and releases are scheduled as a function of

throttle position versus vehicle speed for each gear. An identical set

of fox functions exists for altitude as well (BP\_INTR is the

interpolation factor). Vehicle speeds are modified by the learned N over

V of the vehicle. Some additional features exist for scheduled converter

clutch applies.

a) Speed ratio must be greater than a minimum value. This prevents

application of the converter clutch while significant torque

multiplications are taking place.

b) Throttle rate must be less than some maximum rate. This prevents

application of the converter clutch when driver business would

continually release and apply the converter clutch.

c) Intermediate altitude scheduled apply delay. This delays

re-application of the converter clutch when driving in mountainous

terrain to prevent business due to constantly changing throttle

position associated with driving up and down hills.

d) W.O.T. Lockup Logic - WOT lockup logic is used to apply the

converter clutch when at Wide Open Throttle to realize a performance

and efficiency benefit. In any gear other than first, the converter

clutch is automatically applied. In first gear, a minimum speed

ratio criteria must be met. If the converter clutch must be released

due to increasing load. The speed ratio criteria becomes

increasingly more difficult so as to prevent cycling of the clutch.

4) FMEM Lock-up Logic - If a Transmission sensor critical to the Converter

Clutch Control Logic fails, Lock-ups will be based on information from

the available sensors.

a) If the TP Sensor fails, locks are based on SPD\_RATIO. If both the TP

Sensor and the VS Sensor fail, locks are based on Engine RPM.

b) If the Vehicle Speed Sensor fails, locks are based on a function of

NEBART and TP\_REL.

18-3

CONVERTER CLUTCH CONTROL, CONVERTER CLUTCH CONTROL - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Bit Flags:

- FLG\_CRV\_LK = Scheduled curve lock-up flag; 0 -> no scheduled lock-up, 1

-> scheduled lock-up.

- FLG\_FMM\_LK = Failure Mode Management lock-up flag; 1 -> lock converter

due to FMEM action.

- FLG\_SFT\_UNLK = Shift control unlock flag; 0 -> no shift control unlock, 1

-> shift control unlock.

- FLG\_UNC\_UNLK = Converter clutch unconditional unlock flag; 0 -> no

unconditional unlock, 1 -> unconditional unlock.

- FLG\_WOT\_LK = WOT lock-up flag; 0 -> no WOT lock-up, 1 -> WOT lock-up.

Calibration Constants:

- SW\_MLK = Switch for manual converter clutch control; 0 -> automatic

converter clutch control, 1 -> unconditional converter clutch lock-up, 2

-> unconditional converter clutch unlock.

OUTPUTS

Bit Flags:

- FLG\_LK\_CM = Converter clutch lock-up commanded flag; 0 -> de-energize

solenoid, unlock converter clutch, 1 -> energize solenoid, lock converter

clutch.

18-4

CONVERTER CLUTCH CONTROL, CONVERTER CLUTCH CONTROL - LHBH0

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PROCESS

STRATEGY MODULE: CCC\_COM1

always ------------------------------| Do "UNCONDITIONAL UNLOCK" LOGIC

| Do "SHIFT UNLOCK" LOGIC

| Do "SCHEDULED LOCK/UNLOCK" LOGIC

| Do "WOT LOCK-UP" LOGIC

| Do "FAILURE MODE MANAGEMENT LOCK-UP"

LOGIC

SW\_MLK = 1 --------------------------| FLG\_LK\_CM = 1

(Development unconditional lock-up) | (Lock converter clutch)

|

| --- ELSE ---

FLG\_UNC\_UNLK = 1 --------------| |

(Unconditional unlock) |OR --| FLG\_LK\_CM = 0

| | (Unlock converter clutch)

FLG\_SFT\_UNLK = 1 --------------| |

(Shift control unlock) |

| --- ELSE ---

FLG\_WOT\_LK = 1 ----------------| |

(WOT lockup) | |

| |

FLG\_CRV\_LK = 1 ----------------|OR --| FLG\_LK\_CM = 1

(Scheduled curve lock-up) | | (Lock converter clutch)

| |

FLG\_FMM\_LK = 1 ----------------| |

(FMEM lock-up) |

| --- ELSE ---

|

| FLG\_LK\_CM = 0

| (Unlock converter clutch)

18-5

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

UNCONDITIONAL UNLOCK LOGIC

DEFINITIONS

INPUTS

Registers:

- BP = Barometric pressure.

- CS\_SFT\_MULT = Cold start shift multiplier.

- DD\_UNC\_UNL = The driver demand position used in the unconditional unlock

routine, counts.

- GEAR\_CUR = Current transmission gear.

- GEAR\_OLD = Last commanded gear.

- GR\_CM = Commanded gear for shift solenoids.

- GR\_DS = Desired transmission gear.

- NEBART = Filtered engine speed, RPM.

- PDL = Current PRNDL position.

- TM\_LK\_DLY = Timer for converter clutch unconditional unlock.

- TM\_UN\_CT = Timer for closed throttle converter clutch relock.

- TP\_RATE = Throttle position rate.

- TP\_REL = Relative Throttle Position.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission,

MPH.

Bit Flags:

- BIFLG = Brake applied flag; 0 -> brake not applied, 1 -> brake applied.

- FLG\_FRST\_CM = First time a shift is commanded flag; 0 -> no shift

commanded

this background pass, 1 -> shift commanded this background pass.

- FLG\_LK\_CM = Converter clutch lock-up commanded flag; 0 -> de-energize

solenoid, unlock converter clutch, 1 -> energize solenoid, lock converter

clutch.

- FLG\_UN\_ALT = High altitude unconditional unlock flag; 0 -> not at high

altitude, 1 -> high altitude.

- FLG\_UN\_BRK = Brake applied unconditional unlock flag; 0 -> brake not

applied, 1 -> brake applied.

18-6

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_UN\_CT = Closed throttle unconditional unlock flag; 0 -> not closed

throttle, 1 -> closed throttle.

- FLG\_UN\_MDN = Manual downshift sequence unconditional unlock flag;

0 -> no manual downshift unlock, 1 -> manual downshift unlock.

- FLG\_UN\_NE = Engine speed unconditional unlock flag; 0 -> no low engine

speed unlock, 1 -> low engine speed unlock.

- FLG\_UN\_PRN = PRNDL position unconditional unlock flag; 0 -> no PRNDL

position unconditional unlock, 1 -> PRNDL in park, reverse, neutral, or

manual

one.

- FLG\_UN\_TEMP = Cold temperature unconditional unlock flag; 0 -> no cold

unlock, 1 -> cold unlock.

- FLG\_UN\_TRA = Throttle rate accel unconditional unlock flag; 0 -> not

high positive throttle rate, 1 -> high positive throttle rate.

- FLG\_UN\_TRD = Throttle rate decel unconditional unlock flag; 0 -> not high

negative throttle rate, 1 -> high negative throttle rate.

- FLG\_UN\_ULSF = Unlocked shift unconditional unlock flag; 0 -> locked up

prior to start of shift, 1 -> unlocked prior to start of shift.

- OFMFLG = ETV overcurrent monitor failure flag; 0 -> ETV O.K., 1 ->

ETV failure mode.

- TFMFLG = TP FMEM flag = 0 -> no TP failure; 1 -> TP failure, operating

in FMEM mode.

Calibration Constants:

- BPUNMH = Hysteresis for BPUNMN.

- BPUNMN = Minimum BP to unlock converter clutch.

- BRKDLY = Brake relock delay.

- CTDLY = Closed throttle relock delay.

- D21DLY = Unlocked 2 -> 1 shift relock delay.

- D32DLY = Unlocked 3 -> 2 shift relock delay.

- D43DLY = Unlocked 4 -> 3 shift relock delay.

- LUDLY = High altitude/cold engine relock delay.

- NELUMN = Minimum NEBART to lock-up converter clutch.

- PRNDLY = PRNDL relock delay.

- SW\_MLK = Switch for manual converter clutch control; 0 -> automatic

converter clutch control, 1 -> unconditional converter clutch lock-up,

2 -> unconditional converter clutch unlock.

18-7

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TMCTDY = Minimum time before relock at closed throttle.

- TPUNBRK = Maximum relative TP for brake applied unlock.

- TPUNCH = Hysteresis for TPUNCT.

- TPUNCT = Maximum relative TP for closed throttle unlock.

- TPUNTR = Relative TP breakpoint for high and low unlock throttle rate.

- TRADLY = High throttle rate, accel, relock delay.

- TRDDLY = High throttle rate, decel, relock delay.

- TRUHAC = Throttle rate unlock, high TP, accel.

- TRULAC = Throttle rate unlock, low TP, accel.

- TRUHDC = Throttle rate unlock, high TP, decel.

- TRULDC = Throttle rate unlock, low TP, decel.

- U12DLY = Unlocked 1 -> 2 shift relock delay.

- U23DLY = Unlocked 2 -> 3 shift relock delay.

- U34DLY = Unlocked 3 -> 4 shift relock delay.

- VSCTDY = Minimum vehicle speed for closed throttle relock.

18-8

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- TM\_LK\_DLY = See above.

- TM\_UN\_CT = See above.

Bit Flags:

- FLG\_UN\_ALT = See above.

- FLG\_UN\_BRK = See above.

- FLG\_UN\_CT = See above.

- FLG\_UN\_MDN = See above.

- FLG\_UN\_NE = See above.

- FLG\_UN\_PRN = See above.

- FLG\_UN\_TEMP = See above.

- FLG\_UN\_TRA = See above.

- FLG\_UN\_TRD = See above.

- FLG\_UN\_ULSF = See above.

18-9

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_UNCOND\_UNLCK\_COM1

DD\_UNC\_UNL = TP\_REL (Performed during engineering units conversion)

DD\_UNC\_UNL < TPUNCT --------------|S Q--| FLG\_UN\_CT = 1

| | (Closed throttle unlock)

DD\_UNC\_UNL >= TPUNCT + TPUNCH ----|C |

| --- ELSE ---

|

| FLG\_UN\_CT = 0

TP\_RATE >= TRUHAC ---------|

|AND -|

DD\_UNC\_UNL >= TPUNTR ------| |

|OR --| FLG\_UN\_TRA = 1

TP\_RATE >= TRULAC ---------| | | (High tip-in rate)

|AND -| |

DD\_UNC\_UNL < TPUNTR -------| | --- ELSE ---

|

| FLG\_UN\_TRA = 0

TP\_RATE <= TRUHDC --------|

|AND -|

DD\_UNC\_UNL >= TPUNTR -----| |

|OR --| FLG\_UN\_TRD = 1

TP\_RATE <= TRULDC --------| | | (High tip-out rate)

|AND -| |

DD\_UNC\_UNL < TPUNTR ------| | --- ELSE ---

|

| FLG\_UN\_TRD = 0

BIFLG = 1 ----------------------| | FLG\_UN\_BRK = 1

|AND -| (Brake applied)

DD\_UNC\_UNL <= TPUNBRK ----------| |

| --- ELSE ---

|

| FLG\_UN\_BRK = 0

PDL = 7 OR 6 or 5 or 1 ---------------| FLG\_UN\_PRN = 1

| (Park, reverse, neutral, or

| manual one)

|

| --- ELSE ---

|

| FLG\_UN\_PRN = 0

18-10

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CS\_SFT\_MULT <> 1.0 -------------------| FLG\_UN\_TEMP = 1

| (Cold engine)

|

| --- ELSE ---

|

| FLG\_UN\_TEMP = 0

PDL = 2 OR 1 -------------------|

|AND -| FLG\_UN\_MDN = 1

GR\_DS <> GR\_CM -----------------| | (Manual downshift sequence

| not completed)

|

| --- ELSE ---

|

| FLG\_UN\_MDN = 0

BP <= BPUNMN -------------------|S Q--| FLG\_UN\_ALT = 1

| | (High altitude)

BP > BPUNMN + BPUNMH -----------|C |

| --- ELSE ---

|

| FLG\_UN\_ALT = 0

FLG\_FRST\_CM = 1 ----------------|

(Shift commanded) |

|AND -| FLG\_UN\_ULSF = 1

FLG\_LK\_CM = 0 ------------------| | (Minimum unlock time after

(Converter already unlocked) | start of unlocked shift)

|

| --- ELSE ---

|

| FLG\_UN\_ULSF = 0

NEBART < NELUMN ----------------------| FLG\_UN\_NE = 1

| (Low engine speed)

|

| --- ELSE ---

|

| FLG\_UN\_NE = 0

FLG\_UN\_CT = 1 ------------------------| Allow TM\_UN\_CT to count up

(Closed throttle) |

| --- ELSE ---

|

| TM\_UN\_CT = 0

18-11

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_UN\_CT = 1 ------------------|

(Closed throttle) |AND -| TM\_LK\_DLY = CTDLY

|

TM\_LK\_DLY < CTDLY --------------|

FLG\_UN\_TRA = 1 -----------------|

(High tip-in rate) |AND -| TM\_LK\_DLY = TRADLY

|

TM\_LK\_DLY < TRADLY -------------|

FLG\_UN\_TRD = 1 -----------------|

(High tip-out rate) |AND -| TM\_LK\_DLY = TRDDLY

|

TM\_LK\_DLY < TRDDLY -------------|

FLG\_UN\_BRK = 1 -----------------|

(Brake applied) |AND -| TM\_LK\_DLY = BRKDLY

|

TM\_LK\_DLY < BRKDLY -------------|

FLG\_UN\_PRN = 1 -----------------|

(Park, rev, neut) |AND -| TM\_LK\_DLY = PRNDLY

|

TM\_LK\_DLY < PRNDLY -------------|

OFMFLG = 1 ---------------|

(ETV sol. shorted) |

|

FLG\_UN\_NE = 1 ------------|

(Low engine speed) |

|

FLG\_UN\_TEMP = 1 ----------|

(Cold temperature) |

|

FLG\_UN\_MDN = 1 -----------|OR --|

(Manual downshift) | |

| |AND -| TM\_LK\_DLY = LUDLY

FLG\_UN\_ALT = 1 -----------| |

(High altitude) | |

| |

TFMFLG = 1 ---------------| |

(TP failure) |

|

TM\_LK\_DLY < LUDLY --------------|

18-12

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_UN\_ULSF = 1 ----------|

|

GEAR\_CUR = 2 -------------|AND -| TM\_LK\_DLY = U12DLY

| |

GEAR\_OLD = 1 -------------| | --- ELSE ---

|

FLG\_UN\_ULSF = 1 ----------| |

| |

GEAR\_CUR = 1 -------------|AND -| TM\_LK\_DLY = D21DLY

| |

GEAR\_OLD > 1 -------------| | --- ELSE ---

|

FLG\_UN\_ULSF = 1 ----------| |

| |

GEAR\_CUR = 3 -------------|AND -| TM\_LK\_DLY = U23DLY

| |

GEAR\_OLD < 3 -------------| | --- ELSE ---

|

FLG\_UN\_ULSF = 1 ----------| |

| |

GEAR\_CUR = 2 -------------|AND -| TM\_LK\_DLY = D32DLY

| |

GEAR\_OLD > 2 -------------| | --- ELSE ---

|

FLG\_UN\_ULSF = 1 ----------| |

| |

GEAR\_CUR = 4 -------------|AND -| TM\_LK\_DLY = U34DLY

| |

GEAR\_OLD < 4 -------------| | --- ELSE ---

|

FLG\_UN\_ULSF = 1 ----------| |

| |

GEAR\_CUR = 3 -------------|AND -| TM\_LK\_DLY = D43DLY

|

GEAR\_OLD = 4 -------------|

18-13

CONVERTER CLUTCH CONTROL, UNCONDITIONAL UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SW\_MLK = 2 --------------------------|

(Unconditional unlock) |

|

FLG\_UN\_CT = 1 -----------------| |

|AND -|

TM\_UN\_CT <= TMCTDY ------------| |

(Closed throttle, short time) |

|

TM\_UN\_CT > TMCTDY -------------| |

(Closed throttle long enough) | |

|AND -|

VSBART\_RT < VSCTDY ------------| |

(Low speed) |

|

FLG\_UN\_TRA = 1 ----------------------|

(High tip-in) |

|

FLG\_UN\_TRD = 1 ----------------------|OR --|S Q--| FLG\_UNC\_UNLK = 1

(High tip-out) | | | (Unconditionally unlock

| | | converter clutch)

FLG\_UN\_BRK = 1 ----------------------| | |

(Brake applied) | | | --- ELSE ---

| | |

FLG\_UN\_PRN = 1 ----------------------| | | FLG\_UNC\_UNLK = 0

(Park, rev, neut) | | | (Allow lock-up if

| | | scheduled)

FLG\_UN\_TEMP = 1 ---------------------| |

(Cold temperature) | |

| |

FLG\_UN\_MDN = 1 ----------------------| |

(Manual downshift) | |

| |

FLG\_UN\_ALT = 1 ----------------------| |

(High altitude) | |

| |

FLG\_UN\_ULSF = 1 ---------------------| |

(Unlocked shift) | |

| |

TFMFLG = 1 --------------------------| |

(TP failure) | |

| |

FLG\_UN\_NE = 1 -----------------------| |

(Low engine speed) | |

| |

OFMFLG = 1 --------------------------| |

(ETV solenoid shorted) |

|

TM\_LK\_DLY = 0 -----------------------------|C

18-14

CONVERTER CLUTCH CONTROL, SHIFT UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SHIFT UNLOCK LOGIC

DEFINITIONS

INPUTS

Registers:

- GR\_CM = Commanded gear for shift solenoids.

- GEAR\_CUR = Current transmission gear.

- GR\_DS = Desired transmission gear.

- GEAR\_OLD = Last commanded gear.

Bit Flags:

- FLG\_DN\_LK = Downshift relock control flag.

- FLG\_DN\_UNLK = Downshift unlock control flag.

- FLG\_FRST\_CM = First time a shift is commanded flag; 0 -> no shift

commanded this background pass, 1 -> shift commanded this background

pass.

- FLG\_FRST\_DS = First time a shift is desired flag; 0 -> no shift.

- FLG\_UP\_LK = Upshift relock control flag.

- FLG\_UP\_UNLK = Upshift unlock control flag.

OUTPUTS

Registers:

- TM\_SFT\_CCO = Time for converter clutch to unlock prior to commanded

shift.

18-15

CONVERTER CLUTCH CONTROL, SHIFT UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_SHFT\_UNLCK\_COM1

FLG\_FRST\_DS = 1 -------------|

(Shift desired this pass) |

|AND -| DO "INITIALIZE DOWNSHIFT CONVERTER

GR\_DS < GR\_CM ---------------| | CLUTCH" LOGIC

(Downshift) | DO "DOWNSHIFT CONVERTER CLUTCH" LOGIC

|

FLG\_FRST\_CM = 1 -------------| | --- ELSE ---

(Shift commanded this pass) | |

|AND -| DO "INITIALIZE UPSHIFT CONVERTER

GEAR\_CUR > GEAR\_OLD ---------| | CLUTCH" LOGIC

(Upshift) | DO "UPSHIFT CONVERTER CLUTCH" LOGIC

|

FLG\_DN\_UNLK = 1 -------------| | --- ELSE ---

(Downshift unlock control) | |

|OR --| DO "DOWNSHIFT CONVERTER CLUTCH" LOGIC

FLG\_DN\_LK = 1 ---------------| |

(Downshift relock control) | --- ELSE ---

|

FLG\_UP\_UNLK = 1 -------------| |

(Upshift unlock control) | |

|OR --| DO "UPSHIFT CONVERTER CLUTCH" LOGIC

FLG\_UP\_LK = 1 ---------------| |

(Upshift relock control) | --- ELSE ---

|

| TM\_SFT\_CCO = 0

18-16

CONVERTER CLUTCH CONTROL, INITIALIZE DOWNSHIFT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

INITIALIZE DOWNSHIFT

DEFINITIONS

OUTPUTS

Registers:

- TM\_SFT\_CCO = Time for converter clutch to unlock prior to commanded

shift.

Bit Flags:

- FLG\_DN\_LK = Downshift relock control flag.

- FLG\_DN\_UNLK = Downshift unlock control flag.

- FLG\_HS\_LK = High speed upshift relock control flag.

- FLG\_HS\_UNLK = High speed upshift unlock control flag.

- FLG\_SFT\_UNLK = Shift control unlock flag; 0 -> no shift control unlock, 1

-> shift control unlock.

- FLG\_UP\_LK = Upshift relock control flag.

- FLG\_UP\_UNLK = Upshift unlock control flag.

PROCESS

STRATEGY MODULE: CCC\_INI\_DWN\_COM1

Always ------------------------| FLG\_HS\_UNLK = 0

(Downshift desired this pass) | FLG\_HS\_LK = 0

| (Disable high speed speed ratio checks)

| FLG\_UP\_UNLK = 0

| FLG\_UP\_LK = 0

| FLG\_DN\_LK = 0

| (Clear all other shift control flags)

| FLG\_DN\_UNLK = 1

| (Set downshift unlock control flag)

| FLG\_SFT\_UNLK = 1

| (Unlock converter clutch)

| TM\_SFT\_CCO = 0

| (Reset converter clutch unlock timer)

18-17

CONVERTER CLUTCH CONTROL, DOWNSHIFT CONVERTER CLUTCH - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DOWNSHIFT CONVERTER CLUTCH

DEFINITIONS

INPUTS

Registers:

- DNUN\_TM = FN624(TP\_REL) = Time to delay downshift for converter to

unlock.

- TM\_SFT\_CCO = Time for converter clutch to unlock prior to commanded

shift.

Bit Flags:

- FLG\_DN\_LK = Downshift relock control flag.

- FLG\_DN\_UNLK = Downshift unlock control flag.

Calibration Constants:

- TMDNLK = Time for converter clutch relock after commanded downshift, sec.

OUTPUTS

Registers:

- TM\_SFT\_CCO = See above.

Bit Flags:

- FLG\_DN\_LK = See above.

- FLG\_DN\_UNLK = See above.

- FLG\_SF\_AUTO = Automatic upshift/downshift flag; 0 -> manual.

- FLG\_SFT\_UNLK = Shift control unlock flag; 0 -> no shift control unlock, 1

-> shift control unlock.

18-18

CONVERTER CLUTCH CONTROL, DOWNSHIFT CONVERTER CLUTCH - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_DWN\_CNVR\_CLCH\_COM1

FLG\_DN\_UNLK = 1 ------------|

(Downshift unlock control) |

|AND -| FLG\_DN\_UNLK = 0

TM\_SFT\_CCO >= DNUN\_TM ------| | (Clear downshift unlock control flag)

(Converter clutch released) | FLG\_DN\_LK = 1

| (Set downshift relock control flag)

| TM\_SFT\_CCO = 0

| (Reset converter clutch relock timer)

| A downshift will be commanded at

| this time

|

FLG\_DN\_LK = 1 --------------| | --- ELSE ---

(Downshift relock control) | |

|AND -| FLG\_DN\_LK = 0

TM\_SFT\_CCO >= TMDNLK -------| | (Clear downshift relock control flag)

(Shift is complete) | FLG\_SF\_AUTO = 0

| (Automatic downshift completed)

| FLG\_SFT\_UNLK = 0

| (Permit relock if desired)

18-19

CONVERTER CLUTCH CONTROL, INITIALIZE UPSHIFT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

INITIALIZE UPSHIFT

DEFINITIONS

INPUTS

Registers:

- GEAR\_CUR = Current transmission gear.

- NOBART = Filtered output shaft speed, RPM.

- RT\_GR\_CUR = Current transmission gear ratio.

- RT\_ULK\_PWR = Power on upshift unlock speed ratio.

- SPD\_RT\_STRT = Speed Ratio at Start of shift.

- TP\_REL = Relative Throttle Position.

Bit Flags:

- FLG\_LK\_CM = Conv. clutch lockup commanded flag.

- FLG\_UN\_UPSFT = Unlocked upshift flag.

- FLG\_UP\_NE = WOT engine RPM upshift flag.

Calibration Constants:

- FN2LK = Speed ratio delta to relock on upshift to 2nd gear.

- FN2ULK = Speed ratio delta to unlock on usphift to 2nd gear.

- FN3LK = Speed ratio delta to relock on upshift to 3rd gear.

- FN3ULK = Speed ratio delta to unlock on usphift to 3rd gear.

- FN4LK = Speed ratio delta to relock on upshift to 4th gear.

- FN4ULK = Speed ratio delta to unlock on usphift to 4th gear.

- PUL\_PER\_REV = Pulses per revolution. Number of PIPs per engine revolution

for E4OD gas; 1/2 the number of fuel pump teeth for E4OD\_DIESEL.

- SRLK2 = Minimum speed ratio for scheduled 2nd gear lockup.

- SRLK3 = Minimum speed ratio for scheduled 3rd gear lockup.

- SRLK4 = Minimum speed ratio for scheduled 4th gear lockup.

- TMLFN2 = Power off upshift to 2nd relock time, sec.

- TMLFN3 = Power off upshift to 3rd relock time, sec.

- TMLFN4 = Power off upshift to 4th relock time, sec.

18-20

CONVERTER CLUTCH CONTROL, INITIALIZE UPSHIFT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TMLFW2 = Power off WOT upshift to 2nd relock time, sec.

- TMLFW3 = Power off WOT upshift to 3rd relock time, sec.

- TMLFW4 = Power off WOT upshift to 4th relock time, sec.

- TMLON2 = Power on upshift to 2nd relock time, sec.

- TMLON3 = Power on upshift to 3rd relock time, sec.

- TMLON4 = Power on upshift to 4th relock time, sec.

- TMLOW2 = Power on WOT upshift to 2nd relock time, sec.

- TMLOW3 = Power on WOT upshift to 3rd relock time, sec.

- TMLOW4 = Power on WOT upshift to 4th relock time, sec.

- TMUFN2 = Power off upshift to 2nd unlock time, sec.

- TMUFN3 = Power off upshift to 3rd unlock time, sec.

- TMUFN4 = Power off upshift to 4th unlock time, sec.

- TMUFW3 = Power off WOT upshift to 3rd unlock time, sec.

- TMUFW4 = Power off WOT upshift to 4th unlock time, sec.

- TMUOW3 = Power on WOT upshift to 3rd unlock time, sec.

- TMUOW4 = Power on WOT upshift to 4th unlock time, sec.

18-21

CONVERTER CLUTCH CONTROL, INITIALIZE UPSHIFT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- RT\_GR\_CUR = See above.

- RT\_LK\_PWR = Power on upshift relock speed ratio.

- RT\_ULK\_PWR = See above.

- SR\_PP\_LIM = Power on upshift speed ratio, PIP-to-PIP limit.

- SRLK = Shift ratio to allow lockup.

- TE\_LK\_PWR = Power on upshift relock time.

- TE\_LK\_UP = Power off upshift relock time.

- TE\_ULK\_PWR = Power on upshift unlock time.

- TE\_ULK\_UP = Power off upshift unlock time.

- TM\_SFT\_CCO = Time for converter clutch to unlock prior to commanded

shift.

Bit Flags:

- FLG\_DN\_LK = Downshift relock control flag.

- FLG\_DN\_UNLK = Downshift unlock control flag.

- FLG\_HS\_LK = High speed upshift relock control flag.

- FLG\_HS\_UNLK = High speed upshift unlock control flag.

- FLG\_TIP\_RATE = Upshift tip-in rate flag; 0 -> no tip-in occured during

upshift, 1 -> tip-in occurred during.

- FLG\_UP\_LK = Upshift relock control flag.

- FLG\_UP\_UNLK = Upshift unlock control flag.

18-22

CONVERTER CLUTCH CONTROL, INITIALIZE UPSHIFT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_INI\_UP\_COM1

always --------------| FLG\_DN\_UNLK = 0

| FLG\_DN\_LK = 0

| FLG\_UP\_LK = 0

| (clear all other shift control flags)

| FLG\_UP\_UNLK = 1

| (set upshift unlock control flag)

| TM\_SFT\_CCO = 0

| (reset unlock default timer)

| FLG\_HS\_LK = 0

| (disable high speed relock check)

| FLG\_TIP\_RATE = 0

| (reset tip-in rate flag)

FLG\_UP\_NE = 0 -|

|AND -| TE\_ULK\_UP = TMUFN4

GEAR\_CUR = 4 --| | TE\_LK\_UP = TMLFN4

| (power off unlock/relock timer)

| TE\_ULK\_PWR = TMUON4

| TE\_LK\_PWR = TMLON4

| (power on unlock/relock timers)

| RT\_ULK\_PWR = SPD\_RT\_STRT + FN4ULK(TP\_REL)

| RT\_LK\_PWR = SPD\_RT\_STRT + FN4LK(TP\_REL)

| (power on speed ratio checks)

| SRLK = SRLK4

|

| --- ELSE ---

FLG\_UP\_NE = 1 -| |

|AND -| TE\_ULK\_UP = TMUFW4

GEAR\_CUR = 4 --| | TE\_LK\_UP = TMLFW4

| (power off unlock/relock timers)

| TE\_ULK\_PWR = TMUOW4

| TE\_LK\_PWR = TMLOW4

| (power on unlock/relock timers)

| RT\_ULK\_PWR = SPD\_RT\_STRT + FN4ULK(TP\_REL)

| RT\_LK\_PWR = SPD\_RT\_STRT + FN4LK(TP\_REL)

| (power on speed ratio checks)

| SRLK = SRLK4

|

| --- ELSE ---

FLG\_UP\_NE = 0 -| |

|AND -| TE\_ULK\_UP = TMUFN3

GEAR\_CUR = 3 --| | TE\_LK\_UP = TMLFN3

| (power off unlock/relock timers)

| TE\_ULK\_PWR = TMUON3

| TE\_LK\_PWR = TMLON3

| (power on unlock/relock timers)

| RT\_ULK\_PWR = SPD\_RT\_STRT + FN3ULK(TP\_REL)

| RT\_LK\_PWR = SPD\_RT\_STRT + FN3LK(TP\_REL)

| (power on speed ratio checks)

| SRLK = SRLK3

|

| --- ELSE ---

(continued on next page)

18-23

CONVERTER CLUTCH CONTROL, INITIALIZE UPSHIFT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

FLG\_UP\_NE = 1 -| |

|AND -| TE\_ULK\_UP = TMUFW3

GEAR\_CUR = 3 --| | TE\_LK\_UP = TMLFW3

| (power off unlock/relock timers)

| TE\_ULK\_PWR = TMUOW3

| TE\_LK\_PWR = TMLOW3

| (power on unlock/relock timers)

| RT\_ULK\_PWR = SPD\_RT\_STRT + FN3ULK(TP\_REL)

| RT\_LK\_PWR = SPD\_RT\_STRT + FN3LK(TP\_REL)

| (power on speed ratio checks)

| SRLK = SRLK3

|

| --- ELSE ---

FLG\_UP\_NE = 0 -| |

|AND -| TE\_ULK\_UP = TMUFN2

GEAR\_CUR = 2 --| | TE\_LK\_UP = TMLFN2

| (power off unlock/relock timers)

| TE\_ULK\_PWR = TMUON2

| TE\_LK\_PWR = TMLON2

| (power on unlock/relock timers)

| RT\_ULK\_PWR = SPD\_RT\_STRT + FN2ULK(TP\_REL)

| RT\_LK\_PWR = SPD\_RT\_STRT + FN2LK(TP\_REL)

| (power on speed ratio checks)

| SRLK = SRLK2

|

| --- ELSE ---

FLG\_UP\_NE = 1 -| |

|AND -| TE\_ULK\_UP = TMUFW2

GEAR\_CUR = 2 --| | TE\_LK\_UP = TMLFW2

| (power off unlock/relock timers)

| TE\_ULK\_PWR = TMUOW2

| TE\_LK\_PWR = TMLOW2

| (power on unlock/relock timers)

| RT\_ULK\_PWR = SPD\_RT\_STRT + FN2ULK(TP\_REL)

| RT\_LK\_PWR = SPD\_RT\_STRT + FN2LK(TP\_REL)

| (power on speed ratio checks)

| SRLK = SRLK2

always --------------| SR\_PP\_LIM = (RT\_ULK\_PWR \* 60) / (NOBART \*

| RT\_GR\_CUR \* PUL\_PER\_REV)

| FLG\_HS\_UNLK = 1

| (enable high speed unlock check)

FLG\_LK\_CM = 0 -------| FLG\_UN\_UPSFT = 1

| (upshift commanded on an unlocked converter)

|

| --- ELSE ---

|

| FLG\_UN\_UPSFT = 0

18-24

CONVERTER CLUTCH CONTROL, UPSHIFT CONVERTER CLUTCH - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

UPSHIFT CONVERTER CLUTCH

DEFINITIONS

INPUTS

Registers:

- NOBART = Filtered output shaft speed.

- RT\_GR\_CUR = Current transmission gear ratio.

- RT\_LK\_PWR = Power on upshift relock speed ratio.

- RT\_ULK\_PWR = Power on upshift unlock speed ratio.

- SPD\_RATIO = Speed ratio across torque converter (Output/Input).

- SRLK = Shift ratio to allow lockup.

- TE\_LK\_PWR = Power on upshift relock time.

- TE\_LK\_UP = Power off upshift relock time.

- TE\_ULK\_PWR = Power on upshift unlock time.

- TE\_ULK\_UP = Power off upshift unlock time.

- TM\_SFT\_CCO = Time for converter clutch to unlock prior to commanded

shift.

- TP\_RATE = Delta TP Counts Per BG Pass = (TP - TPBART).

- TSLSFT = Time since last shift timer.

Bit Flags:

- FLG\_HS\_LK = High speed upshift relock control flag.

- FLG\_HS\_UNLK = High speed upshift unlock control flag.

- FLG\_PWR = Power mode flag; 0 -> power off, 1 -> power on.

- FLG\_UP\_LK = Upshift relock control flag.

- FLG\_TIP\_RATE = Unlocked upshift tip-in rate flag; 0 -> no tip-in occurred

during upshift, 1 -> tip-in occurred during.

- FLG\_UP\_UNLK = Upshift unlock control flag.

- FLG\_UN\_UPSFT = Unlocked upshift flag.

Calibration Constants:

- PUL\_PER\_REV = Pulses per revolution. Number of PIPs per engine revolution

for E4OD gas; 1/2 the number of fuel pump teeth for E4OD\_DIESEL.

18-25

CONVERTER CLUTCH CONTROL, UPSHIFT CONVERTER CLUTCH - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- TM\_ACT\_SFT = Re-lock delay time after a tip-in.

- UP\_TIP\_RATE = Tip-in rate above which FLG\_TIP\_RATE is set.

OUTPUTS

Registers:

- SR\_PP\_LIM = Power on upshift speed ratio, PIP-to-PIP limit.

- TM\_SFT\_CCO = See above.

Bit Flags:

- FLG\_HS\_LK = See above.

- FLG\_HS\_UNLK = See above.

- FLG\_SFT\_UNLK = Shift control unlock flag; 0 -> no shift control unlock,

1 -> shift control unlock.

- FLG\_SF\_AUTO = Automatic shift flag.

- FLG\_TIP\_RATE = See above.

- FLG\_UP\_LK = See above.

- FLG\_UP\_UNLK = See above.

PROCESS

STRATEGY MODULE: CCC\_UP\_CNVR\_CLCH\_COM2

FLG\_PWR = 0 --------------------------------| SR\_PP\_LIM = 0

(power off) | (zero will never meet speed

| ratio criteria, uses default

| timer)

|

| --- ELSE ---

FLG\_PWR = 1 --------------------------| |

(power on) | |

|AND -| SR\_PP\_LIM = RT\_ULK\_PWR \* 60 /

FLG\_UP\_UNLK = 1 ----------------------| | NOBART \* RT\_GR\_CUR \*

(upshift unlock control) | PUL\_PER\_REV

| (calculate upshift unlock

| speed ratio comparator)

|

| --- ELSE ---

FLG\_PWR = 1 --------------------------| |

(power on) | |

|AND -| SR\_PP\_LIM = RT\_LK\_PWR \* 60 /

FLG\_UP\_LK = 1 ------------------------| | NOBART \* RT\_GR\_CUR \*

(upshift relock control) | PUL\_PER\_REV

18-26

CONVERTER CLUTCH CONTROL, UPSHIFT CONVERTER CLUTCH - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_UN\_UPSFT = 1 ---------------------|

|AND -| FLG\_TIP\_RATE = 1

TP\_RATE > UP\_TIP\_RATE ----------------|

FLG\_UP\_UNLK = 1 ----------------------|

(upshift unlock control) |

|

FLG\_HS\_UNLK = 0 -----------------| |AND -| FLG\_UP\_UNLK = 0

(high speed routine unlock) | | | (done with upshift unlock

| | | control)

FLG\_PWR = 1 ---------------| | | | FLG\_UP\_LK = 1

(power on) | | | | (set upshift relock control

|AND -|OR -| | flag)

TM\_SFT\_CCO >= TE\_ULK\_PWR --| | | TM\_SFT\_CCO = 0

(default timer expired) | | (reset default relock timer)

| | FLG\_SFT\_UNLK = 1

FLG\_PWR = 0 ---------------| | | (unlock converter clutch)

(power off) | | | SR\_PP\_LIM = RT\_LK\_PWR \* 60

|AND -| | NOBART\*RT\_GR\_CUR\*PUL\_PER\_REV

TM\_SFT\_CCO >= TE\_ULK\_UP ---| | FLG\_HS\_LK = 1

(default timer expired) | (enable high speed relock

| check)

| FLG\_HS\_UNLK = 0

| (disable high speed unlock

| check)

|

| --- ELSE ---

FLG\_TIP\_RATE = 0 ---------------------| |

| |

FLG\_UP\_LK = 1 ------------------------| |

(upshift relock control) | |

|AND -| FLG\_UP\_LK = 0

FLG\_HS\_LK = 0 ------------------| | | (clear upshift relock flag)

(high speed routine relock) | | | FLG\_HS\_LK = 0

| | | (disable high speed relock

FLG\_PWR = 1 --------------| | | | check)

(power on) | | | | FLG\_SFT\_UNLK = 0

|AND -|OR --| | (permit relock if permitted)

TM\_SFT\_CCO >= TE\_LK\_PWR --| | | FLG\_SF\_AUTO = 0

(default timer expired) | | (done with automatic shift)

| |

FLG\_PWR = 0 --------------| | |

(power off) | | |

|AND -| |

TM\_SFT\_CCO >= TE\_LK\_UP ---| |

| --- ELSE ---

FLG\_TIP\_RATE = 1 ---------------------| |

|AND -| FLG\_HS\_LK = 0

TSLSFT < TM\_ACT\_SFT ------------------| | (disable high speed relock

| check)

| FLG\_SFT\_UNLK = 1

| (don't allow scheduled lock)

|

| --- ELSE ---

(continued on next page)

18-27

CONVERTER CLUTCH CONTROL, UPSHIFT CONVERTER CLUTCH - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

FLG\_UN\_UPSFT = 1 ---------------------| |

(unlocked upshift) | |

| |

FLG\_TIP\_RATE = 1 ---------------------|AND -| FLG\_SFT\_UNLK = 0

(tip-in detected) | | (allow a lock if scheduled)

| | FLG\_TIP\_RATE = 0

SPD\_RATIO >= SRLK --------------------| | (reset tip-in flag)

(speed ratio is high enough) |

| --- ELSE ---

FLG\_UN\_UPSFT = 1 ---------------------| |

(unlocked upshift) | |

|AND -| FLG\_SFT\_UNLK = 1

FLG\_TIP\_RATE = 1 ---------------------| | (don't allow scheduled lock)

(tip-in detected)

18-28

CONVERTER CLUTCH SOLENOID CONTROL, SCHEDULED LOCK/UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SCHEDULED LOCK/UNLOCK LOGIC

DEFINITIONS

INPUTS

Registers:

- BP = Barometric pressure.

- BP\_INTR = Output of FN615(BP). This is used to modify shift schedules

and converter lockup as a function of barometric pressure.

- GEAR\_CUR = Current transmission gear.

- SPD\_RATIO = Speed ratio across the torque converter.

- TM\_CRV\_UNLK = Timer for converter clutch scheduled relocks.

- TP = Throttle position.

- TP\_REL\_H = Relative TP (TP - RATCH) high byte only.

- TPBARTC = UROLAV(TP,TCTPTC)

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission,

Bit Flags:

- FLG\_CRV\_DS = Scheduled lockup desired from curve flag.

- FLG\_CRV\_LST = Last pass value of FLG\_CRV\_DS.

- FLG\_FRST\_CM = First time a shift is commanded flag; 0 -> no shift

commanded this background pass, 1 -> shift commanded this background

pass.

- FLG\_SCHD\_DLY = Scheduled unlock flag.

- FLG\_SFT\_IN = Shift in progress flag.

- FLG\_UNC\_UNLK = Converter clutch unconditional unlock flag; 0 -> no

unconditional unlock, 1 -> unconditional unlock.

- FLG\_UN\_BRK = Brake applied unconditional unlock flag; 0 -> brake not

applied, 1 -> brake applied.

- FLG\_UN\_CT = Closed throttle unconditional unlock flag; 0 -> not closed

throttle, 1 -> closed throttle.

Calibration Constants:

- ALTDLY = Time to delay scheduled lockups at intermediate altitudes, sec.

- BPUNMN = Minimum BP to unlock converter clutch.

18-29

CONVERTER CLUTCH SOLENOID CONTROL, SCHEDULED LOCK/UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- BPUNMX = Maximum BP altitude unlock delay, " Hg.

- CRVDLY = Time to delay scheduled lockups after STEADYSRLK1 throttle

achieved, sec.

- FN2LA(TP\_REL\_H) = Delta vehicle speed for 2nd gear lockup at altitude:

Input TP\_REL\_H, counts; Output vehicle speed, MPH.

- FN2LS(TP\_REL\_H) = Vehicle speed for 2nd gear lockup at sea level: Input

TP\_REL\_H, counts; Output vehicle speed, MPH.

- FN2UA(TP\_REL\_H) = Delta Vehicle speed for 2nd gear unlock at altitude:

Input TP\_REL\_H, counts; Output vehicle speed, MPH.

- FN2US(TP\_REL\_H) = Vehicle speed for 2nd gear unlock at sea level: Input

TP\_REL\_H, counts; Output vehicle speed, MPH.

- FN3LA(TP\_REL\_H) = Delta vehicle speed for 3rd gear lockup at altitude:

Input TP\_REL\_H, counts; Output vehicle speed, MPH.

- FN3LS(TP\_REL\_H) = Vehicle speed for 3rd gear lockup at sea level: Input

TP\_REL\_H, counts; Output vehicle speed, MPH.

- FN3UA(TP\_REL\_H) = Delta Vehicle speed for 3rd gear unlock at altitude:

Input TP\_REL\_H, counts; Output vehicle speed, MPH.

- FN3US(TP\_REL\_H) = Vehicle speed for 3rd gear unlock at sea level: Input

TP\_REL\_H, counts; Output vehicle speed, MPH.

- FN4LA(TP\_REL\_H) = Delta vehicle speed for 4th gear lockup at altitude:

Input TP\_REL\_H, counts; Output vehicle speed, MPH.

- FN4LS(TP\_REL\_H) = Vehicle speed for 4th gear lockup at sea level: Input

TP\_REL\_H, counts; Output vehicle speed, MPH.

- FN4UA(TP\_REL\_H) = Delta Vehicle speed for 4th gear unlock at altitude:

Input TP\_REL\_H, counts; Output vehicle speed, MPH.

- FN4US(TP\_REL\_H) = Vehicle speed for 4th gear unlock at sea level: Input

TP\_REL\_H, counts; Output vehicle speed, MPH.

- SRLK2 = Minimum speed ratio for scheduled 2nd gear lockup.

- SRLK3 = Minimum speed ratio for scheduled 3rd gear lockup.

- SRLK4 = Minimum speed ratio for scheduled 4th gear lockup.

- SW\_RLK = Closed throttle/brake hysteresis switch; 0 -> unlock in

hysteresis zone, 1 -> remain locked in hysteresis zone.

- TPUNCT = Maximum relative TP for closed throttle unlock.

- TPUNCH = Hysteresis for TPUNCT.

18-30

CONVERTER CLUTCH SOLENOID CONTROL, SCHEDULED LOCK/UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- TM\_CRV\_UNLK = Timer for converter clutch scheduled relocks.

Bit Flags:

- FLG\_CRV\_DS = See above.

- FLG\_CRV\_LK = Scheduled curve lock-up flag; 0 -> no scheduled lock-up, 1

-> scheduled lock-up.

- FLG\_CRV\_LST = See above.

- FLG\_SCHD\_DLY = See above.

PROCESS

STRATEGY MODULE: CCC\_SCHLD\_LCK\_UNLCK\_COM1

always --------------------------------------| FLG\_CRV\_LST = FLG\_CRV\_DS

FLG\_UN\_CT = 1 -------------------|

|OR --|

FLG\_UN\_BRK = 1 ------------------| |

|AND -| No change to FLG\_CRV\_DS

SW\_RLK = 1 ----------------------------| | Retain last state while

| in hysteresis zone

|

| --- ELSE ---

|

FLG\_UNC\_UNLK = 1 ----------------------------| FLG\_CRV\_DS = 0

(Unconditional unlock)

18-31

CONVERTER CLUTCH SOLENOID CONTROL, SCHEDULED LOCK/UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

GEAR\_CUR = 2 --------------------------|

|

SPD\_RATIO >= SRLK2 --------| |

(Speed ratio high enough) | |

|AND -| |

FLG\_SFT\_IN = 0 ------------| | |

(Not shifting) |OR --|AND -| FLG\_CRV\_DS = 1

| | |

FLG\_SFT\_IN = 1 ------------------| | |

(Shifting disregard speed ratio) | |

| |

VSBART\_RT > FN2LS + [BP\_INTR \* FN2LA] -| |

| --- ELSE ---

GEAR\_CUR = 3 --------------------------| |

| |

SPD\_RATIO >= SRLK3 --------| | |

(Speed ratio high enough) | | |

|AND -| | |

FLG\_SFT\_IN = 0 ------------| | | |

(Not shifting) |OR --|AND -| FLG\_CRV\_DS = 1

| | |

FLG\_SFT\_IN = 1 ------------------| | |

(Shifting - disregard speed ratio) | |

| |

VSBART\_RT > FN3LS + [BP\_INTR \* FN3LA] -| |

| --- ELSE ---

GEAR\_CUR = 4 --------------------------| |

| |

SPD\_RATIO >= SRLK4 ---------| | |

|AND -| | |

FLG\_SFT\_IN = 0 -------------| |OR -|AND -| FLG\_CRV\_DS = 1

| | |

FLG\_SFT\_IN = 1 -------------------| | |

| |

VSBART\_RT > FN4LS + [BP\_INTR \* FN4LA] -| |

| --- ELSE ---

|

GEAR\_CUR = 1 --------------------------------| FLG\_CRV\_DS = 0

|

| --- ELSE ---

GEAR\_CUR = 2 --------------------------| |

|AND -| FLG\_CRV\_DS = 0

VSBART\_RT < FN2US + [BP\_INTR \* FN2UA] -| |

| --- ELSE ---

GEAR\_CUR = 3 --------------------------| |

|AND -| FLG\_CRV\_DS = 0

VSBART\_RT < FN3US + [BP\_INTR \* FN3UA] -| |

| --- ELSE ---

GEAR\_CUR = 4 --------------------------| |

|AND -| FLG\_CRV\_DS = 0

VSBART\_RT < FN4US + [BP\_INTR \* FN4UA] -| |

| --- ELSE ---

|

| No change to FLG\_CRV\_DS

18-32

CONVERTER CLUTCH SOLENOID CONTROL, SCHEDULED LOCK/UNLOCK LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FLG\_FRST\_CM = 1 -----------------------------| FLG\_SCHD\_DLY = 0

(Shift is commanded) | (Shift about to occur, do not

| check steady state criteria)

|

| --- ELSE ---

FLG\_CRV\_DS = 0 ------------------------| |

| |

FLG\_CRV\_LST = 1 -----------------------|AND -| FLG\_SCHD\_DLY = 1

| | (Set flag to indicate

FLG\_UNC\_UNLK = 0 ----------------------| | scheduled unlock. Apply

(Unlock transition due | steady state throttle

solely to schedule) | criteria for relock)

FLG\_SCHD\_DLY = 1 ----------------------|

|

FLG\_CRV\_DS = 1 ------------------------|AND -| TM\_CRV\_UNLK = CRVDLY

(Relock after scheduled unlock) | | (If throttle is not steady

| | state load delay timer)

|TP - TPBARTC| >= TPUNSC --------------| |

(Throttle not steady state)

FLG\_CRV\_LST = 0 -----------------------|

|

FLG\_CRV\_DS = 1 ------------------------|AND -| TM\_CRV\_UNLK = ALTDLY

(Scheduled lock desired) | | (Delay scheduled relock at

| | altitude)

BPUNMN < BP < BPUNMX ------------------|

(Intermediate altitude)

TM\_CRV\_UNLK = 0 -----------------------------| FLG\_CRV\_LK = FLG\_CRV\_DS

| (Allow desired state to pass

| through)

| FLG\_SCHD\_DLY = 0

| (Reset steady state relock

| flag)

18-33

CONVERTER CLUTCH CONTROL, WOT LOCK-UP LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

WOT LOCK-UP LOGIC

DEFINITIONS

INPUTS

Registers:

- GEAR\_OLD = Last commanded gear.

- NEBART = Filtered engine speed, RPM.

- PDL = Current PRNDL position.

- RLKCTR = WOT converter clutch relock counter.

- SPD\_RATIO = Speed ratio across the torque converter.

- TP\_REL = Relative Throttle Position.

Bit Flags:

- FLG\_LK\_CM = Converter clutch lock-up commanded flag; 0 -> de-energize

solenoid, unlock converter clutch, 1 -> energize solenoid, lock converter

clutch.

- FLG\_RLK\_WOT = WOT relock first pass flag.

Calibration Constants:

- NELKWH = Hysteresis for NELKWOd, RPM.

- NELKWO = Minimum RPM for converter clutch WOT lockup, RPM.

- RTLKWO = Minimum speed ratio for 1st gear WOT converter clutch lockup.

- RTLKWH = Hysteresis for RTLKWO.

- TPLKWO = Minimum TP for converter clutch WOT lockup, counts.

- TPLKWH = TPLKWO hysteresis for converter clutch WOT lockup, counts.

OUTPUTS

Registers:

- RLKCTR = See above.

Bit Flags:

- FLG\_RLK\_WOT = See above.

- FLG\_WOT\_LK = WOT lock-up flag; 0 -> no WOT lock-up, 1 -> WOT lock-up.

18-34

CONVERTER CLUTCH CONTROL, WOT LOCK-UP LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_WOT\_LCK\_UP\_COM1

TP\_REL < TPLKWO - TPLKWH ------|

(low TP) |

|

TP\_REL >= TPLKWO -------| |OR ---| RLKCTR = 1

(high TP) | | | FLG\_RLK\_WOT = 0

| | | (not at WOT or at WOT

GEAR\_CUR <> 1 ----------|AND --| | in higher gear. Set up

(not 1st gear) | | for next time.)

| |

PDL <> 2 ---------------| |

(not manual 2) | --- ELSE ---

|

NEBART > NELKWO ----------------------| FLG\_RLK\_WOT = 1

(above engine torque peak) | (set first pass relock flag)

|

| --- ELSE ---

NEBART > NELKWO - NELKWH ------| |

(in hystersis zone) | |

| |

FLG\_LK\_CM = 1 -----------------|AND --| FLG\_RLK\_WOT = 0

(currently locked) | | RLKCTR = RLKCTR + 1

| | (RPM is dropping with a

FLG\_RLK\_WOT = 1 ---------------| | locked converter. Increment

(rpm was high) | counter to relock at a

| higher speed ratio next time

| and clear first pass flag)

|

| --- ELSE ---

|

| Do Not Change

| FLG\_RLK\_WOT or RLKCTR

18-35

CONVERTER CLUTCH CONTROL, WOT LOCK-UP LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TP\_REL >= TPLKWO ---------------------|

(at WOT) |

|

GEAR\_CUR <> 1 ----------| |AND --|S Q -| FLG\_WOT\_LK = 1

(not 1st gear) |AND --| | | | (at WOT in high enough

| | | | | gear or high enough

PDL <> 2 --------------| | | | | rpm and speed ratio;

(not manual 2) |OR ---| | | lock up converter

| | | regardless of lockup

NEBART > NELKWO --------| | | | curves)

(above torque peak) | | | |

|AND --| | | --- ELSE ---

SPD\_RATIO >= RTLKWO + | | |

(RTLKWH \* RLKCTR) --| | | FLG\_WOT\_LK = 0

(above speed ratio | | (not at WOT or rpm or

for lockup) | | speed ratio too low;

| | use normal lockup

TP\_REL < TPLKWO - TPLKWH -------------| | | curves)

| |

NEBART <= NELKWO - NELKWH ------------|OR ---|C

|

SPD\_RATIO < RTLKWO + |

(RTLKWH \* RLKCTR) -------|

18-36

CONVERTER CLUTCH SOLENOID CONTROL, HIGH SPEED UPSHIFT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HIGH SPEED UPSHIFT

DEFINITIONS

INPUTS

Registers:

- DT12S\_AVG = Filtered PIP period for transmission, ticks.

- NOBART = Filtered output shaft speed, RPM.

- RT\_GR\_CUR = Current transmission gear ratio.

- SR\_PP\_LIM = Power on upshift speed ratio, PIP-to-PIP limit.

Bit Flags:

- FLG\_HS\_LK = High speed upshift relock control flag.

- FLG\_HS\_UNLK = High speed upshift unlock control flag.

- FLG\_LK\_CM = Converter clutch lock-up commanded flag; 0 -> de-energize

solenoid, unlock converter clutch, 1 -> energize solenoid, lock converter

clutch.

Calibration Constants:

- PUL\_PER\_REV = Pulses per revolution. Number of PIPs per engine

revolution for E4OD gas; 1/2 the number of fuel pump teeth for

E4OD\_DIESEL.

OUTPUTS

Registers:

- SR\_PP\_LIM = See above.

Bit Flags:

- FLG\_HS\_LK = See above.

- FLG\_HS\_UNLK = See above.

- FLG\_LK\_CM = See above.

- FLG\_SFT\_UNLK = Shift control unlock flag; 0 -> no shift control unlock, 1

-> shift control unlock.

18-37

CONVERTER CLUTCH SOLENOID CONTROL, HIGH SPEED UPSHIFT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CONVERTER\_CLUTCH\_REPEAT\_COM3

HIGH SPEED UPSHIFT SPEED RATIO CHECK

(Executed during 1 msec repeater)

FLG\_HS\_UNLK = 1 ----------------|

(Look for unlock speed ratio) |

|AND -| FLG\_HS\_UNLK = 0

DT12S\_AVG > SR\_PP\_LIM ----------| | (Disable high speed unlock check)

(Speed ratio high enough) |

| FLG\_SFT\_UNLK = 1

| (Request conv. clutch unlock)

|

| FLG\_LK\_CM = 0

| (Unlock conv. clutch)

|

| --- ELSE ---

FLG\_HS\_LK = 1 ------------------| |

(Look for relock speed ratio) | |

|AND -| FLG\_HS\_LK = 0

DT12S\_AVG > SR\_PP\_LIM ----------| | (Disable high speed relock check)

(Speed ratio high enough) |

| FLG\_SFT\_UNLK = 0

| (End upshift unlock)

NOTE: SR\_PP\_LIM is computed each background pass.

"SPEED RATIO CALIBRATION PARAMETER" \* 60

SR\_PP\_LIM = ----------------------------------------

NOBART \* RT\_GR\_CUR \* PUL\_PER\_REV

CONVERTER CLUTCH OUTPUT CONTROL

(Executed during 1 msec repeater)

FLG\_LK\_CM = 1 ------------------| Energize conv. clutch output

| to apply converter clutch

|

| --- ELSE ---

|

FLG\_LK\_CM = 0 ------------------| De-energize conv. clutch output

| to release converter clutch

18-38

CONVERTER CLUTCH CONTROL, CONVERTER CLUTCH VALIDATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CONVERTER CLUTCH VALIDATION

OVERVIEW

The converter clutch validation logic verifies that the engine speed over

vehicle speed computation is consistent. This in turn verifies that the

converter clutch was applied.

The actual computed N/V divided by the base N/V should equal the N/V ratio

stored in KAM. If the ratio remains consistent, it verifies that the

converter clutch was applied during the actual N/V calculation.

If these do not equal, then either:

a) the converter clutch was not applied during the actual N/V calculation

--- OR ---

b) the converter clutch was not applied when the original N/V KAM

calculation was made.

In either case, there was a fault with converter clutch, and an error code is

flagged.

If the converter clutch was not applied when the N/V value was stored in KAM,

yet the current calculation matches the incorrect KAM value, then no error is

stored. It is, however, highly probable that the actual N/V computation will

differ from the KAM value eventually during the vehicle operation (since the

converter is not applied), and the error will be noted at that time.

DEFINITIONS

INPUTS

Registers:

- C628CNT = Warm up cycle counter for code 628.

- C628\_KAM\_BIT = Code 628 KAM bit.

- NOV\_ACT = Actual N/V calculation.

- RT\_NOVS\_KAM = N/V value stored in KAM.

- TP\_REL = Relative TP (TP - RATCH)

18-39

CONVERTER CLUTCH CONTROL, CONVERTER CLUTCH VALIDATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- FLG\_FRST\_NOV = Flag indicating a new value has been stored in RT\_NOVS\_KAM

during current power-up.

- FLG\_NEW\_NOV = Flag, if set to 1, indicates a new NOV\_ACT has been

calculated.

- FLG\_4X4L = 4x4l flag, 0 -> not in 4x4 low mode, 1 -> in 4x4 low mode

Calibration Constants:

- CCE\_TPMN = Minimum TP required to do converter clutch validation logic.

- CC\_FM\_LVL = number of warm up cycles converter clutch failure mode action

will be executed after a fault is detected.

- NOV\_ERR\_BAND = Error band allowed on the N/V calculation.

- NVBASE = Base N/V.

OUTPUTS

Bit Flags:

- CC\_FM\_FLG = Converter clutch failure mode flag; 0 -> normal operation, 1

-> Converter clutch failure mode

18-40

CONVERTER CLUTCH CONTROL, CONVERTER CLUTCH VALIDATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_VALID\_COM2

FLG\_4X4L = 0 --------------------------|

(not in 4x4 low) |

|

FLG\_FRST\_NOV = 1 ----------------------|

(new NOV ratio stored in KAM) |

|

FLG\_NEW\_NOV = 1 -----------------------|AND -|

(new NOV\_ACT calculated) | |

| | error\_detected := 1

|NOV\_ACT | | | (converter clutch

|------- - RT\_NOVS\_KAM| > NOV\_ERR\_BAND-| | inoperative)

| NVBASE | | | DO: FAULT FILTER for code

| | 628 procedure

TP\_REL > CCE\_TPMN ---------------------| |

| --- ELSE ---

FLG\_FRST\_NOV = 1 ----------------------| |

|AND -| (converter clutch operative)

FLG\_NEW\_NOV = 1 -----------------------| | DO: FAULT FILTER for code

| 628 procedure

C628\_KAM\_BIT = 1 --------------------|

(converter clutch error detected) |AND -| CC\_FM\_FLG = 1

| | (fault detected, execute

C628CNT < CC\_FM\_LVL -----------------| | converter clutch failure

(not enough warm up cycles since | mode action)

error detection to exit failure |

mode action) | --ELSE--

|

| CC\_FM\_FLG = 0

| (no fault deteced or enough

| warm up cycles have passed

| since detection to exit

| converter clutch failure mode)

18-41

CONVERTER CLUTCH CONTROL, COAST CLUTCH CONTROL - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

COAST CLUTCH CONTROL

OVERVIEW

The coast clutch is a clutch used to provide engine braking in 3rd gear when

the PRNDL is in the drive position. Without the coast clutch the

transmission would free-wheel in third gear while the vehicle was coasting.

\* In overdrive, the coast clutch is hydraulically off. Engine braking is

provided by the overdrive clutch in fourth gear.

\* In drive, the software turns on the coast clutch to provide engine

braking. A short delay is provided to allow the overdrive clutch to

release fully.

\* In manual 2 or 1 the coast clutch is applied hydraulically. Intermediate

band application is delayed until the coast clutch actually engages as

inferred by the shift in progress timer. This is to prevent the

intermediate band from absorbing excessive driveline deceleration energy

which could be better handled by the larger coast clutch.

\* If the vehicle speed sensor has failed, the coast clutch is applied in

all gears below fourth to provide engine braking and prevent rapid

free-wheeling downshifts to first gear when the throttle is closed.

DEFINITIONS

INPUTS

Registers:

- GR\_CM = Commanded gear for shift solenoids.

- GR\_OLD = Last commanded gear.

- PDL = Current PRNDL position.

- PDL\_LST = PRNDL position last background pass.

- TM\_CS\_DLY = Timer to delay coast clutch application.

- TM\_CS\_ENG = Timer for coast clutch to engage.

Bit Flags:

- FLG\_CS\_CM = Coast clutch commanded output state; 1 -> command coast

clutch on, 0 -> command coast clutch off.

- FLG\_CS\_FRST = Coast clutch engagement first pass flag; 1 -> first time

coast clutch engages, 0 -> not first time for coast clutch engagement.

- FLG\_DEL\_MDN = Flag which indicates a manual downshift is being delayed; 0

-> no manual downshift is being delayed, 1 -> a manual downshift is being

delayed.

18-42

CONVERTER CLUTCH CONTROL, COAST CLUTCH CONTROL - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FLG\_FRST\_CM = First time a shift is commanded flag; 1 -> shift commanded

this background pass, 0 -> no shift commanded this background pass.

- FLG\_PWR = Power mode flag; 1 -> power on mode, 0 -> power off mode.

- FLG\_SFT\_MDN = Power off manual downshift flag; 1 -> power off manual

downshift in progress, 0 -> power off manual downshift not in progress.

Calibration Constants:

- TMCSE2 = Time for coast clutch to engage, PDL = 2 or 1.

- TMCSE3 = Time for coast clutch to engage, PDL = 3.

- TMCSOD = Time to delay coast clutch when PDL = 3.

OUTPUTS

Registers:

- TM\_CS\_DLY = See above.

- TM\_CS\_ENG = See above.

Bit Flags:

- FLG\_CS\_CM = See above.

18-43

CONVERTER CLUTCH CONTROL, COAST CLUTCH CONTROL - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_CST\_CLTCH\_CTL\_COM1

TM\_CS\_DLY TIMER CONTROL

FLG\_FRST\_CM = 1 -------------|

(shift commanded) |

|AND -| TM\_CS\_DLY = TMCSOD

GR\_OLD = 4 ------------------| | (delay coast clutch engagement

| | in third gear to prevent two

GR\_CM = 3 -------------------| | elements being on at once)

TM\_CS\_ENG TIMER CONTROL

PDL = 3 ---------------------|

(PRNDL = 3) |

|

FLG\_CS\_CM = 1 ---------------|AND -| TM\_CS\_ENG = TMCSE3

(coast clutch commanded on) | | (coast clutch will be engaged when

| | timer expires)

FLG\_CS\_FRST = 0 -------------| | FLG\_CS\_FRST = 1

(1st pass thru) | (set first pass flag)

|

| --- ELSE ---

PDL = 1 ---------------| |

|OR --| |

PDL = 2 ---------------| | |

(M1 or M2) | |

|AND -| TM\_CS\_ENG = TMCSE2

PDL\_LST = 4 -----------------| | (coast clutch will be engaged when

(4-2 or 4-1) | | timer expires)

| | FLG\_CS\_FRST = 1

FLG\_CS\_FRST = 0 -------------| | (set first pass flag)

(first pass thru)

18-44

CONVERTER CLUTCH CONTROL, COAST CLUTCH CONTROL - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

COAST CLUTCH OUTPUT CONTROL

GR\_DS\_TV = 4 ----------------------| FLG\_CS\_CM = 0

| (verifing a 3-4 upshift, de-energize

| Coast clutch)

|

| --- ELSE ---

CS\_PDL\_4 = 1 ----------| |

| |

PDL <= 3 --------------|OR --| |

| | |

VSFMFLG = 1 -----------| | |

|AND -| FLG\_CS\_CM = 1

TM\_CS\_DLY = 0 ---------------| | (energize coast clutch output)

| |

GR\_CM <> 4 ------------------| |

| --- ELSE ---

|

| FLG\_CS\_CM = 0

| (de-energize coast clutch output.

| Coast clutch is off hydraulically

| in 4th. Coast clutch is on

| hydraulically when PDL = 2 or 1)

INFER COAST CLUTCH ENGAGEMENT

FLG\_CS\_CM = 0 ---------------------| FLG\_CS\_ENG = 0

| (coast clutch is hydraulically off)

| FLG\_CS\_FRST = 0

|

| --- ELSE ---

TM\_CS\_ENG = 0 ---------| |

(timer expired) | |

|AND -| |

TM\_CS\_DLY = 0 ---------| | |

| | |

FLG\_PWR = 1 -----------| |OR --| FLG\_CS\_ENG = 1

(power on) | | (coast clutch is inferred to be

| | on. Once on, it remains on until

FLG\_SFT\_MDN = 0 -------| | | the PRNDL goes to overdrive

(manual downshift |AND -| | position)

complete |

|

FLG\_PWR = 0 -----------|

(power off) |

|

FLG\_DEL\_MDN = 0 -------|

(manual downshift

delay is complete)

18-45

CONVERTER CLUTCH CONTROL, FAILURE MODE MANAGEMENT LOCK-UP - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FAILURE MODE MANAGEMENT LOCK-UP

OVERVIEW

This module determines converter clutch lock-ups during a TP Sensor or a

Vehicle Speed Sensor failure. If the Vehicle Speed Sensor fails, locks are

based on a function of NEBART and TP\_REL. If the TP Sensor fails, locks are

based on SPD\_RATIO.

Once an FMEM lock-up is requested, locks continue to be based on this module,

until the next power-up.

Unlocks occur as a result of Unconditional unlocks only.

DEFINITIONS

INPUTS

Registers:

- NEBART = Filter engine speed, RPM.

- SPD\_RATIO = Speed Ratio across the torque converter.

Bit Flags:

- FLG\_FMM\_LK = Failure Mode Management lock-up flag; 1 -> lock converter

due to FMEM action.

- FLG\_FMM\_CC = Flag used to insure once FMEM lock-up is activated, it is

not de-activated until next power-up; 0 -> Failure mode lock-up is not in

use this power-up, 1 -> Failure mode lock-up is in use this power-up.

- FLG\_UNC\_UNLK = Converter clutch unconditional unlock flag; 0 -> no

unconditional unlock, 1 -> unconditional unlock.

- TFMFLG = TP FMEM flag; 0 -> no TP failure, 1 -> TP failure, operating in

FMEM mode.

- VSFMFLG = Vehicle speed sensor failure flag; 1 -> VSS failure, 0 -> no

VSS failure.

18-46

CONVERTER CLUTCH CONTROL, FAILURE MODE MANAGEMENT LOCK-UP - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- FN689L(TP\_REL) = Engine Speed to lock converter when TP sensor is still

available, for Failure Mode Management, RPM.

- NELK\_FM = Engine Speed to lock converter when TP sensor has failed, for

Failure Mode Management, RPM.

- SRLK\_FM = Speed Ratio to lock converter for Failure Mode Management.

OUTPUTS

Bit Flags:

- FLG\_FMM\_LK = Failure Mode Management lock-up flag; 1 -> lock converter

due to FMEM action.

- FLG\_FMM\_CC = Flag used to insure once FMEM lock-up is activated, it is

not de-activated until next power-up; 0 -> Failure mode lock-up is not in

use this power-up, 1 -> Failure mode lock-up is in use this power-up.

18-47

CONVERTER CLUTCH CONTROL, FAILURE MODE MANAGEMENT LOCK-UP - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: CCC\_FMEM\_COM2

FLG\_FMM\_LK = 1 -----------------------------------|

(Failure Mode Lock Requested) |AND -| FLG\_FMM\_LK = 0

| | (Reset FMEM

FLG\_UNC\_UNLK = 1 ---------------------------------| | lock-up flag)

(Unconditional Unlock Requested)

VSFMFLG = 1 --------------------------------|

(VS Sensor failure) |

|

TFMFLG = 0 ---------------------| |AND -|

(TP Sensor OK) |AND -| | |

| | | |

NEBART > FN689L(TP\_REL) --------| | | |

(Engine Speed above failure |OR --| |

mode minimum) | |OR --| FLG\_FMM\_LK = 1

| | | FLG\_FMM\_CC = 1

TFMFLG = 1 ---------------------| | | | (Continue with

(TP Sensor failure) |AND -| | | FMEM Lock-up

| | | until next

NEBART > NELK\_FM ---------------| | | power-up)

(Engine Speed above failure |

mode minimum) |

|

TFMFLG = 1 ---------------------------| |

(TP Sensor Failure) |OR --| |

| | |

FLG\_FMM\_CC = 1 -----------------------| |AND -|

(FMEM lock-up activated this power-up) |

|

SPD\_RATIO > SRLK\_FM ------------------------|

(Speed Ratio above failure mode minimum)

18-48

CHAPTER 19

TRANSMISSION INPUT CONVERSIONS

19-1

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL INDICATOR LIGHT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TRANSMISSION CONTROL INDICATOR LIGHT

OVERVIEW

The Transmission Control Indicator Light (TCIL), located in the instrument

panel, visually indicates the status of "Transmission Control" to the driver,

or alerts the driver to certain transmission faults. If not indicating a

fault, the light is on when overdrive is canceled; off when overdrive is

enabled. A flashing light indicates a transmission fault. The transmission

control switch and inhibition of fourth gear will continue to operate

normally in the flashing mode, but there is no visual indication of cancel

mode.

To disable flashing for any fault, set TCIL\_TM\_DLY = 31.875.

To enable flashing for specific faults, set TCIL\_TM\_DLY < 31.875, and set the

calibration switch for that fault = 1. For example, to flash the TCIL for

converter clutch errors and shift errors, set CC\_ERR\_SW = 1 and SFT\_ERR\_SW =

1, and all remaining switches = 0.

NOTE: The OFMFLG does not have a switch associated with it. When

TCIL\_TM\_DLY < 31.875, the TCIL flash for an EPC short circuit, regardless of

the state of any of the calibration switches.

DEFINITIONS

INPUTS

Registers:

- TCILTMR = Time since transmission fault occurred, sec.

- TCIL\_FLASH\_TMR = Time since TCIL changed states in flashing mode, sec.

Bit Flags:

- CC\_FM\_FLG = converter clutch failure mode flag; 0 -> normal action, 1 ->

execute converter clutch failure mode action.

- CRKFLG = Flag indicating engine mode status; 0 -> not in CRANK mode, 1 ->

in CRANK mode.

- EPC\_OPEN\_FLG = Indicates EPC open circuit; 1 -> EPC open circuit

detected.

- FLG\_TCS = Transmission Control flag; 0 -> overdrive enable, 1 ->

overdrive lockout mode.

- OFMFLG = Flag indicating that an EPC solenoid short circuit failure has

been detected; 0 -> EPC solenoid circuit not shorted, 1 -> EPC solenoid

circuit shorted.

- OTEMP\_FM\_FLG = Transmission overtemperature FMEM flag; 1 -> Transmission

is overtemperature, 0 -> Transmission temperature okay.

19-2

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL INDICATOR LIGHT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- MFMFLG = MAP sensor FMEM flag; 1 -> MAP sensor failure, 0 -> MAP sensor

okay.

- PDL\_ERROR = PRNDL error flag; 1 -> PRNDL error, 0 -> PRNDL okay.

- SFT\_FM\_FLG = Flag indicating whether 1-2 or 2-3 or 3-4 shifts are failing

to occur properly; 0 -> shifts OK, 1 -> Shifts not OK.

- STIFLG = Flag which, if set, indicates Self Test has been requested.

- TCIL\_STATE = Flag indicating state of TCIL; 0 -> TCIL off, 1 -> TCIL on.

- TFMFLG = TP FMEM flag; 0 -> no TP failure, 1 -> TP failure, operating in

FMEM mode.

- VSFMFLG = Vehicle Speed FMEM flag; 1 -> Vehicle speed sensor failure, 0

-> Vehicle speed sensor okay.

Calibration Constants:

- CC\_ERR\_SW = Calibration selection switch to enable/disable flashing TCIL

for converter clutch error; 0 -> disable, 1 -> enable.

- EPC\_ERR\_SW = Calibration selection switch to enable/disable flashing TCIL

for EPC open circuit error; 0 -> disable, 1 -> enable.

- PDL\_ERR\_SW = Calibration selection switch to enable/disable flashing TCIL

for PRNDL error; 0 -> disable, 1 -> enable.

- MAP\_ERR\_SW = Calibration selection switch to enable/disable flashing TCIL

for MAP sensor failure; 0 -> disable, 1 -> enable.

- OTEMP\_ERR\_SW = Calibration selection switch to enable/disable flashing

TCIL for Transmission overtemperature condition; 0 -> disable, 1 ->

enable.

- SFT\_ERR\_SW = Calibration selection switch to enable/disable flashing TCIL

for Shift Errors; 0 -> disable, 1 -> enable.

- TCILTM1 = Flashing TCIL "ON"/"OFF" time period, sec.

- TCIL\_TM\_DLY = Time after fault has occurred before the TCIL begins to

flash, sec. Set to 31.875 to disable flashing.

- TP\_ERR\_SW = Calibration selection switch to enable/disable flashing TCIL

for TP sensor failure; 0 -> disable, 1 -> enable.

- VS\_ERR\_SW = Calibration selection switch to enable/disable flashing TCIL

for VS Sensor failure; 0 -> disable, 1 -> enable.

19-3

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL INDICATOR LIGHT - LHBH0

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OUTPUTS

Registers:

- TCILTMR = See above.

- TCIL\_FLASH\_TMR = See above.

Bit Flags:

- TCIL\_STATE = See above.

19-4

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL INDICATOR LIGHT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_TCIL\_STATE\_COM1

FLG\_TCS = 0 -----------------------|

(overdrive enable) |AND -|

| |

STIFLG = 1 ------------------| | |

(in Self Test) |OR --| |

| |OR --| (turn TCIL off)

TCILTMR <= TCIL\_TM\_DLY ------| | | TCIL\_STATE = 0

(flashing mode entry delay) | | TCIL\_FLASH\_TMR = 0

| |

TCIL\_FLASH\_TMR >= TCILTM1 ---------| | |

(flashing period expired) |AND -| |

| |

TCIL\_STATE = 1 --------------------| |

(TCIL currently on) |

| --- ELSE ---

FLG\_TCS = 1 -----------------------| |

(overdrive lockout mode) |AND -| |

| | |

STIFLG = 1 ------------------| | | |

|OR --| |OR --| (turn TCIL on)

TCILTMR <= TCIL\_TM\_DLY ------| | | TCIL\_STATE = 1

| | TCIL\_FLASH\_TMR = 0

TCIL\_FLASH\_TMR >= TCILTM1 ---------| | |

|AND -| |

TCIL\_STATE = 0 --------------------| |

(TCIL currently off) |

| --- ELSE ---

|

| Do not change TCIL\_STATE

| Increment TCIL\_FLASH\_TMR

19-5

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL INDICATOR LIGHT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TCILTMR LOGIC

STIFLG = 1 ------------------------------|

|

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

|

OFMFLG = 0 ------------------------| |

| |

SFT\_ERR\_SW = 0 --------------| | |

|OR --| |

SFT\_FM\_FLG = 0 --------------| | |

| |OR --| TCILTMR = 0

CC\_ERR\_SW = 0 ---------------| | | |

|OR --| | |

CC\_FM\_FLG = 0 ---------------| | | |

| | |

EPC\_OPEN\_FLG = 0 ------------| | | |

|OR --| | |

EPC\_ERR\_SW = 0 --------------| | | |

| | |

PDL\_ERROR = 0 ---------------| | | |

|OR --| | |

PDL\_ERR\_SW = 0 --------------| |AND -| |

| |

OTEMP\_FM\_FLG = 0 ------------| | |

|OR --| |

OTEMP\_ERR\_SW = 0 ------------| | |

| |

TFMFLG = 0 ------------------| | |

|OR --| |

TP\_ERR\_SW = 0 ---------------| | |

| |

MFMFLG = 0 ------------------| | |

|OR --| |

MAP\_ERR\_SW = 0 --------------| | |

| |

VSFMFLG = 0 -----------------| | |

|OR --| |

VS\_ERR\_SW = 0 ---------------| |

| --- ELSE ---

|

| Increment TCILTMR

19-6

TRANSMISSION INPUT CONVERSIONS, TCIL OUTPUT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TCIL OUTPUT

OVERVIEW

The Transmission Control Indicator Light (TCIL), located in the instrument

panel, visually indicates the status of "Overdrive Cancel" to the drive, or

alerts the driver to certain transmission fault. If not indicating a fault,

the light is on when overdrive is canceled; off when overdrive is enabled. A

flashing light indicates a transmission fault. The transmission control

switch and inhibition of fourth gear will continue to operate normally, but

since the light is flashing, there is no visual indication of cancel mode

selection.

DEFINITIONS

INPUTS

Bit Flags:

- TCIL\_STATE = Flag indicating state of TCIL; 0 -> TCIL off, 1 -> TCIL on.

PROCESS

STRATEGY MODULE: INTRN\_TCIL\_REPEAT\_COM1

TCIL\_STATE = 0 -----------| De-engerize TCIL output

(normal overdrive and | (turns off the transmisison control light since

start-up mode) | the turned off transistor provides no ground

| for the light)

|

| --- ELSE ---

|

TCIL\_STATE = 1 -----------| Energize TCIL output

(overdrive lockout mode) (turns on the transmission control light since

the turned on transistor provides a ground for

the light)

19-7

TRANSMISSION INPUT CONVERSIONS, TORQUE CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TORQUE CALCULATION

OVERVIEW

The engine output torque, or net torque, is calculated from a table of

indicated torque versus speed/load, determined at MBT spark timing, 14.6 A/F

ratio and no EGR. This torque value is then adjusted by multiplying by a

factor dependent on the difference between MBT spark (adjusted for actual EGR

flow), actual spark advance, and if in open loop fuel control, by a factor

dependent on the value of lambse. This value is then further reduced by

subtracting friction torque and accessory load torque. Net torque (TQ\_NET)

is used in the electronic transmission control strategy in calculating the

EPC required for "static capacity".

DEFINITIONS

INPUTS

Registers:

- AMT = Air Mass flow for torque calculation.

- ARCHG = Air charge inducted per intake stroke. Value is updated once per

background loop at the time that AMT is computed,lb.

- EGRACT = Actual EGR rate, \_%.

- ENGCYL = Number of injections per engine revolution = 2, 3, 4 for 4, 6,

and 8-cylinder engines respectively.

- LAMBSE = Air/fuel equivalence ratio.

- LOAD = Normalized air charge value (ARCHG/SARCHG).

- N = Engine speed, rpm.

- N\_BYTE = Byte value of engine speed, rpm.

- SAFTOT = Total spark advance, including knock and tip-in retard, deg

BTDC.

- SPD\_RATIO = Speed ratio across torque converter.

- SPK\_DELTA = Difference between MBT spark and SAFTOT, deg BTDC.

- SPK\_LAMBSE = Value of LAMBSE to be used in SPARK calculations, unitless.

- TLS\_24\_FLG = Torque limiting strategy - 1/2 fuel flag; 0 -> normal fuel,

1 -> 1/2 fuel.

- TLS\_34\_FLG = Torque limiting strategy - 3/4 fuel flag; 0 -> normal fuel,

1 -> 3/4 fuel.

- TQ\_NET = Net engine torque into transmission, ft-lb.

19-8

TRANSMISSION INPUT CONVERSIONS, TORQUE CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- ACCFLG = Air conditioning clutch status flag; 1 -> A/C on.

- OLFLG = Open Loop fuel flag: 1 -> open loop fuel; 0 -> closed loop fuel.

- TLS\_NV\_FLG = Engine speed/Vehicle speed limiting flag; 0 -> not limiting

speed, 1 -> limiting speed.

Calibration Constants:

- FN034A(LOAD) = LOAD normalizing function for torque calculation table

lookups.

- FN070C(N) = Engine speed normalizing function for torque calculation

table lookups.

- FN617(SPD\_RATIO) = Torque converter torque ratio.

- FN618(N\_BYTE) = Accessory load torque, less A/C load, ft-lb.

- FN619(N\_BYTE) = Air conditioning compressor load torque, ft-lb.

- FN621(SPK\_DELTA) = Indicated torque table (FN1615A) multiplier versus

SPK\_DELTA.

- FN623(LAMBSE) = Fuel multiplier used to calculate TQ\_NET in open loop.

- FN730(SPK\_LAMBSE) = Required adjustment to the base spark in order to

maintain MBT as the air/fuel ratio changes.

- FN1615A = Indicated engine torque at MBT spark and no EGR, ft-lb.

x = FN070C(N) = Normalized engine rpm.

y = FN034A(LOAD) = Normalized LOAD.

- FN1616 = Engine friction torque, ft-lb.

x = FN070C(N) = Normalized engine rpm.

y = FN034A(LOAD) = Normalized LOAD.

- FN1617 = MBT spark advance with no EGR, deg BTDC.

x = FN070C(N) = Normalized engine rpm.

y = FN034A(LOAD) = Normalized LOAD.

- MBTEGR = Number of degrees MBT spark increases per percent EGR, deg/\_%.

- SARCHG = Standard Aircharge = 4.4256E-05 \* CID / of cylinders.

- TCTTA = Time constant for torque truncation aircharge filtering.

OUTPUTS

Registers:

- ARCHG = See above.

19-9

TRANSMISSION INPUT CONVERSIONS, TORQUE CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- LOAD = Normalized air charge value (ARCHG/SARCHG).

- SPK\_DELTA = See above.

- SPK\_LAMBSE = See above.

- TQ\_NET = See above.

- TQ\_OFM = Transmission input torque, ft-lb.

PROCESS

STRATEGY MODULE: INTRN\_EQ\_TQ\_CALC\_COM2

TLS\_NV\_FLG = 1 ----|

|

TLS\_24\_FLG = 1 ----|OR --| ARCHG = UROLAV(AMT/[ENGCYL\*N], TCTTA)

(1/2 fuel) | | (Filter ARCHG in torque truncation)

| |

TLS\_34\_FLG = 1 ----| |

(3/4 fuel) | --- ELSE ---

|

| ARCHG = AMT/(ENGCYL \* N)

Always ---------| LOAD = ARCHG / SARCHG

| SPK\_DELTA = FN1617(N,LOAD) + MBTEGR \* EGRACT

| + FN730(SPK\_LAMBSE) - SAFTOT

(clip SPK\_DELTA to ZERO minimum)

OLFLG = 1 -----| TQ\_NET = [FN1615A(N,LOAD)\*FN621(SPK\_DELTA)\*FN623(LAMBSE)]

| - FN1616(N,LOAD) - FN618(N\_BYTE) [- FN619(N\_BYTE)]

| (clip TQ\_NET to ZERO minimum)

|

| --- ELSE ---

|

| TQ\_NET = FN1615A(N,LOAD)\*FN621(SPK\_DELTA) - FN1616(N,LOAD)

| - FN618(N\_BYTE) [- FN619(N\_BYTE)]

| (clip TQ\_NET to ZERO minimum)

always --------| TQ\_OFM = TQ\_NET \* FN617(SPD\_RATIO)

Note: "[ ]" indicates FN619 is not always included in TQ\_NET caculation.

The following logic controls FN619 usage:

ACCFLG = 1 --------| Include FN619 in TQ\_NET

|

| --- ELSE ---

|

| Do not include FN619 in TQ\_NET

19-10

TRANSMISSION INPUT CONVERSIONS, TORQUE CALCULATION - LHBH0

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SPK\_LAMBSE is one when the fuel calculation is closed loop because the

air/fuel mixture will be at stoichiometry regardless of the value of LAMBSE.

By assuming the SPK\_LAMBSE to be one, the spark is not erroneously corrected

for a mixture when closed loop fuel control has controlled to stoichiometry.

Note that LAMBSE1 and LAMBSE2 are the same in the open loop calculation.

OLFLG = 1 -----------------| SPK\_LAMBSE = LAMBSE1

(open loop fuel control) |

| --- ELSE ---

|

| SPK\_LAMBSE = 1

| (air/fuel mixture is close to stoichiometry)

19-11

TRANSMISSION INPUT CONVERSIONS, E4OD TRANSMISSION CALCULATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

E4OD TRANSMISSION CALCULATIONS

OVERVIEW

These System Equations are used in the E4OD Transmission Calculation Process.

DEFINITIONS

INPUTS

Registers:

- AM = Air Mass flow through the throttle body, lb/min.

- BP = Barometric pressure as defined in the Inferred BP Section.

- DT12S\_AVG = Filtered PIP period for transmission, ticks.

- N = Engine RPM.

- NEBART = Filtered engine RPM for transmission.

- NOBART = Filtered output shaft speed.

- RATCH = Closed throttle position, counts.

- RT\_GR\_CUR = Current transmission gear ratio.

- RT\_NOVS\_KAM = Ratio of actual N/V to base N/V in KAM.

- TP = Throttle Position, counts.

- TPBART = Filtered throttle position for transmission.

- VS = Instantaneous vehicle speed.

- VSBART = Filtered vehicle speed for transmission.

- VSBART\_RT = Filtered vehicle speed adjusted for RT\_NOVS for transmission.

Calibration Constants:

- NVBASE = Base N/V.

- PIPFIL = Filter constant factor for DT12S\_AVE, unitless.

- TCNE = Time constant for filtered RPM.

- TCTPTC = Time constant for filtered TP for converter clutch.

- TCTPTE = Time constant for filtered TP.

- TCTPTV = Time constant for filtered TP for TV pressure.

19-12

TRANSMISSION INPUT CONVERSIONS, E4OD TRANSMISSION CALCULATIONS - LHBH0

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- TCVST = Time constant for vehicle speed filter.

OUTPUTS

Registers:

- BP\_INTR = BP interpolation factor = FN615(BP).

- LOAD = Nondimensional, generic engine load.

- NEBART = See above.

- NOBART = See above.

- SPD\_RATIO = Speed ratio across torque converter.

- TP\_RATE = Throttle rate.

- TP\_REL = Relative TP = TP - RATCH.

- TPBART = See above.

- VSBART = See above.

- VSBART\_RT = See above.

19-13

TRANSMISSION INPUT CONVERSIONS, E4OD TRANSMISSION CALCULATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_E4OD\_SYS\_EQU\_COM1

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

\* FILTERED PIP PERIOD \*

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

(Performed on PIP rising edge)

CRKFLG = 1 ----------------------| DT12S\_AVG = DT12S

|

| --- ELSE ---

|

| DT12S\_AVG = (1 - FK)\*DT12S\_AVG

| + FK\*DT12S

Where:

1

FK = -----------

2\*\*PIPFIL

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

\* RELATIVE TP \*

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

TP\_REL = TP - RATCH (Clip to 0 as a minimum)

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

\* FILTERED ENGINE SPEED FOR TRANSMISSIONS USE \*

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

NEBART = UROLAV(N,TCNE)

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

\* FILTERED VEHICLE SPEED FOR TRANSMISSION USE \*

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

VSBART = UROLAV(VS,TCVST)

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

\* FILTERED VEHICLE SPEED ADJUSTED FOR RT\_NOVS \*

\* FOR TRANSMISSION USE \*

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

VSBART\_RT = VSBART \* RT\_NOVS

19-14

TRANSMISSION INPUT CONVERSIONS, E4OD TRANSMISSION CALCULATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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

\* FILTERED THROTTLE POSITION FOR TRANSMISSION USE \*

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

TPBART = UROLAV(TP,TCTPTE)

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

\* FILTERED TRANSMISSION OUTPUT SHAFT SPEED \*

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

NOBART = VSBART\_RT \* NVBASE

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

\* THROTTLE POSITION RATE \*

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

TP\_RATE = TP - TPBART (TP\_RATE is clipped to +/- 512 counts)

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

\* BP INTERPOLATION FACTOR \*

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

BP\_INTR = FN615(BP)

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

\* SPEED RATIO ACROSS TORQUE CONVERTER \*

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

NOBART \* RT\_GR\_CUR

SPD\_RATIO = ------------------

NEBART

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

\* FILTERED THROTTLE POSITION FOR TV PRESSURE \*

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

TPBARTV = UROLAV(TP,TCTPTV)

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

\* FILTERED THROTTLE POSITION FOR CONVERTER CLUTCH \*

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

TPBARTC = UROLAV(TP,TCTPTC)

19-15

TRANSMISSION INPUT CONVERSIONS, VSBART\_FM CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

VSBART\_FM CALCULATION

OVERVIEW

This module defines the calculation of VSBART\_FM. VSBART\_FM is the vehicle

speed calculated from the engine speed NEBART. It is only correct during

power-on non-shifting operation. When not power-on, one-way clutches may be

overrunning, resulting in VSBART\_FM being lower then VSBART. During shifts,

the value of VSBART\_FM is frozen at the value prior to commanding the shift.

DEFINITIONS

INPUTS

Registers:

- NEBART = Filtered engine RPM for transmission.

- RT\_GR\_CUR = Current transmission gear ratio.

- RT\_NOVS = Ratio of actual N/V to base N/V in KAM.

Bit Flags:

- FLG\_SFT\_IN = Shift in progress flag.

Calibration Constants:

- NVBASE = Base N/V.

OUTPUTS

Registers:

- VSBART\_FM = VS calculated based on NIBART, NEBART, or NOBART.

PROCESS

STRATEGY MODULE: INTRN\_CALC\_VSBART\_FM\_COM4

FLG\_SFT\_IN = 0 -----------| VSBART\_FM = NEBART / (RT\_GR\_CUR \* RT\_NOVS \*

(shift not in progress) | NVBASE)

| (not shifting, TSS failed - used engine speed)

19-16

TRANSMISSION EQUATIONS, ETV OVERCURRENT MONITOR VOLTAGE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ETV OVERCURRENT MONITOR VOLTAGE

OVERVIEW

(Performed during A to D conversion)

The A to D conversion of the ETV overcurrent monitor voltage (ETVOCM) will

vary depending on the actual value of VREF (+/- 5%). To increase the

capability to detect a partial failure in the solenoid circuit, ETVOCM is

adjusted by a calibration voltage input.

DEFINITIONS

INPUTS

Registers:

- IETVOCM = A to D conversion of the ETV overcurrent monitor voltage,

counts.

- IVCAL = A to D conversion of the calibration input voltage, counts.

OUTPUTS

Registers:

- ETVOCM = Corrected ETV overcurrent monitor voltage, counts.

PROCESS

STRATEGY MODULE: INPUT\_ETVOCM\_COM1

ETVOCM = IETVOCM \* 512/IVCAL

Where: (512/IVCAL) is clipped between 0.95 and 1.05.

19-17

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL SWITCH - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TRANSMISSION CONTROL SWITCH

OVERVIEW

The momentary contact Transmission Control Switch allows the driver to 1)

select an alternate shift pattern or 2) lockout overdrive (fourth gear). The

function of the Transmission Control Switch is dependent on the application.

On each power-up, the state of the Transmission Control Switch is 1)

alternate shift pattern disabled or 2) overdrive lockout disabled.

DEFINITIONS

INPUTS

Registers:

- TM\_TCS\_RES = Transmission Control switch input residence timer, sec.

Bit Flags:

- FLG\_FRST\_TCS = Flag used to prevent multiple toggles of FLG\_TCS during a

single activation of TCS button; 0 -> FLG\_TCS has not been toggled, 1 ->

FLG\_TCS has been toggled.

- ITCS = Transmission Control switch input state; 0 -> TCS depressed, 1 ->

TCS not depressed.

Calibration Constants:

- TMTCS = Transmission Control switch residence time, sec.

OUTPUTS

Registers:

- TM\_TCS\_RES = See above.

Bit Flags:

- FLG\_FRST\_TCS = See above.

- FLG\_TCS = Transmission control switch flag.

19-18

TRANSMISSION INPUT CONVERSIONS, TRANSMISSION CONTROL SWITCH - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_TCS\_COM1

ITCS = 1 ---------------------------------| Allow TM\_TCS\_RES to count up

(TCS button depressed, 12 volts) |

| --- ELSE ---

|

ITCS = 0 ---------------------------------| TM\_TCS\_RES = 0

(normal state, 0 volts) | (zero residence timer)

| FLG\_FRST\_TCS = 0

| (clear first pass flag)

TM\_TCS\_RES >= TMTCS ----------------|

(button depressed long enough) |AND -| Toggle FLG\_TCS

| | (change TCS state)

FLG\_FRST\_TCS = 0 -------------------| | FLG\_FRST\_TCS = 1

(1st time to toggle TCS) | (set first pass flag)

19-19

TRANSMISSION INPUT CONVERSIONS, 4 x 4 LOW SWITCH - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

4 x 4 LOW SWITCH

OVERVIEW

The 4 x 4 switch indicates that the driver has attempted to shift the

transfer case to low range. In the "shift on the fly" package, the 4 x 4

light will flash if the transfer case has not been allowed to shift into 4 x

4 low. If the transfer case has been allowed to shift into 4 x 4 low or in

the non-electronic system, the light will remain steadily on if in 4 x 4 low

mode. If in this mode, the shift schedule will be adjusted by the transfer

case ratio to get shifts at the correct output shift speed. This is done by

modifying RT\_NOVS. Since 12 volts at the module pin means normal mode and 0

volts means 4 x 4 mode, the input to the CPU is read as an inverted input.

DEFINITIONS

INPUTS

Registers:

- I4X4L = Input 4 x 4 state indicator.

- I4X4L\_LST = Last pass state of I4X4L.

- TM\_4X4L\_RES = 4 x 4 residence timer.

Calibration Constants:

- TM4X4L = 4 X 4 low switch residence time.

OUTPUTS

Registers:

- I4X4L\_LST = See above.

- TM\_4X4L\_RES = See above.

Bit Flags:

- FLG\_4X4L = Flag indicating 4 x 4 mode; 1 -> in 4 x 4 mode.

19-20

TRANSMISSION INPUT CONVERSIONS, 4 x 4 LOW SWITCH - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_E4OD\_INPUT\_PROCESSING\_COM1

I4X4L\_LST NOT= I4X4L -----| I4X4L\_LST = I4X4L

| (update state change register)

| TM\_4X4L\_RES = TM4X4L

| (load residence timer)

TM\_4X4L\_RES = 0 ----------| FLG\_4X4L = I4X4L

| (pass along current state, FLG\_4X4L = 1

| is 4 x 4 mode)

19-21

TRANSMISSION INPUT CONVERSIONS, RT\_NOVS\_KAM CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

RT\_NOVS\_KAM CALCULATION

OVERVIEW

This module calculates RT\_NOVS\_KAM.

DEFINITIONS

INPUTS

Registers:

- GEAR\_CUR = Current transmission gear (global register).

- NEBART = Filtered engine RPM for transmission.

- NOV\_ACT = Actual computed N over V.

- NOV\_ACT\_LST = Last pass value of NOV\_ACT.

- NOVCTR = NOV calculation sampling counter.

- RT\_GR\_CUR = Current transmission gear ratio.

- RT\_NOVS\_KAM = NOV ratio in KAM.

- TM\_LK\_CONV = Time since converter clutch commanded on, sec.

- TM\_NOV\_CALC = Time since last NOV\_ACT calculation.

- VSBART = Filtered vehicle speed for transmission.

- VSCTR = Count of MPH sensor errors.

Bit Flags:

- FLG\_4X4L = 4X4L flag; 0 -> not in 4X4 L, 1 -> in 4X4 L.

- FLG\_FRST\_CM = Flag indicating a shift was commanded this background loop.

- FLG\_FRST\_NOV = First pass to store NOV in KAM flag; 0 -> RT\_NOVS\_KAM has

not been loaded, 1 -> RT\_NOVS\_KAM has been loaded.

- FLG\_LK\_CM = Converter clutch commanded state; 0 -> command converter

clutch unlock, 1 -> command converter clutch lock-up.

- TM\_SFT\_IN = Time during which shift is in progress.

- PDL\_ERROR = PRNDL sensor failure; 0 -> no PRNDL sensor failure, 1 ->

PRNDL sensor failure.

- ERROR\_4X4L = 4x4L switch failure; 0 -> no 4x4L switch failure, 1 -> 4x4L

switch failure.

19-22

TRANSMISSION INPUT CONVERSIONS, RT\_NOVS\_KAM CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- SFT\_ERROR = Shift error flag; 1 -> Shift error, 0 -> No shift error.

- VSFMFLG = Vehicle speed sensor failure flag; 1 -> VSS failure, 0 -> No

VSS failure.

- CC\_FM\_FLG = Converter clutch failure mode flag; 0 -> normal operation, 1

-> Converter clutch failure mode.

19-23

TRANSMISSION INPUT CONVERSIONS, RT\_NOVS\_KAM CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- NOVCNT = Minimum number of good NOV samples to update KAM.

- NOVDIF = Maximum difference between NOV samples.

- NVBASE = Base N/V.

- RT4X4L = 4X4 low transfer case ratio.

- RTNVMN = Minimum valid RT\_NOVS\_KAM.

- RTNVMX = Maximum valid RT\_NOVS\_KAM.

- TMNVCAL = Time between consecutive NOV\_ACT calculations.

- TMNVLK = Time delay after converter clutch commanded on before allowing

NOV\_ACT calculation, seconds.

- ERR\_BAN\_4X4L = Maximum allowed deviation between rt\_novs\_kam and rt\_novs

actual in 4x4L.

OUTPUTS

Registers:

- NOV\_ACT = See above.

- NOV\_ACT\_LST = See above.

- NOVCTR = See above.

- RT\_NOVS = Ratio of actual N/V to base N/V in RAM.

- RT\_NOVS\_KAM = See above.

- TM\_LK\_CONV = See above.

- TM\_UNLK\_CONV = Time since converter clutch commanded off.

Bit Flags:

- FLG\_FRST\_NOV = See above.

- FLG\_NEW\_NOV = 1 -> a new NOV\_ACT has been calculated.

- FLG\_NOV\_KAM = Flag indicating at least one update of RT\_NOVS\_KAM since

last KAM initialization.

- ERROR\_4X4L = See above.

19-24

TRANSMISSION INPUT CONVERSIONS, RT\_NOVS\_KAM CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INTRN\_RT\_NOVS\_KAM\_CALC\_COM1

FLG\_LK\_CM = 1 ----------------------| Increment TM\_LK\_CONV

(converter clutch commanded on) | Increment TM\_NOV\_CALC

| TM\_UNLK\_CONV = 0

|

| --- ELSE ---

|

| TM\_LK\_CONV = 0

| TM\_NOV\_CALC = 0

| Increment TM\_UNLK\_CONV

GEAR\_CUR = 3 OR 4 ------------|

(3rd or 4th) |

|

TM\_LK\_CONV >= TMNVLK ---------|

(conv. clutch fully applied) |

|

TM\_NOV\_CALC >= TMNVCAL -------|

(enough time since last |

calculation) |

|AND -| NOV\_ACT\_LST = NOV\_ACT

SFT\_ERROR = 0 ----------------| | (update last pass NOV calc.)

| | TM\_NOV\_CALC = 0

PDL\_ERROR = 0 ----------------| | (reset interval pacer)

| | NOVCTR = NOVCTR + 1

VSFMFLG = 0 ------------------| | (increment sample counter)

| | FLG\_NEW\_NOV = 1

TM\_SFT\_IN = 0 ----------------| | (new NOV\_ACT occurred)

| |

VSCTR = 0 --------------------| |

| --- ELSE ---

|

| FLG\_NEW\_NOV = 0

| (no new NOV\_ACT)

FLG\_NEW\_NOV = 1 --------------|

|AND -| NOV\_ACT = NEBART/(VSBART\*RT\_GR\_CUR)

FLG\_4x4L = 0 -----------------| | (compute actual N/V, not in 4x4l)

|

| --- ELSE ---

FLG\_NEW\_NOV = 1 --------------| |

|AND -| NOV\_ACT = NEBART/(VSBART\*RT\_GR\_CUR

FLG\_4X4L = 1 -----------------| | \* RT4X4L)

| (compute actual NOV, in 4x4l)

19-25

TRANSMISSION INPUT CONVERSIONS, RT\_NOVS\_KAM CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

|NOV\_ACT\_LST - NOV\_ACT| > NOVDIF ---------|

(too much variation in NOV calculations) |OR --| NOVCTR = 0

| | (reset sample counter)

FLG\_FRST\_CM = 1 --------------------------|

(shift commanded this loop)

FLG\_4X4L = 0 -----------------------------|

|

NOVCTR > NOVCNT --------------------------|

(enough consecutive matches) |

|

FLG\_FRST\_NOV = 0 -------------------------|AND -| RT\_NOVS\_KAM =

(new value for KAM) | | (NOV\_ACT/NVBASE)

| | (store new NOV ratio in

RTNVMN <= (NOV\_ACT/NVBASE) <= RTNVMX -----| | KAM)

| FLG\_FRST\_NOV = 1

| FLG\_NOV\_KAM = 1

| (indicate at least

| one update)

CC\_FM\_FLG = 1 ---------------------------|

|

NOVCTR <= NOVCNT ------------------------|

|

FLG\_NEW\_NOV = 0 -------------------------|OR --|

| | NO ACTION ON FAULT

FLG\_4X4L = 0 ----------------------------| | FILTER OR 4X4L ERROR

| | FLAG

FLG\_NOV\_KAM = 0 -------------------------| |

| --- ELSE ---

|

|NOV\_ACT/NVBASE - RT\_NOVS\_KAM| > ERR\_BAN\_4X4L -| error\_detected = 1

| CALL FAULT FILTER 691

| (4x4l sw. fault filter)

| ERROR\_4X4L = 1

|

| --- ELSE ---

|

| error\_detected = 0

| CALL FAULT FILTER 691

| ERROR\_4X4L = 0

FLG\_4X4L = 1 ---------------------|

(in 4x4 low) |AND -| RT\_NOVS = RT\_NOVS\_KAM \* RT4X4L

| |

ERROR\_4X4L = 0 -------------------| |

(4x4 is ok) | --- ELSE ---

|

| RT\_NOVS = RT\_NOVS\_KAM

19-26

CHAPTER 20

SYSTEM EQUATIONS

20-1

SYSTEM EQUATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- A3C = A/C clutch.

- AEMAP = Acceleration Enrichment Map Filter.

- AETP = Filtered TP for recognizing stable TP after AE.

- AM = Air mass flow.

- APT = Throttle mode flag.

- BG\_TMR = Time to complete the previous background loop.

- BP = Barometric Pressure. (Note: Upper byte of BP\_WORD.)

- BPCOR = Corrected BP = FN004(BP).

- BRAKE\_INPUT = State of the brake on/off input to the module. 1 -> Brake

applied, 0 -> Brake not applied.

- CLOCK\_SEC = Dacable clock in seconds; 60 sec. rollover period.

- DATA\_TIME = Interrupt time, clock ticks.

- DNDTI = Derivitive of RPM (unfiltered).

- EVP = EGR valve position, counts.

- EGRBAR = Rolling average EGR position.

- EOFF = Lowest filtered EGR position.

- FIRST\_MPH = Flag which indicates 1st VSS edge.

- IIVPWR = Ignition voltage, A/D counts.

- INDS = Neutral / drive input.

- IVCAL = Calibration input voltage, A/D counts.

- MAP = Manifold Absolute Pressure, " Hg.

- MAPAEF = MAP sample used for aefuel calculations.

- MPHCNT = MPH sensor transition count.

- MPHTIM1 = Last MPH transition time.

- MPHTIM2 = First MPH transition time.

- N = Engine speed, RPM.

20-2

SYSTEM EQUATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- NDDTIM =

- OI\_A4LD = A4LD Solenoid or SIL Output ( 1 = ON ).

- OLDTP = Previous A/D conversion of TP.

- OTIM = Last software TAR update time, lower 16 bits.

- PDL = PRNDL Position - from A to D conversion.

- RATCH = Lowest throttle position since start, stored in KAM.

- TAR = Throttle angle rate.

- TARTMR = S/W TAR time since OLDTP updated.

- TP = Throttle position, counts.

- TP\_REL = Relative TP (TP\_REL).

- TP\_REL\_LST = Previous value of TP\_REL.

- TPBAR = Rolling average throttle angle.

- TSLMPH = Time since last rising VSS edge.

- V\_MODE\_SETUP = Use Throttle Mode VIP Constants in.

- VBAT = Battery voltage.

- VS = Vehicle speed.

- VSBAR = Filtered vehicle speed.

- VSCTR = Counter for unrealistic changes in vehicle speed.

Bit Flags:

- CRKFLG = Crank flag.

- FLG\_LK\_CM = Converter clutch lockup commanded flag.

- MUPET\_FLAG = Filtered MAP update enable time: 1 -> MAP register has been

updated, run AEMAP filter; 0 -> MAP has not been updated, do not run

AEMAP filter.

- NDSFLG = Neutral/drive flag; 1 -> drive.

- RUNNING = RVIP enable flag.

Calibration Constants:

- AEDLMP = Minimum change in MAP to indicate manifold filling (in. Hg)

- BIHP = Calibration switch which determines if a brake on/off switch is

present. 1 -> Brake on/off switch present, 0 -> Brake on/off switch not

present.

20-3

SYSTEM EQUATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- FN004 = Corrected BP as a function of actual BP.

- FN074A = Exhaust pressure as a function of AM. FN074A should be

corrected to sea level when mapping the data.

- FN093 = Time constant for TAPBAR.

- FN394F = Time delay before recognition of N/D transition - Forward.

- 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.

- MAXAET = Maximum time before turning off AE.

- MAXTTM = Maximum time delay before updating OLDTP (150 msec, not

calibratable).

- MPGLSW = MPG mode converter clutch development switch; 1 -> enable TRANSW

logic, 0 -> disable TRANSW logic.

- NDDELT = Time before N/D, D/N switch registers.

- RACHIV = RATCH, TPBAR AND TBART initialization value.

- SMTPDL = Deadband for stable TP - AETP (counts).

- TCAEMP = Time constant for AEMP.

- TCEGR = Time constant for EGRBAR.

- TCMBAR = Time constant for MAP.

- TCN = Time constant for N.

- TCNDT\_ISC = Time constant for DNDT\_ISC.

- TCNDT\_SPK = Time constant for DNDT\_SPK.

- TCTP = Time constant for TPBAR.

- TCTPDL = Time constant for TPDLBR.

- TCVBAT = VBAT time constant. ..Typical value - 0.1 seconds.

- TCVS = Time constant for VS.

- TPDLTA = Minimum TP change for tip-out.

- TRLOAD = Transmission Load Switch.

- TSTRAT = Transmission Strategy Switch; 0 -> no transmission control (man,

AOD, ATX, etc.), 1 -> Shift Indicator.

- VCAL = The value is normally 2.5 volts; this value can be changed on

VECTOR to satisfy the requirements of certain processors.

20-4

SYSTEM EQUATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- VSCNT = Increment to VSCTR when VS changes unrealistically.

- VSDELT = Maximum realistic change in vehicle speed in one background

loop.

- VSTYPE = Integrated vehicle speed/cruise control system present switch; 0

-> no MPH and no VSC, 1 -> MPH and no VSC.

OUTPUTS

Registers:

- AEMAP = Acceleration Enrichment Map Filter.

- AEMTMR = AEMAP filter timer.

- CLOCK\_SEC = See above.

- DNDSUP = Drive neutral select.

- DNDT\_ISC = Filtered rate of change of RPM for Idle Speed Control.

- DNDT\_SPK = Filtered rate of change of RPM for OSCMOD spark.

- EGRBAR = See above.

- EOFF = See above.

- FIRST\_MPH = See above.

- MAPAEF = See above.

- MAPBAR = Time-dependent rolling average filter of filtered MAP.

- MAPOPE = MAP/PEXH, unitless.

- MPHCNT = See above.

- MPHTIM1 = See above.

- MPHTIM2 = See above.

- NBAR = Filtered engine RPM.

- NDSFLG = See above.

- NOVS = N/VSBAR to infer transmission gear (rpm/mph).

- OLDTP = See above.

- OTIM = See above.

- PEXH = Absolute exhaust pressure, in. Hg, FN074A(AM) \* (29.875/BPCOR) +

BP.

20-5

SYSTEM EQUATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- RATCH = See above.

- TAR = See above.

- TARTMR = See above.

- TAPBAR = Filtered TP for Spark.

- TP\_REL = See above.

- TP\_REL\_H = Relative TP (TP - RATCH) high byte only.

- TPBAR = See above.

- TPDLBR = Filtered change of throttle position.

- TSLMPH = See above.

- VACUUM = Engine manifold vacuum (BP - MAP).

- VBAT = Rolling average of instantaneous battery voltage.

- VBAT' = Instantaneous battery voltage.

- VS = See above.

- VSBAR = See above.

- VSCTR = See above.

Bit Flags:

- ACCFLG = A/C clutch status; 0 -> disengaged, 1 -> engaged.

- ACIFLG = ISC system should prepare for A/C load.

- BIFLG = Brake applied flag. 1 -> Brake applied, 0 -> Brake not applied.

- MUPET\_FLAG = See above

- TARFLG = AE Demand Flag; 1 -> Manifold filling, 0 -> Manifold NOT

filling.

20-6

SYSTEM EQUATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EQUA\_LH

S2 ACCEL ENRICHMENT TP FILTER (AETP)

It is used to sense stable TP for purposes of resetting TARFLG to enable AE.

The AETP time constant TCAETP is a calibratable parameter which should be

large enough to prevent TARFLG reset before the TP stops moving.

AETP = UROLAV(TP,TCAETP)

NDSFLG = 0 -----------------------|

(neutral indication) |

|AND -|

NDDTIM >= NDDELT -----------| | |

(transmission disengaged) | | |

|OR --| |

TRLOAD <= 3 ----------------| |OR --| DNDSUP = NDSFLG

(manual trans) | | (update delayed

| | neutral/drive flag)

NDSFLG = 1 -----------------------| |

(drive indication) | |

|AND -|

NDDTIM >= FN394F -----------| |

(transmission engaged) |OR --|

|

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

(manual trans)

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 delays, FN394R and FN394F

are dependent 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.

20-7

SYSTEM EQUATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BRAKE INPUT

The brake input flag, BIFLG, is set/cleared based on the status of the brake

input hardware present switch, BIHP; and, the status of the brake input,

BRAKE\_INPUT. BIFLG is used in the converter clutch control logic.

BIHP = 1 -------------------------------|

|AND -| BIFLG = 1

BRAKE\_INPUT = 1 ------------------------| |

| --- ELSE ---

|

| BIFLG = 0

CLOCK\_SEC

CLOCK\_SEC is a register which contains a clock in engineering units. The

clock rolls over every 60 seconds and displays seconds with millisecond

accuracy. As with any other background calculation, the clock is updated

every background loop.

always ---------------------------| CLOCK\_SEC = CLOCK\_SEC + BG\_TMR

| (add current background loop time

| to the clock)

CLOCK\_SEC >= 60.000 --------------| CLOCK\_SEC = CLOCK\_SEC + 60.000

| (allows clock to roll over)

EGR POSITION FILTER (EGRBAR)

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

calibratable, but should be set to 2.0 seconds.

EGRBAR = UROLAV(EVP,TCEGR)

20-8

SYSTEM EQUATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGR POSITION RATCHET (EOFF)

The lowest filtered EGR position EOFF is controlled by the following logic:

EGRBAR < EOFF --------------------------|

|

CRKFLG = 0 -----------------------------|AND -| EOFF = EGRBAR

(RUN or UNDERSPEED mode) |

|

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

(closed throttle mode)

A/C CLUTCH STATUS (ACCFLG)

ACCFLG reflects the status of the A/C Clutch via the A3C input. The A3C

input differs from the ACD input which indicates whether the driver has

pressed the A/C button on the instrument panel. ACD will indicate driver

demand, however A3C must be used to determine whether the A/C clutch is

actually engaged.

A3C = 1 --------------------------------| ACCFLG = 1

(A/C on) | ACIFLG = 1

| (A/C Clutch engaged)

|

| --- ELSE ---

|

| ACCFLG = 0

| ACIFLG = 0

| (A/C Clutch disengaged)

MANIFOLD ABSOLUTE PRESSURE FILTER (MAPBAR)

The MAPBAR calculation is a time dependent rolling average filter of filtered

manifold absolute pressure MAP. The MAPBAR time constant TCMBAR is a

calibration parameter. MAPBAR is used in the Inferred Barometric Pressure

Strategy.

MAPBAR = UROLAV(MAP,TCMBAR)

20-9

SYSTEM EQUATIONS - LHBH0

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ACCEL ENRICHMENT MAP FILTER (AEMAP)

The AEMAP calculation is a time dependent rolling average filter of manifold

absolute pressure MAP. It is used as a means of sensing the manifold filling

effect during an acceleration, especially from Idle. The AEMAP time constant

TCAEMP is a calibration parameter which should be small enough to prevent a

false inference of manifold filling after the MAP has reached a stable value

and AE fuel is no longer required. AEMAP will be updated only if MAP has

been updated within the last background loop.

The stored MAP value, MAPAEF is used for the AEMAP filter and for TAR

calculation (TAR is used to enable and disable AEFUEL). This is done to

ensure a consistent MAP value for all AEFUEL calculations.

MUPET\_FLAG = 1 --------------------| MAPAEF = MAP

| (store current MAP for AEMAP

| filter and TAR calculation)

| AEMAP = UROLAV(MAPAEF,TCAEMP)

| AEMTMR is the sample rate

| (filter AE MAP)

| MUPET\_FLAG = 0

| (wait for MAP update)

| AEMTMR = 0

| (reset AEMAP timer for next

| update)

NOTE: MUPET\_FLAG is set by the foreground MAP code after the MAP conversion

is done. The above logic clears the flag.

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 a calibration

parameter and should be set to produce a 0.5 seconds.

NBAR = UROLAV(N,TCN)

20-10

SYSTEM EQUATIONS - LHBH0

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NDS - NEUTRAL DRIVE SWITCH

This switch reflects the change in transmission states (i.e., neutral/park,

drive/in gear). Automatic transmissions, except AXOD, use a Neutral/Drive

switch from the transmission; Manuals use a clutch switch, gear switch, or no

switch. A clutch or gear switch is recommend 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.

20-11

SYSTEM EQUATIONS - LHBH0

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INDS INPUT - NEUTRAL DRIVE SWITCH INPUT

This input reflects the applied transmission load to the engine, i.e.,

neutral/park, drive/in-gear.

- Manual transmissions can be configured with a clutch and gear switch, a

clutch switch only, a gear switch only, or neither switch. The input

therefore can be used to determine a neutral state (transmission in

neutral or clutch depressed) versus an in-gear state. If neither clutch

nor 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 transmissions 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 (THS2/3 and THS3/4) to properly decode

neutral, forward, and reverse states.

- Electronic automatic transmissions typically use a 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 provided by NDSFLG. If NDSFLG = 1, the

engine is loaded (transmission in gear or in drive). If NDSFLG = 0, the

engine is unloaded (transmission in neutral or clutch depressed). DNDSUP,

the delayed neutral/drive flag contains exactly the same information as

NDSFLG except that it is delayed (see FN393F/R, NDDTIM, etc.) in an attempt

to match PRNDL movement with actual application of transmission load (manual

transmissions 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).

20-12

SYSTEM EQUATIONS - LHBH0

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TRLOAD ASSIGNMENTS

TRLOAD = 0 Manual trans, no clutch or gear switch, forced

neutral (NDSFLG = 0)

= 1 Manual trans, no clutch or gear switch

= 2 Manual trans, one clutch or gear switch

= 3 Manual trans

= 4 Auto trans, non-electronic, Neutral Drive Switch

= 5 Auto trans, non-electronic, Neutral Pressure

Switch (AXOD)

= 6 Auto trans, electronic, PRNDL sensor Park,

Reverse, Neutral, Overdrive, Manual2, Manual1

configuration.

NDSFLG - INSTANTANEOUS (NON-DELAYED) TRANSMISSION STATE

INDS < 512 -----------------------|

|AND -|

TRLOAD <= 4 ----------------------| |

(not NPS) |

|

TRLOAD = 0 -----------------------------|OR --| NDSFLG = 0

(norced neutral) | | (neutral state; zero

| | NDDTIM timer on the

TRLOAD = 6 -----------------------| | | transition)

(PRNDL sensor) | | |

|AND -| | --- ELSE ---

PDL = 7 --------------------| | |

(park) |OR --| | NDSFLG = 1

| | (drive/loaded state;

PDL = 5 --------------------| | zero NDDTIM timer on

(neutral) | the transition)

20-13

SYSTEM EQUATIONS - LHBH0

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RATE OF CHANGE OF ENGINE RPM FILTER FOR OSCMOD SPARK AND ISC

DNDT\_ISC and DNDT\_SPK are time dependent rolling average filters of the rate

of change of engine RPM. These are updated each time a new value of N is

calculated. The time constants, (TCNDT\_ISC and TCNDT\_SPK) are calibration

parameters. DNDT\_SPK is the input to FN182, the light load RPM oscillation

spark multiplier. DNDT\_ISC is used to calculate the Idle Fuel Modulation

multiplier, ISCMOD.

For ISC:

DNDT\_ISC = ROLAV(DNDTI,TCNDT\_ISC)

For OSCMOD SPARK:

DNDT\_SPK = ROLAV(DNDTI,TCNDT\_SPK)

Where:

- DNDTI = N - N\_PREV/DT\_DNDT, RPM/Sec.

- N\_PREV = Previous value of N.

- DT\_DNDT = Time of current PIP up-edge minus time of up-edge used to

calculate N\_PREV, sec.

20-14

SYSTEM EQUATIONS - LHBH0

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ABSOLUTE EXHAUST PRESSURE (PEXH)

Exhaust back pressure as a function of AM and altitude, in. Hg.

PEXH = FN074A(AM) \* (29.875/BPCOR) + BP

Where:

- BPCOR = BP corrected = FN004(BP).

FN074A 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). Overprediction of

PEXH results in a smaller MAPOPE and PE which in turn results in leaner open

loop fuel values and underprediction of actual EM at altitude.

NOTE: MAPOPE = MAP/PEXH

20-15

SYSTEM EQUATIONS - LHBH0

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BATTERY VOLTAGE (VBAT)

The VBAT calculation is a time dependent rolling average filter of

instantaneous battery voltage. It is updated each background pass while in

RUN or UNDERSPEED mode. The VBAT time constant TCVBAT is a calibration

parameter and should be set to 0.1 seconds.

VBAT = UROLAV(VBAT',TCVBAT)

Instantaneous battery voltage is calculated from;

VBAT' = IIVPWR \* (VCAL/IVCAL) \* KSF/IVCAL

Where:

- VCAL/IVCAL is clipped between 0.00867 and 0.004; and

- VBAT' is clipped to 15.94 maximum.

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 a

calibration parameter and should be set to 2.0 seconds.

TPBAR = UROLAV(TP,TCTP)

THROTTLE POSITION FILTER (TAPBAR)

The TAPBAR calculation is a time and MAP dependent rolling average filter of

instantaneous throttle position (TP). It is updated each background pass

while in RUN or UNDERSPEED mode. The TAPBAR time constant is FN093(MAP).

TAPBAR = UROLAV(TP,FN093(MAP))

20-16

SYSTEM EQUATIONS - LHBH0

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CHANGE OF THROTTLE POSITION FILTER (TPDLBR)

TPDLBR is a time dependent rolling average filter of the change (or delta) in

TP on successive background loops. It is updated each background pass while

in Run or Underspeed mode. TPDLBR is used in the light load RPM oscillation

spark multiplier logic. The time constant, TCTPDL, is a calibration

parameter.

TPDLBR = ROLAV(TP\_REL - TP\_REL\_LST, TCTPDL)

Where:

- TP\_REL = TP - RATCH (clip to 0 as a minimum)

- TP\_REL\_LST = Previous value of TP\_REL

THROTTLE POSITION - RELATIVE TO RATCH (TP\_REL)

The parameter TP\_REL is an indication of the amount of throttle movement, TP,

beyond the idle setting, RATCH. TP\_REL is calculated every background pass,

in all engine modes.

TP\_REL = TP\_REL\_H = TP - RATCH

(clip to zero as a minimum)

Where:

- TP\_REL\_H = (high byte of TP\_REL)

20-17

SYSTEM EQUATIONS - LHBH0

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ENGINE SPEED OVER VEHICLE SPEED (NOVS)

NOVS is the ratio of engine speed over vehicle speed. It is used to infer

the transmission gear ratio selected - both in automatic and manual

transmissions. NOVS is currently used to specify separate entry conditions

based on transmission gear for MPG mode. NOVS is set to 255 in some special

cases: vehicle speed is near 0 or converter clutch is unlocked and MPGLSW =

1. MPGLSW is a development switch to enable/disable the NOVS calculation

with auto transmissions until 3rd gear converter clutch lockup is achieved.

VSBAR <= 5 -----------------------------| NOVS = 255

(vehicle speed low) | (vehicle speed too low)

|

TSTRAT = 2 -----------------| | --- ELSE ---

(A4LD) | |

| |

OI\_A4LD = 0 ----------------|AND -| |

(unlocked) | | |

| | |

MPGLSW = 1 -----------------| | |

|OR --| NOVS = 255

TSTRAT = 4 -----------------| | | (auto trans, clutch

(C6E4) | | | unlocked)

| | |

FLG\_LK\_CM = 0 --------------|AND -| | --- ELSE ---

(unlocked) | |

| | NOVS = N/VSBAR

MPGLSW = 1 -----------------| | (clip NOVS between 0 and 255)

TSTRAT - TRANSMISSION STRATEGY SWITCH

The TSTRAT software switch selects which transmission control strategy is to

be executed.

TSTRAT = 0 No transmission control (Manual trans, AOD, ATX, C6, C3, etc.)

= 1 SIL (Shift Indicator Light)

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

= 3 AXOD

= 4 C6E4 (E4OD)

= 5 A4LD-E

= 6 FAX-4

= 7 AOD-E (AOD-I)

= 8 4EAT

= 9 CD4E

20-18

SYSTEM EQUATIONS - LHBH0

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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. RATCH is continuously updated

during the VIP Throttle Adjust Mode.

During the VIP Throttle Adjust Mode the value of RATCH is always updated to

TPBAR. RATCH is clipped to RACHIV as maximum.

During RUNNING VIP RATCH is not updated.

CRKFLG = 1 -----------------------------------| No change to RATCH

|

| --- ELSE ---

|

V\_MODE\_SETUP = 1 -----------------------------| RATCH = TPBAR

| (clip RATCH to RACHIV

| as maximum)

|

TPBAR <= RATCH -------------------------| | --- ELSE ---

| |

N > 450 RPM ----------------------------|AND -| RATCH = TPBAR

| |

RUNNING = 0 ----------------------------| | --- ELSE ---

|

| No change to RATCH

20-19

SYSTEM EQUATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SOFTWARE TAR CALCULATION

Background:

The S/W TAR Logic replaces the H/W TAR Logic and circuit. The H/W TAR Logic

reads and A/D channel and converts the count value into deg/sec for use in

the AE Fuel Calculation (normalized input to FN1303). The S/W TAR Logic

calculates a throttle rate of change directly from the TP input:

TP - OLDTP

TAR = ------------------------ deg/sec

9.57 \* ("NTIM" - "OTIM")

Where:

- OLDTP is last TP, and ("NTIM" - "OTIM") is time between successive A/D

conversions.

- Because TAR is used as an anticipatory driver demand indicator,

additional logic prevents the value of TAR from becoming 0 until the

Accel Enrichment requirements of the engine are met.

- TAR is calculated by the software after initiation of a tip-in, until the

manifold starts to fill. In general, this TAR value remains constant

until after the manifold has filled (MAP - AEMAP < AEDLMP). This

"latching" of TAR causes AEFUEL to be calculated until the need for it

goes away, even if TP stops moving. TAR will be reset to 0 when the

engine transient has dissipated (i.e., manifold has filled) or if a decel

is recognized. (Throttle moves in closed direction). During part and

W.O.T. mode, the higher airflow causes TP jitter. To avoid erroneous

TAR calculation, as a result of this jitter, TPDLTA must be at least 20

counts.

- The original software TAR algorithm updated TAR every background loop

(approximately 13 msecs at idle). This update rate prevented recognition

of accels which are less than 160 deg/sec, i\_.e\_., TAR = (20

counts)/(9.57 counts per degree \* 13 msec) = 160 deg/sec.

- The revised S/W TAR strategy implements a pacing scheme to accommodate

slow accels. The software will wait up to 150 msec (approx. 12

background loops) for the TP sensor to travel TPDLTA counts. If the TP

sensor has not moved within the 12 background loops, the software will

update OLDTP and "OTIM".

NOTE: The first TAR calculated after a tip-in will probably be incorrect.

To enable the S/W TAR calculation, set TARHP = 0.

20-20

SYSTEM EQUATIONS - LHBH0

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TARFLG LOGIC

TARFLG is the mechanism for latching TAR until engine demand conditions can

be met by the normal fuel equation. TARFLG is set when the manifold is

filling and reset after the TP remains stable for a period of time (or as a

result of a decel).

MAPAEF - AEMAP >= AEDLMP ---------------| TARFLG = 1

| (manifold filling)

|

OLDTP - TP >= TPDLTA -------------| | --- ELSE ---

|OR --|

TP - AETP < SMTPDL ---------------| | TARFLG = 0

| (manifold not filling)

|

| --- ELSE ---

|

| No change to TARFLG

20-21

SYSTEM EQUATIONS - LHBH0

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TAR CALCULATION

(Do in Engineering Units Conversion)

TP - OLDTP >= TPDLTA ------------|

|AND -| Do TAR CONVERSION LOGIC

MAPAEF - AEMAP >= AEDLMP --| | | OLDTP = TP

|OR --| | "OTIM" = "NTIM"

TARFLG = 0 ----------------| | TARTMR = 0

|

| --- ELSE ---

0 < TP - OLDTP < TPDLTA ---------| |

| | (steady state mode or very

MAPAEF - AEMAP >= AEDLMP --| | | slow accel)

|OR --|AND -| (do not calculate TAR, wait

TARFLG = 0 ----------------| | | until TP - OLDTP is larger)

| | No change to "OTIM", OLD TP

TARTMR < MAXTTM -----------------| | or TAR

|

| --- ELSE ---

OLDTP - TP >= TPDLTA ------------| |

| |

TARFLG = 1 ----------------| | |

|AND -|OR --| TAR = 0

MAPAEF - AEMAP < AEDLMP ---| | | OLDTP = TP

| | "OTIM" = "NTIM"

TP - AETP < SMTPDL --------------| | TARTMR = 0

| | (turn off AE)

TARTMR > MAXAET -----------------| |

| | --- ELSE ---

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

| No change to TAR

| "OTIM" = "NTIM"

| OLDTP = TP

| (manifold is filling due

| to previous tip-in)

20-22

SYSTEM EQUATIONS - LHBH0

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TAR CONVERSION LOGIC

always -------------------------| (TP - OLDTP)

| TAR' = ------------------------

| 9.57 \* ("NTIM" - "OTIM")

| (calculate TAR in temporary

| register)

TAR' > TAR ---------------------| TAR = TAR'

| (new value of TAR is larger than

| old value, use it as TAR)

|

| --- ELSE ---

|

| TAR = UROLAV(TAR',TCTAR)

| (TAR is falling off, filter down

| the highest value so far)

20-23

SYSTEM EQUATIONS - LHBH0

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VACUUM - MANIFOLD VACUUM

VACUUM is used in the idle speed logic (FN820A) and the A4LD logic (FN002A).

VACUUM = BP - MAP

(clip vacuum to 0 as a minimum)

VSS - VEHICLE SPEED SENSOR

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).

20-24

SYSTEM EQUATIONS - LHBH0

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VEHICLE SPEED (VS)

The variable reluctance type Vehicle Speed Sensor produces an AC signal with

frequency proportional to vehicle speed. Through appropriate gearing, the

sensor generates 8000 cycles/mile, for a frequency range of 0 HZ at 0 MPH to

283.3 Hz at 127.5 MPH. Interface hardware in the EEC converts the AC signal

to a digital signal for input to the CPU. The strategy updates VS once per

background loop if at least one new rising edge was received (MPHCNT > 0)

during the previous loop. If, after 255 milleseconds, no new signals are

received (< 1.75 MPH), VS is set to 0. This ensures a zero vehicle speed if

the vehicle is stopped, or if the sensor fails.

On the rising edge of the vehicle speed sensor interrupt:

FIRST\_MPH = 0 --------------------------------| FIRST\_MPH = 1

| MPHTIM2 = DATA\_TIME

| TSLMPH = 0

|

| --- ELSE ---

|

| MPHTIM1 = DATA\_TIME

| MPHCNT = MPHCNT + 1

| TSLMPH = 0

Once per background; the following logic is executed:

VSTYPE = 0 ------------------------|

(no vehicle speed sensor) |

|OR --| VS = 0

TSLMPH >= 255 msec ----------------| | MPHCNT = 0

| FIRST\_MPH = 0

|

| --- ELSE ---

|

| 0.45 \* MPHCNT

MPHCNT > 0 ------------------------------| VS = -------------------

| (MPHTIM1 - MPHTIM2)

| MPHCNT = 0

| MPHTIM2 = MPHTIM1

|

| --- ELSE ---

|

| Do not update VS

| or MPHTIM2

20-25

SYSTEM EQUATIONS - LHBH0

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NOTE:

- (MPHTIM1 - MPHTIM2) must be converted from clock ticks to seconds.

- The software will handle the units conversion from clock ticks to seconds

(1 tick = 3.0\*10E-6 sec., 12 MHz EEC, = 2.4\*10E-6 sec., 15 MHz EEC).

VEHICLE SPEED FILTER (VSBAR)

The VSBAR calculation is a time dependent rolling average filter of

instantaneous vehicle speed (VS). The time constant, TCVS, is a calibration

parameter.

VSBAR = UROLAV(VS,TCVS)

VSCTR LOGIC

Previous VS = 0 ------------------|

|AND -| Exit, no action

TSLMPH >= 255 msec ---------------| | (don't update counter if no

| new data)

|

| --- ELSE ---

|

|VS - Previous VS| > VSDELT ------------| VSCTR = VSCTR + VSCNT

|

| --- ELSE ---

|

| Decrement VSCTR

VEHICLE SPEED FILTER (VSBAR)

The VSBAR calculation is a time dependent rolling average filter of

instantaneous vehicle speed (VS). It is updated each background pass while

in RUN or UNDERSPEED mode. The VSBAR time constant, TCVS, is a calibration

parameter.

VSBAR = UROLAV(VS,TCVS)

20-26

INPUT CONVERSIONS AND FILTERS, VS\_RATEPH CALCULATIONS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

VS\_RATEPH CALCULATIONS

OVERVIEW

Vehicle acceleration rate VS\_RATEPH is calculated by differentiating VS with

time.

DEFINITIONS

INPUTS

Registers:

- CTR\_VSRATE = Counts the # of background loops of VSRATE.

- TM\_VSRATE = Time between VSRATE calculations.

- VSBARTL = Low byte vehicle speed for transmission, mph.

- VSBARTL\_PREV = Previous value of VSBARTL.

- VS\_RATEPH = Filtered vehicle acceleration rate for Powertrain Hunting

prevention.

Calibration Constants:

- CNTVSRATE = Number of background loops between VSRATE calculations.

- TCVSRPH = Time constant for vehicle acceleration for Powertrain Hunting

prevention.

OUTPUTS

Registers:

- CTR\_VSRATE = See above.

- TM\_VSRATE = See above.

- VSBARTL\_PREV = See above.

- VS\_RATEPH = See above.

20-27

INPUT CONVERSIONS AND FILTERS, VS\_RATEPH CALCULATIONS - LHBH0

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PROCESS

STRATEGY MODULE: INPUT\_VS\_RATE\_CALC\_COM2

CTR\_VSRATE >= CNTVSRATE ----------| vsr = (VSBARTL - VSBARTL\_PREV) /

| TM\_VSRATE

| VS\_RATEPH = ROLAV(vsr,TCVSRPH)

| CTR\_VSRATE = 0

| TM\_VSRATE = 0

| VSBARTL\_PREV = VSBARTL

|

| --- ELSE ---

|

| CTR\_VSRATE = 1 + CTR\_VSRATE

20-28

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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MANIFOLD ABSOLUTE PRESSURE (MAP\_WORD and MAP)

OVERVIEW

The MAP\_WORD calculation is a conversion of the SCAP (Silicon CAPacitance)

sensor output. The sensor outputs a digital frequency modulated signal in

the 89 to 162 Hz range. Each edge output from the sensor is the equivalent

of the integration of the pressure seen at the sensor since the last edge.

The conversion of SCAP edges into frequency and then into a MAP\_WORD value in

inches of mercury is carried out during one of two foreground routines. If

the sensor is determined to be not operating properly, a background routine

(CNVERT) will substitute a value for MAP\_WORD. The value of MAP is a less

precise value of MAP\_WORD that is contained within a byte.

1. During CRANK or MAPCNT register overflow:

The calculation of MAP\_WORD is performed on every other SCAP edge by dividing

the number of edges (2) by the time period which starts at the time of the

last calculation and ends with the second edge. This produces the value of

MAP\_FREQ which is then converted to MAP\_WORD by a linear equation.

SCAP INPUT SIGNAL

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

| |\_\_\_\_\_\_| |\_\_\_\_\_\_| |\_\_\_\_\_\_| |\_

<---period---><---period---><---period---><---period

20-29

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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2. During UNDERSPEED and RUN:

The calculation of MAP\_WORD is performed in three parts. In some special

cases, the second part may be extended to provide a sufficient number of

edges for stability in the calculation.

a. The first part is the interpolation of the fractional SCAP edge

between the time of the last PIP up-edge and the next SCAP edge

following that PIP up-edge. (see diagram on next page)

b. The second part is the counting of the number of SCAP edges between

PIP up-edges. The counting SCAP edges continues until there have been

at least MAPEDG (minimum of 2) edges since the last calculation of

MAP\_WORD and a PIP up-edge is reached. If MAPCNT is not at least

(MAPEDG - 1) edges by the next PIP up-edge, the third part is not

computed and the time for the PIP period is accumulated in DT12SA. No

registers or flags are changed and a new MAP\_WORD value is not computed.

This feature prevents the calculation of a new MAP\_WORD using only

fractional data and provides increased stability in the MAP\_WORD value.

In exceptional cases, it may be necessary to compute the value of

MAP\_WORD over an engine cycle to provide enough stability to the value.

At present, the only known requirement for this is at wide open throttle

and must be requested by the calibrator by setting LONG\_MAP\_RQD to 1.

If the number of SCAP edges counted and stored in MAPCNT is greater than

or equal to 28 (MAX\_SCAP\_EDGES), then the "MAPCNT overflow flag"

(MAPOFL) is set and the calculation of MAP\_FREQ and MAP\_WORD is

performed by the same method used in CRANK. MAPOFL is cleared on the

next PIP up-edge.

c. The third part is the extrapolation of the fractional SCAP edge

between the time of the last SCAP edge prior to and including the PIP

up-edge. After this extrapolation, the calculation of MAP\_FREQ is the

summation of each of these parts divided by two (number of edges in a

whole SCAP period) and the time between the PIP up-edges. The value of

MAP\_FREQ is checked to insure that the frequency is within an acceptable

band and then it is converted to MAP\_WORD by a linear equation. MAP is

set equal to MAP\_WORD.

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

PIP \_\_\_\_| |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_| |\_\_\_\_\_\_\_\_\_

SCAP \_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_\_\_\_ \_

|\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_| |\_\_\_\_|

-->| a|<--

->| b |<-- ISF = a/b (part 1)

MAPCNT = 0 ISF 1+I 2+I 3+I 4+I 5+I 6+I (part 2)

->| d |<-

->|c|<- lsf = c/d (part 3)

|<------------- DT12SA ----------->|

MAP\_FREQ = [(ISF + 6 + lsf) \* 0.5] / DT12SA

MAP\_WORD = SLOPE(x) \* MAP\_FREQ - OFSET(x)

20-30

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

3. In some exceptional cases when the amplitude of the pulsations in the

manifold become large and the signal at the SCAP sensor is not symmetrical

for all cylinders, it may be necessary to compute the value of MAP\_WORD over

either an engine revolution or over an engine cycle to provide enough

stability in the computed value. At present, the only known requirement for

this is at wide open throttle, and must be requested by the calibrator by

setting LONG\_MAP\_RQD to one (1). In the event that LONG\_MAP\_RQD is one (1),

then when the throttle mode is wide open, the flag LONG\_MAP\_AVG is set

indicating a desire to perform the long average. MAP\_WORD will continue to

be computed on each PIP if enough SCAP information is available until the

appropriate number of cylinders have passed since start of the routine. This

allows the MAP\_WORD value to follow the transient changes and then stabilize.

The flag LONG\_MAP\_FST is used to tell the system when enough cylinders have

passed and the long average can actually begin. The number of cylinders to

average over is computed from the calibration parameter MAP\_CYCLE, which if

set to zero (0), negates the long average; if set to one (1), averages over

an engine revolution; and if set to two (2), averages over an engine cycle.

An example of the start of the long average is shown below for a four

cylinder engine with MAP\_CYCLE = 2:

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

PIP | | | | | | | | | | | | | | | | | | |

\_\_\_\_| |\_\_\_| |\_\_\_| |\_\_\_| |\_\_\_| |\_\_\_| |\_\_\_| |\_\_\_| |\_\_\_| |\_\_\_|

MAP calculated at arrows for period indicated

^ ^ ^ ^ ^ ^ ^

|<----->|<----->|<----->|<----->|

|<------SAMPLE PERIOD---------->|<-------SAMPLE PERIOD--------->|

|<-----WOT-----------------------------------------------------------

|<--- LONG\_MAP\_AVG = 1 ----------------------------------------------

|<--- LONG\_MAP\_FST = 1 ----------

MAP\_PIPCNT

.0.......0.......1.......2.......3.......4.0.....1.......2.......3.......4

20-31

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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4. During SCAP sensor failure:

In a background routine (CNVRT), there are two checks to verify proper SCAP

sensor operation. These checks are:

a. LAST\_MAP2 = LAST\_MAP - this checks to see if the sensor ever

started, since once an edge is captured, the time in LAST\_MAP will not

be equal to LAST\_MAP2. b. MAPTMR >= VMPMAX - this check uses a

background timer to count the amount of time since the last SCAP edge

was processed and if the timer exceeds the calibration value VMPMAX, the

sensor is assumed to have stopped putting out edges.

Once the sensor has been determined to have failed, the condition of the

throttle position sensor is checked, and if the TP failure flag is not set,

the value of MAP and MAP\_WORD are set to the output of the function FN095

(TP\_REL). If the TP sensor has also failed, then the value substituted for

MAP and MAP\_WORD is the calibration value, MAPFMM. If the sensor has failed

and the CRANK flag is set, the values substituted for MAP and MAP\_WORD is a

constant, 29.875.

The calculation of MAP and MAP\_WORD on a PIP up-edge is based on the

assumption that in engines with a vacuum tap properly placed, the signal

supplied to the SCAP sensor will be of near equal height and shape for all

cylinders. Therefore, obtaining the value over one or more cylinders should

produce the same average and no errors for partial period averaging.

At each PIP up-edge after FIRST\_PIP = 1:

always -----------------------------------| MAPOFL = 0

| (clear MAP overflow flag)

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

(in crank) |

| --- ELSE ---

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

(not in crank) | | DT12SA = DT12SA + DT12S

|AND -| (PIP period accumulator)

ISF\_UP\_FLG = 0 ---------------------|

(not first SCAP transition after

PIP up-edge)

LONG\_ISF\_UP\_FLG = 0 ----------------------| LONG\_DT12SA =

(at PIP edge and in long MAP average) | LONG\_DT12SA + DT12S

| (PIP period accumulator)

| MAP\_PIPCNT = MAP\_PIPCNT + 1

| (increment PIP period counter)

LONG\_DT12SA > 65536 ticks ----------------| LONG\_MAP\_AVG = 0

(PIP period accumulator has overflowed) | LONG\_DT12SA = 0

| LONG\_MAPCNT = 0

| MAP\_PIPCNT = 0

| LONG\_ISF\_UP\_FLG = 1

| (leave long MAP mode)

20-32

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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always ----------------------------| (LAST\_HI\_PIP - LAST\_MAP)

(compute last sample fraction) | lsf = ------------------------

| (LAST\_MAP - LAST\_MAP2)

NOTE: MAPEDG is the minimum number of SCAP transitions between PIP up-edges

required to compute a MAP update. "One" is subtracted from MAPEDG because

MAPCNT is incremented by ISF (a number less than 1) on the first SCAP

transition. MAPEDG should not be calibrated larger than the minimum

necessary to avoid unacceptable MAP jitter. The minimum value is 2 and the

maximum recommended values are: 4 cyl = 6; 6 cyl = 4; and 8 cyl = 3. Values

greater than these will result in multiple PIPs between MAP updates at low

engine speeds, causing slow MAP response.

20-33

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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DEFINITIONS

INPUTS

Registers:

- APT = At part throttle flag.

- DT12S = Time between two PIP rising edges.

- DT12SA = An accumulation of DT12S over a SCAP averaging period.

- IMAP\_WORD = Raw manifold absolute pressure.

- ISF = Initial sample fraction; the ratio of time between last PIP up-edge

and latest SCAP transition, and the time between the most recent two SCAP

transitions.

- LONG\_DT12SA = Time period accumulator for LONG\_MAP\_AVG.

- LONG\_ISF = Initial sample fraction for LONG\_MAP\_AVG.

- LONG\_MAP\_AVG = Flag that indicates when a long period average of MAP is

in progress.

- LONG\_MAPCNT = SCAP edge counter in LONG\_MAP\_AVG.

- LAST\_HI\_PIP = Time of last PIP up-edge.

- LAST\_MAP = Time of most recent processed SCAP transition.

- LAST\_MAP2 = Time of the second most recent processed SCAP transition.

- MAP\_FREQ = Integrated value of frequency in Hertz of the output of SCAP

sensor.

- MAP\_PIPCNT = Cylinder counter to determine period for averaging MAP over

a long period.

- MAP\_WORD = Same function as MAP, but with greater precision.

- MAPTMR = Free-running timer which is cleared in background if at least

one SCAP edge is recognized in the foreground. Its purpose is to provide

detection of a sensor failure.

- MAPUP\_NORM = Set -> MAP update is complete and ready for calculation of

normalized value; Clear -> Normalized value has been calculated.

- MDELTA = Latest SCAP half period.

- NEW\_MAP = Flag indicating whether SCAP edge has been received to allow

clearing of MAPTMR in background.

- TP\_REL = Relative TP (TP\_REL).

- UNDSP = Underspeed flag; 0 -> engine is in RUN mode.

20-34

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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Bit Flags:

- CRKFLG = State of engine mode; 0 -> Run/Underspeed, 1 -> Crank.

- ISF\_UP\_FLG = Flag which indicates whether initial sample has been

calculated after last PIP up-edge.

- LONG\_ISF\_UP\_FLG = Flag to indicate new MAP average completed and to

computed the new ISF for long average.

- LONG\_MAP\_FST = Flag to indicate first pass through a long period average

of

- MAPCNT = Number of SCAP transitions occurring between PIP up-edges.

- MAPOFL = Flag that indicates that MAPCNT has reached the overflow limit

and that MAP calculations will be performed as during crank.

- MFMFLG = Map failure mode flag.

- MUPET\_FLAG = Filtered MAP update enable time; 1 -> MAP register has been

updated, run AEMAP filter, 0 -> MAP has not been updated, do not run

AEMAP filter.

- TFMFLG = TP failure mode flag.

- V\_VACFLG = MAPVAC error flag.

Calibration Constants:

- FN095(TP\_REL) = Provides reasonable engine load value if MAP sensor is

faulty. Input: TP - RATCH, counts; Output: MAP, in Hg.

- LONG\_MAP\_RQD = 1 = Request long MAP avg. at WOT. MAP is in progress.

- MAPBK1 = Point of intersection of the first two line segments describing

MAP function (frequency versus inches).

- MAPBK2 = Point of intersection of the second and third line segments

describing the MAP function (frequency versus inches).

- MAPBK3 = Point of intersection of the third and fourth segments

describing the MAP function (frequency versus inches).

- MAPBK4 = Point of intersection of fourth and fifth segments describing

the MAP function (frequency versus inches).

- MAPBK5 = Point of intersection of the fifth and sixth segments describing

the MAP function (frequency versus inches).

- MAPEDG = Minimum number of SCAP edges to calculate a MAP value.

- MAPFMM = Value that MAP is set equal to if both SCAP and TP sensors fail.

- MAX\_SCAP\_EDGES = Maximum number of SCAP edges to calculate a MAP value.

- OFSET1 = Offset for the first linear equation describing MAP as function

of frequency and inches of Hg.

20-35

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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- OFSET2 = Offset for the second linear equation describing MAP as a

function of frequency and inches of Hg.

- OFSET3 = Offset for the third linear equation describing MAP as a

function of frequency and inches of Hg.

- OFSET4 = Offset for the fourth linear equation describing MAP as a

function of frequency and inches of Hg.

- OFSET5 = Offset for the fifth linear equation describing MAP as a

function of frequency and inches of Hg.

- OFSET6 = Offset for the sixth linear equation describing MAP as a

function of frequency and inches of Hg.

- SLOPE1 = Slope for the first linear equation for MAP.

- SLOPE2 = Slope for the second linear equation for MAP.

- SLOPE3 = Slope for the third linear equation for MAP.

- SLOPE4 = Slope for the fourth linear equation for MAP.

- SLOPE5 = Slope for the fifth linear equation for MAP.

- SLOPE6 = Slope for the sixth linear equation for MAP.

- TCMAPW = Time constant to use in rolling average routine for MAP\_WORD.

- VMPMAX = Maximum amount of time to wait for next SCAP edge before

deciding sensor has failed.

OUTPUTS

Registers:

- DT12SA = See above.

- IMAP\_WORD = See above.

- ISF = See above.

- LONG\_DT12SA = See above.

- LONG\_MAPCNT = See above.

- MAP = See above.

- MAP\_PIPCNT = See above.

- MAP\_FREQ = See above.

- MAP\_WORD = See above.

- MAPCNT = See above.

20-36

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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- MAPUP\_NORM = See above.

- MAPWBAR = Rolling average of MAP\_WORD.

Bit Flags:

- ISF\_UP\_FLG = See above.

- LONG\_ISF\_UP\_FLG = See above.

- LONG\_MAP\_AVG = See above.

- LONG\_MAP\_FST = See above.

- MFMFLG = See above.

- MUPET\_FLAG = See above.

20-37

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: SYSEQ\_MAP\_COM1

LONG\_MAP\_AVG = 1 -------------------|

(need long MAP average) |AND -| LONG\_MAP\_FST = 1

| | fractot = LONG\_ISF + lsf +

MAP\_PIPCNT >= | | LONG\_MAPCNT

(MAP\_CYCLE \* ENGCYL) ---------| | MAP\_FREQ =

(enough PIPs have passed) | (fractot \* 0.5) / LONG\_DT12SA

| Call Subroutine "MAP\_CALC"

| LONG\_DT12SA = 0

| LONG\_MAPCNT = 0

| MAP\_PIPCNT = 0

| LONG\_ISF\_UP\_FLG = 1

|

| --- ELSE ---

LONG\_MAP\_AVG = 0 -------------------| |

(need normal MAP average) | | (normal MAP average)

|AND -| LONG\_MAP\_FST = 0

MAPCNT >= (MAPEDG - 1.0) -----------| | fractot = MAPCNT + lsf

(enough edges to average) | | MAP\_FREQ =

| | (fractot \* 0.5) / DT12SA

ISF\_UP\_FLG = 0 ---------------------| | Call Subroutine "MAP\_CALC"

| LONG\_DT12SA = 0

| LONG\_MAPCNT = 0

| MAP\_PIPCNT = 0

| LONG\_ISF\_UP\_FLG = 1

|

| --- ELSE ---

LONG\_MAP\_AVG = 1 -------------------| |

(need long MAP avg) | | (normal MAP average during

| | first long MAP average)

LONG\_MAP\_FST = 0 -------------------|AND -| LONG\_MAP\_FST = 0

(first time for long MAP) | | fractot = MAPCNT + lsf

| | MAP\_FREQ =

MAPCNT >= (MAPEDG - 1.0) -----------| | (fractot \* 0.5) / DT12SA

(enough edges to average) | Call Subroutine "MAP\_CALC"

|

| --- ELSE ---

LONG\_MAP\_AVG = 1 -------------------| |

| |

LONG\_MAP\_FST = 1 -------------------|AND -| ISF\_UP\_FLG = 1

| | DT12SA = 0

MAPCNT >= (MAPEDG - 1.0) -----------| | MAPCNT = 0

| (long MAP average without

| sufficient PIP's)

|

| --- ELSE ---

|

| Return

20-38

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

As each SCAP sensor edge is processed:

Clear MAP\_INT flag (new SCAP transition available), then:

MAPOFL = 1 ------------|

(too many edges) |

|OR --|

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

(crank mode) |AND -| MAP\_FREQ = 1/(DATA\_TIME - LAST\_MAP2)

| | Call MAP\_CALC

MAPCNT >= 1 -----------------| |

(average over two periods) |

| --- ELSE ---

MAPOFL = 1 ------| |

|OR --| |

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

|AND -| |

MAPCNT < 1 ------------| | |

|OR --| MAPCNT = MAPCNT + 1

CRKFLG = 0 ------------| | | (increment SCAP edge counter)

|AND -| |

ISF\_UP\_FLG = 0 --------| |

(not 1st SCAP after PIP) |

| --- ELSE ---

|

CRKFLG = 0 ------------------| | (DATA\_TIME - LAST\_HI\_PIP)

|AND -| ISF = -------------------------

ISF\_UP\_FLG = 1 --------------| | (DATA\_TIME - LAST\_MAP)

(this is 1st SCAP after PIP) | ISF\_UP\_FLG = 0

| MAPCNT = ISF

| (calculate inital sample fraction)

After incrementing MAPCNT, check the following:

MAPCNT >= MAX\_SCAP\_EDGES -----------------| MAPOFL = 1

| (too many SCAP edges)

NOTE: MAX\_SCAP\_EDGES is set to 28 and must not be changed. This prevents

the registers "MAPCNT" and "FRACTOT" from overflowing if an additional SCAP

edge comes in before PIP and allows for the addition of the last sample

fraction to "FRACTOT" without an overflow check.

20-39

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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

|

LONG\_MAP\_AVG = 1 ------------|AND -| LONG\_ISF\_UP\_FLG = 0

(need long MAP avg) | | LONG\_ISF = ISF

| |

LONG\_ISF\_UP\_FLG = 1 ---------| |

(this is 1st SCAP after PIP) |

| --- ELSE ---

LONG\_MAP\_AVG = 1 ------------| |

|AND -| LONG\_MAPCNT = LONG\_MAPCNT + 1

LONG\_ISF\_UP\_FLG = 0 ---------| | (increment SCAP edge counter)

Additionally:

Set LAST\_MAP2 = LAST\_MAP (move time of previous SCAP edge)

Set LAST\_MAP = DATA\_TIME (store time of current SCAP edge)

Set NEW\_MAP flag (notify self test of new edge)

Set MDELTA = LAST\_MAP - LAST\_MAP2 (time between SCAP edges)

20-40

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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The subroutine "MAP CALC" consists of the conversion routine for MAP

frequency into MAP\_WORD. The logic below is describing the method to perform

the conversion in the least number of steps. A partial example of the

conversion tree is shown below:

MAP\_FREQ

|

|

yes <-------- MAP\_FREQ < MAPBK3 --------> no

| |

| |

yes <----- MAP\_FREQ < MAPBK1 ------> no

| |

| |

yes <-- MAP\_FREQ < FMAP1 --> no yes <-- MAP\_FREQ < MAPBK2 --> no

| | | |

| | | |

The logic that implements this tree is:

MAP\_FREQ < MAPBK3 -----------|

|

MAP\_FREQ < MAPBK1 -----------|AND -| IMAP\_WORD = SLOPE1 \* FMAP1 - OFSET1

| |

MAP\_FREQ < FMAP1 ------------| |

| --- ELSE ---

MAP\_FREQ >= MAPBK3 ----------| |

| |

MAP\_FREQ >= MAPBK5 ----------|AND -| IMAP\_WORD = SLOPE6 \* FMAP2 - OFSET6

| |

MAP\_FREQ >= FMAP2 -----------| |

| --- ELSE ---

MAP\_FREQ < MAPBK3 -----------| |

|AND -| IMAP\_WORD = SLOPE1 \* MAP\_FREQ - OFSET1

MAP\_FREQ < MAPBK1 -----------| |

| --- ELSE ---

MAP\_FREQ < MAPBK3 -----------| |

|AND -| IMAP\_WORD = SLOPE2 \* MAP\_FREQ - OFSET2

MAP\_FREQ < MAPBK2 -----------| |

| --- ELSE ---

|

MAP\_FREQ < MAPBK3 -----------------| IMAP\_WORD = SLOPE3 \* MAP\_FREQ - OFSET3

|

| --- ELSE ---

MAP\_FREQ < MAPBK5 -----------| |

|AND -| IMAP\_WORD = SLOPE4 \* MAP\_FREQ - OFSET4

MAP\_FREQ < MAPBK4 -----------| |

| --- ELSE ---

|

MAP\_FREQ < MAPBK5 -----------------| IMAP\_WORD = SLOPE5 \* MAP\_FREQ - OFSET5

|

| --- ELSE ---

|

| IMAP\_WORD = SLOPE6 \* MAP\_FREQ - OFSET6

20-41

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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After the calculation of MAP\_WORD, complete the following:

Set MUPET\_FLAG = 1 (New MAP value for AEMAP calculation)

Set ISF\_UP\_FLG = 1 (Ready to restart MAP calculation)

Set DT12SA = 0 (Clear normal MAP time accumulator)

Set MAPCNT = 0 (Clear normal MAP edge counter)

Set MAPUP\_NORM = 1 (New MAP value for MAP normalizing routine)

V\_VACFLG = 0 -------------------------------| MFMFLG = 0

| MAP\_WORD = IMAP\_WORD

| MAPWBAR =

| ROLAV(MAP\_WORD,TCMAPW)

| MAP = IMAP\_WORD

|

| --- ELSE ---

|

| MFMFLG = 1

MAPUP\_NORM = 1 -----------------------------| MAPWBAR =

| ROLAV(MAP\_WORD,TCMAPW)

|

| --- ELSE ---

|

| Do not calculation MAPWBAR

20-42

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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In the background module CNVRT, perform the following:

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

(MAP sensor failure) |

|AND -| (crank mode and SCAP sensor

CRKFLG = 1 ----------------------------| | have failed)

(in crank) | MAP = 29.875

| MAP\_WORD = 29.875

| MFMFLG = 1

| MUPET\_FLAG = 1

| MAPUP\_NORM = 1

|

| --- ELSE ---

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

| |

MAPTMR >= VMPMAX ----------------|OR --| |

(time since last edge too long) | | |

| | |

LAST\_MAP2 = LAST\_MAP ------------| |AND -| (SCAP sensor failed to start

(MAP sensor did not start) | | or has stopped; TP okay)

| | MAP = FN095(TP\_REL)

TFMFLG = 0 ----------------------------| | MAP\_WORD = FN095(TP\_REL)

(throttle position sensor okay) | MFMFLG = 1

| MUPET\_FLAG = 1

| MAPUP\_NORM = 1

|

| --- ELSE ---

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

| |

MAPTMR >= VMPMAX ----------------|OR --| |

| | |

LAST\_MAP2 = LAST\_MAP ------------| |AND -| MAP = MAPFMM

| | MAP\_WORD = MAPFMM

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

(throttle sensor failure) | MUPET\_FLAG = 1

| MAPUP\_NORM = 1

| (SCAP sensor never started

| or has stopped; TP sensor

| has also failed)

|

| --- ELSE ---

|

| Calculate MAP and MAP\_WORD

| in the normal manner in

| "Foreground MAP"

20-43

SYSTEM EQUATIONS, MANIFOLD ABSOLUTE PRESSURE - LHBH0

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

(at wide open throttle) |

|

UNDSP = 0 -----------------------------|AND -| LONG\_MAP\_AVG = 1

(in run mode) | | (need to do long MAP average)

| |

LONG\_MAP\_RQD = 1 ----------------------| | --- ELSE ---

(long average requested when above |

conditions are met) | LONG\_MAP\_AVG = 0

20-44

SYSTEM EQUATIONS, ENGINE SPEED CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE SPEED CALCULATION (EQNCALC)

OVERVIEW

The rpm calculation is performed in background if the foreground has signaled

that a new PIP period is available for calculation - (NEW\_RPM = 1). If the

time since last PIP up-edge is >= 800 msec, rpm is set to zero.

DEFINITIONS

INPUTS

Registers:

- DNDTI = Rate of change of Engine rpm.

- DT\_DNDT = Time delta between PIP up-edges used to calculate current and

previous values of N.

- LAST\_HI\_PIP = Time of last PIP up-edge.

- N = Engine rpm.

- N\_PREV = Previous value of N.

- TSLPIP = A timer that indicates the time since last PIP low-to-high

transition.

Bit Flags:

- FIRST\_RPM = Flag indicating first PIP received.

- NEW\_RPM = Flag indicating new PIP information is available for

calculation of rpm.

Calibration Constants:

- ENGCYL = Number of PIPs (or injections) per revolution.

- STALLN = Stall rpm; If the first rpm calculated is greater than this

value assume that there was a re-init.

- TCNDT\_ISC = Time constant for DNDT\_ISC.

- TCNDT\_SPK = Time constant for DNDT\_SPK.

OUTPUTS

Registers:

- DNDT\_ISC = A derivative of rpm (filtered).

- DNDTI = See above.

20-45

SYSTEM EQUATIONS, ENGINE SPEED CALCULATION - LHBH0

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- DNDT\_SPK = Filtered rate of change of rpm for OSCMOD.

- FIRST\_RPM = See above.

- N = See above.

- N\_BYTE = Byte value of N.

- N\_PREV = See above.

- NBAR = Filtered engine rpm.

- NEW\_RPM = See above.

- PREV\_N\_PIP = Time of previous high PIP used for rpm calculation.

Bit Flags:

- FIRST\_PIP = Flag indicating first PIP has been received.

- REFLG = Re-init flag; 1 -> re-init occurred, 0 -> no re-init.

20-46

SYSTEM EQUATIONS, ENGINE SPEED CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

TSLPIP >= 800 msec ---| FIRST\_PIP = 0

(engine is stopped) | REFLG = 0

| N = 0

| N\_BYTE = 0

| N\_PREV = 0

| DNDTI = 0

| DNDT\_ISC = 0

| DNDT\_SPK = 0

| NBAR = 0

| Do FIRST\_RPM and REFLG Logic (below)

| Look up normalized N

| EXIT RPM LOGIC

|

| --- ELSE ---

|

NEW\_RPM = 1 ----------| NEW\_RPM = 0

(new PIP information | N\_PREV = N

is available for | N = 60/(ENGCYL \* PIP period)

calculation of rpm) | N\_BYTE = byte value of N

| (resolution = 16, max value = 4080)

| DNDTI = (N - N\_PREV)/DT\_DNDT

| DNDT\_ISC = ROLAV(DNDTI,TCNDT\_ISC)

| DNDT\_SPK = ROLAV(DNDTI,TCNDT\_SPK)

| PREV\_N\_PIP = LAST\_HI\_PIP

| Calculate NBAR

| Do FIRST\_RPM and REFLG Logic (below)

| Look up normalized N

| EXIT RPM LOGIC

|

| --- ELSE ---

|

| No action

| EXIT RPM LOGIC

WHERE: DT\_DNDT = Time of current PIP up-edge (LAST\_HI\_PIP) minus the time of

the PIP up-edge last used to calculate N (PREV\_N\_PIP).

NOTE: PREV\_N\_PIP IS INITIALIZED TO THE TIME OF THE FIRST HI PIP IN

FOREGROUND.

20-47

SYSTEM EQUATIONS, ENGINE SPEED CALCULATION - LHBH0

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FIRST\_RPM and REFLG LOGIC

FIRST\_RPM = 0 -|

|AND -| FIRST\_RPM = 1

N >= STALLN ---| | REFLG = 1

| (this is a re-init)

|

| --- ELSE ---

FIRST\_RPM = 0 -| |

|AND -| FIRST\_RPM = 1

N < STALLN ----| |

| --- ELSE ---

|

| No action

20-48

SYSTEM EQUATIONS, SPEED DENSITY AIR MASS CALCULATION - LHBH0

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SPEED DENSITY AIR MASS CALCULATION

OVERVIEW

The total air mass flow into the engine (AMPEM) is computed from the basic

equation:

Mass = Pressure \* Volume / (Gas Law Constant \* Temperature in Rankine)

Because the pressure can not be directly computed it is inferred from engine

speed and manifold absolute pressure and a table of volumetric efficiency as

a function of engine speed and load. BASEMD must be calibrated to provide

the engine volume for this calculation as well as the Gas Law Constant.

AMPEM and AMPEMT are calculated in the same manner but use unique air mass

multipliers from functions of air charge temperature and volumetric

efficiency. AMPEM and AMPEMT both get EM (EGR mass) subtracted from them in

the Actual Mass Flow Equations in order to determine AM and AMT (air mass).

AMT is only used for air mass in the torque calculation. AM is used

everywhere else that air mass is required.

DEFINITIONS

INPUTS

Registers:

- ACT = Air Charge Temperature in degrees Fahrenheit (input to FN305).

- ACT(DEG R) = ACT in degrees Rankine (not displayed).

- AM = Air Mass (input to FN074A).

- BP = Barometric Pressure " Hg (input to PEXH equation).

- BPCOR = Barometric Pressure Corrected [output from FN004(BP)].

- ECT = Engine Coolant Temperature in degrees Fahrenheit (input to FN326).

- MAPWBAR = Rolling average of Manifold Absolute Pressure Word (" Hg).

- MAP\_WORD = Manifold Absolute Pressure " Hg.

- N = Engine speed.

- NORM\_MAPOPE21 = The output from the evaluation of FN021(MAPOPE), the

MAPOPE normalizing function (input to FN1320).

- NORM\_N070 = The output from the evaluation of FN070(N), the engine speed

normalizing function (input to FN1320).

- PEXH = Absolute exhaust pressure " Hg (not displayed) = FN074(AM) \*

(29.75/BPCOR) + BP

20-49

SYSTEM EQUATIONS, SPEED DENSITY AIR MASS CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Calibration Constants:

- BASEMD = 0.0234393 \* Engine Displacement in Liters (lbm - deg R/in. Hg -

rev).

- FN004(BP) = Empirical correction to PEXH for altitude with input a

function of barometric pressure.

- FN074A(AM) = Exhaust pressure as a function of air flow. NOTE: FN074A

should be corrected to sea level when mapping the data. [Exhaust

Pressure (Gauge) \* BP / 29.875]

- FN305(ACT) = Multiplier of air mass as a function of Air Charge

Temperature in degrees Fahrenheit.

- FN326(ECT) = Multiplier of air mass as a function of Engine Coolant

Temperature in degrees Fahrenheit.

- FN405(ACT) = Multiplier of air mass as a function of Air Charge

Temperature, degree F.

- FN1320(NORM\_N070,NORM\_MAPOPE21) = TABLVF is a 10 x 10 table of volumetric

efficiency multipliers for air mass as a function of NORM\_N070,

normalized engine speed, and NORM\_MAPOPE21, normalized MAPOPE.

- FN1420(NORM\_N070,NORM\_MAPOPE21) = 10 x 10 table of volumetric efficiency

multipliers for air mass as a function of NORM\_N070, and NORM\_MAPOPE21,

normalized MAPOPE.

- KVEFF = AMPEM and AMPEMT multiplier.

20-50

SYSTEM EQUATIONS, SPEED DENSITY AIR MASS CALCULATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- AMPEM = Air mass flow plus EGR mass flow, lb/min.

- AMPEMT = Air mass flow plus EGR mass flow, lb/min.

- MAPOPE = MAP\_WORD/PEXH.

- MAPWBG = MAP\_WORD updated once per background pass. Used in fuel

pulsewidth calculation.

PROCESS

STRATEGY MODULE: EQSDMA\_LL

Store the current value of MAP\_WORD for this background pass:

MAPWBG = MAP\_WORD

Compute the value of AMPEM and AMPEMT:

AMPEM = KVEFF \* BASEMD \* FN305(ACT) \* FN326(ECT) \*

FN1320(NORM\_N070,NORM\_MAPOPE21) \* MAPWBG \* N/ACT(deg R)

AMPEMT = KVEFF \* BASEMD \* FN405(ACT) \* FN326(ECT) \*

FN1420(NORM\_N070,NORM\_MAPOPE21) \* MAPWBAR \* N/ACT(deg R)

20-51

SYSTEM EQUATIONS, ROLLING AVERAGE ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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 RATE); the sampling

rate is the time elapsed between new calculations. For most filters, the

sampling rate 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 new value. 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:

- FK\_TMR = sampling rate (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.

20-52

SYSTEM EQUATIONS, ROLLING AVERAGE ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

FKxxxx = 1/[1 + (TCxxx/FK\_TMR)

new value - old average <= 1 BIT -------------| new average = new value

|

| --- ELSE ---

FK \* (new value - old average) < 1 BIT -| |

|AND -| new average = old average

new value < old average ----------------| | - 1 BIT

|

| --- ELSE ---

FK \* (new value - old average) < 1 BIT -| |

|AND -| new average = old average

new value > old average ----------------| | + 1 BIT

|

| --- ELSE ---

|

| new average = old average

| + FK \*

| (new value - old average)

20-53

SYSTEM EQUATIONS, ROLLING AVERAGE ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

INPUT LIST FOR ROLLING AVERAGE FILTER ROUTINE

new value old average FK\_TMR TCxxxx

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

AM/(ENGCYL\*N) ARCHG BG\_TMR TCTTA

EGRACT' EGRACT BG\_TMR TCEACT

DELOPT' DELOPT BG\_TMR TCDLOP

TP DSTPBR BG\_TMR TCDASU

TP DSTPBR BG\_TMR TCDASD

DSDRPM DESNLO BG\_TMR TCDESN

TP AETP BG\_TMR TCAETP

EVP EGRBAR BG\_TMR TCEGR

MAP MAPBAR BG\_TMR TCMBAR

IECT ECT BG\_TMR TCECT

ACT ECT BG\_TMR TCECT

MAPAEF AEMAP AEMTMR TCAEMP

N NBAR BG\_TMR TCN

N NEBART BG\_TMR TCNE

VBAT' VBAT BG\_TMR TCVBAT

TP TPBAR BG\_TMR TCTP

TP TAPBAR BG\_TMR FN093

TP TPBARTV BG\_TMR TCTPTV

TP TPBARTC BG\_TMR TCTPTC

TP TPBART BG\_TMR TCTPTE

TAR' TAR BG\_TMR TCTAR

VS VSBAR BG\_TMR TCVS

VS VSBART BG\_TMR TCVST

MAP+FN1033\*BP BPPTWT BG\_TMR TCBP

IEGO EGOBAR BG\_TMR VTCEGO

TP TBART BG\_TMR TCTPT

TP\_REL-TP\_REL\_LST TPDLBR BG\_TMR TCTPDL

DNDTI DNDT\_SPK DT\_DNDT TCNDT\_SPK

DNDTI DNDT\_ISC DT\_DNDT TCNDT\_ISC

SPK\_IDLE SPK\_RAMP BG\_TMR TCRAMP

RPMERR RPMERR\_A BG\_TMR TCBPA

RPMERR RPMERR\_S BG\_TMR TCFBS

20-54

SYSTEM EQUATIONS, ROLLING AVERAGE ROUTINE - LHBH0

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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] \* sample rate

(Sample rate approximately equals background loop time for most filters.)

2. Several filter constants were previously non-calibratable. With EMR

8-059, 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 8-059.

20-55

SYSTEM EQUATIONS, TCSTRT, ACSTRT, INIT\_TOT ROUTINE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TCSTRT, ACSTRT, AND INIT\_TOT ROUTINE

OVERVIEW

This routine computes TCSTRT (engine coolant temperature), ACSTRT (air charge

temperature), and INIT\_TOT (transmission oil temperature) at start-up. If

one or more of the sensor readings are out-of-range, the other sensor's

reading is substituted as indicated in the logic below.

DEFINITIONS

INPUTS

Registers:

- ACT = Air charge temperature, deg F.

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

- IECT = A/D conversion of ECT sensor, counts.

- PUTMR = Power-up timer, sec.

Calibration Constants:

- ECTMAX = Maximum valid A/D value for ECT sensor, counts.

- ECTMIN = Minimum valid A/D value for ECT sensor, counts.

- FN703(IECT) = Transfer function for ECT sensor.

- TKYON2 = Time at which BPKYON, TCSTRT, & ACSTRT updates begin (NOT

calibratable).

- TOTMAX = Maximum allowable Transmission Oil Temperature counts.

- TOTMIN = Minimum allowable Transmission Oil Temperature counts.

OUTPUTS

Registers:

- ACSTRT = ACT at start-up; arithmetic average of first 8 readings, deg F.

- ECTCNT = See above.

- INITTOT = Transmission Oil Temperature at start-up; arithmetic average of

the first 8 Transmission Oil Temperature readings.

- TCSTRT = ECT at start-up; arithmetic average of first 8 readings, deg F.

20-56

SYSTEM EQUATIONS, TCSTRT, ACSTRT, INIT\_TOT ROUTINE - LHBH0

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PROCESS

PUTMR > TKYON2 ----------------|

|AND -| ECTCNT = ECTCNT + 1

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

| --- ELSE ---

|

| Exit Routine

| Do NOT update TCSTRT, ACSTRT,

| INIT\_TOT, or ECTCNT

Always ------------------------------| ACSTRT = ACSTRT + ACT/8

IECT <= ECTMAX ----------------|

|AND -| TCSTRT = TCSTRT + FN703(IECT)/8

IECT >= ECTMIN ----------------| |

| --- ELSE ---

|

| TCSTRT = TCSTRT + ACT/8

ITOT <= TOTMAX ----------------|

|AND -| INIT\_TOT = INIT\_TOT + FN703D(ITOT)/8

ITOT >= TOTMIN ----------------| |

| --- ELSE ---

|

IECT <= ECTMAX ----------------| |

|AND -| INIT\_TOT = INIT\_TOT + FN703(IECT)/8

IECT >= ECTMIN ----------------| |

| --- ELSE ---

|

| INIT\_TOT = INIT\_TOT + ACT/8

20-57

SYSTEM EQUATIONS, PIP NOISE FILTERING - LHBH0

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PIP NOISE FILTERING

OVERVIEW

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\* \* \* \*

\* \* \* \*

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

|<--------------------->|

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 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).

20-58

SYSTEM EQUATIONS, POWER MODE - LHBH0

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POWER MODE (PWRMODE)

OVERVIEW

This module determines Power-On or Power-Off mode and set the flag, FLG\_PWR

accordingly. If the throttle position is greater than the sum of the minimum

throttle position, RATCH, and some calibratable delta, DELTAT, then the

engine/transmission is considered to be in the Power-On mode. Otherwise, the

engine/transmission is considered to be in the Power-Off mode. Hysteresis is

provided for mode stability.

actual speed ratio (SPD\_RATIO). If the speed ratio is greater than some

calibratable minimum, SPD\_PM, then the mode is considered to be Power-Off.

Again, hysteresis is provided for mode stability.

DEFINITIONS

INPUTS

Registers:

- SPD\_RATIO = Speed Ratio.

- RATCH = Kicker off lowest filtered throttle position.

- TP = Throttle position, counts.

- TP\_REL = Relative Throttle Position, TP - RATCH.

Bit Flags:

- TFMFLG = Flag indicating TP sensor is in/out of range.

Calibration Constants:

- DELTAT = Part throttle to closed throttle breakpoint for Power mode.

- HYSTSPD = Hysteresis for SPD\_PM for FMEM Power mode.

- HYSTST = Hysteresis for DELTAT for Power Mode.

- SPD\_PM = Minimum Speed Ratio for Power-Off mode.

OUTPUTS

Bit Flags:

- FLG\_PWR = Power Mode flag; 1 -> Power-On mode, 0 -> Power-Off mode.

20-59

SYSTEM EQUATIONS, POWER MODE - LHBH0

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PROCESS

TFMFLG = 0 --------------------------|

(Normal power mode determination) |

|AND -|

TP\_REL <= DELTAT --------------|S Q--| |

| |

TP\_REL > DELTAT + HYSTST ------|C |

|OR --| FLG\_PWR = 0

TFMFLG = 1 --------------------------| | | (Power off mode)

(FMEM power mode determination) | | |

|AND -| | --- ELSE ---

SPD\_RATIO >= SPD\_PM -----------|S Q--| |

| | FLG\_PWR = 1

SPD\_RATIO < SPD\_PM - HYSTSPD --|C (Power on mode)

20-60

SYSTEM EQUATIONS, COLD TEMPERATURE TV SOLENOID OPERATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

COLD TEMPERATURE TV SOLENOID OPERATION

OVERVIEW

The amount of Engagement TV pressure is a function of the Transmission Oil

Temperature, TOT. This logic sets the flag, FLG\_TVENG\_CD, if the TOT sensor

indicates cold and the flag, FLGTVENG\_CD if moderately cold. FLG\_TVENG\_CD

will be cleared when the time since the first engagement exceeds a

calibratable value, even if TOT does not increase.

The amount of start-up TV is a function of TOT also. This logic sets the

flag, FLG\_TVSTR\_CD if the TOT sensor indicates cold temperature.

DEFINITIONS

INPUTS

Registers:

- TSFETMR = Time since first transmission engagement, sec.

- TOT = Transmission Oil Temperature, deg. F.

Calibration Constants:

- CD\_TVENG\_TM = Maximum time since the first transmission engagement to use

TVEMAX engagement TV, sec.

- TOTTV1 = Maximum TOT to use TVCHRG for start-up, deg F.

- TOTTV2 = Minimum ECT to use TVEMAX engagement TV, deg F.

- TOTTV3 = Minimum ECT to use TVEMOD engagement TV, deg F.

OUTPUTS

Bit Flags:

- FLG\_TVENG\_CD = Flag which indicates cold temperature for engagement TV:

0 -> Don't use TVEMAX in engagement TV; 1 -> Use TVEMAX in engagement TV.

- FLG\_TVENG\_MD = Flag which indicates moderate temperature for engagement

TV: 0 -> Don't use TVEMOD in engagement TV; 1 -> Use TVEMOD in

engagement TV.

- FLG\_TVSTR\_CD = Flag which indicates cold temperature for start-up TV: 0

-> Don't use TVCHRG in start-up TV; 1 -> Use TVCHRG in start-up TV.

20-61

SYSTEM EQUATIONS, COLD TEMPERATURE TV SOLENOID OPERATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EQCTEMP\_LH

TOT <= TOTTV1 ----------------------| FLG\_TVSTR\_CD = 1

|

| --- ELSE ---

|

| FLG\_TVSTR\_CD = 0

TOT <= TOTTV2 ----------------|

|AND -| FLG\_TVENG\_CD = 1

TSFETMR < CD\_TVENG\_TM --------| |

| --- ELSE ---

|

| FLG\_TVENG\_CD = 0

TOT <= TOTTV3 ----------------------| FLG\_TVENG\_MD = 1

|

| --- ELSE ---

|

| FLG\_TVENG\_MD = 0

20-62

SYSTEM EQUATIONS, DYNAMIC TV DUE TO COLD TRANSMISSION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DYNAMIC TV DUE TO COLD TRANSMISSION

OVERVIEW

The accumulator pressure is the hydraulic pressure used to apply, release,

and hold the various clutches and bands in the transmission during shifts.

When the transmission is not shifting, the hydraulic pressure is determined

by the line pressure. The accumulator pressure is less than the line

pressure. Therefore, it is necessary to add additional hydraulic pressure

via the TV solenoid during shifts. This additional pressure is called

"dynamic TV."

The accumulator in the E4OD transmission may stick when the transmission is

cold. When the accumulator sticks, the transmission always operates with

accumulator pressure; during shifts and during steady-state gear conditions.

Of course, the pressure is inadequate during the steady-state conditions,

since the EEC-IV is not adding the additional TV which is added during the

shifts. With inadequate pressure, the transmission is unable to transmit

large amounts of torque.

Therefore, logic is needed to also add dynamic TV when conditions exist, such

that the accumulator may stick.

DEFINITIONS

INPUTS

Registers:

- TOT = Transmission Oil Temperature.

Calibration Constants:

- TOTTV4 = The maximum temperature where it is no longer necessary to add

dynamic TV due to the accumulator sticking.

OUTPUTS

Registers:

- FLG\_DYN\_CD = Flag which indicates that it is necessary to add dynamic TV

due to cold transmission conditions.

20-63

SYSTEM EQUATIONS, DYNAMIC TV DUE TO COLD TRANSMISSION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: EQCOLDTV\_LH

TOT < TOTTV4 ----------------------------| FLG\_DYN\_CD = 1

|

| --- ELSE ---

|

| FLG\_DYN\_CD = 0

20-64

SYSTEM EQUATIONS, COLD SHIFT MULTIPLIER - LHBH0

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COLD SHIFT MULTIPLIER (CS\_SFT\_MULT)

OVERVIEW

During cold weather starts/drives, the initial shifts of the transmission

seem delayed. This impression results from the decrease in engine torque

during the early part of the cold start. Therefore, strategy which computes

shift schedules as a function of the initial Transmission Oil Temperature,

TOT, (temperature at the time of the start), as well as the current TOT is

required.

The strategy shown below sets CS\_SFT\_MULT, the cold start shift multiplier,

to a value other than one, when cold transmission conditions exist. Cold

transmission conditions exist when the actual TOT is not greater than the

initial TOT by some calibratable value. The multiplier is then applied to

the appropriate shift curve to alter the shift schedules such that the shifts

occur earlier during cold weather conditions.

The cold weather strategy output CS\_SFT\_MULT, is also used in the

unconditional converter clutch unlock strategy. When CS\_SFT\_MULT is not

equal to one, the converter clutch is unconditionally unlocked; i.e., when

cold transmission conditions exist, the converter clutch is kept unlocked.

Cold shift schedule logic will be disabled when the time since the first

engagement exceeds a calibratable value, even if TOT has not increased.

CS\_SFT\_MULT is also used to raise the vehicle speed where shifts occur when

an ETV overcurrent condition has been detected (OFMFLG = 1) to provide better

drivability during torque limiting operation.

20-65

SYSTEM EQUATIONS, COLD SHIFT MULTIPLIER - LHBH0

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DEFINITIONS

INPUTS

Registers:

- TOT = Transmission Oil Temperature, deg F.

- TSFETMR = Time since the first transmission engagement, sec.

Bit Flags

- OFMFLG = Flag, when set, indicates an ETV solenoid overcurrent.

Calibration Constants:

- CS\_MAX\_TIME = Maximum time allowed in cold start shift schedules.

- CS\_MUL = Cold Start Multiplier.

- FN690(INIT\_TOT) = Temperature required to leave cold start shift

schedules.

- OFM\_MUL = Shift schedule multiplier for ETV solenoid overcurrent.

OUTPUTS

Registers:

- CS\_SFT\_MULT = Cold Start Shift Multiplier.

PROCESS

OFMFLG = 1 ----------------------------| CS\_SFT\_MULT = OFM\_MUL

|

| --- ELSE ---

TOT < FN690(INIT\_TOT) -----------| |

|AND -| CS\_SFT\_MULT = CS\_MUL

TSFETMR < CS\_MAX\_TIME -----------| |

| --- ELSE ---

|

| CS\_SFT\_MULT = 1.0

20-66

TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - LHBH0

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MLPS CONVERSION

OVERVIEW

This strategy is a fully calibratable control strategy to allow the use of a

six position Manual Lever Position Sensor (MLPS) combined with the

Transmission Control Switch (TCS-if present). As defined by TAPME, all

transmissions have three forward positions, neutral, reverse and park. The

three forward positions are overdrive, second (if TCS present) or drive (if

no TCS present) and first. The second to last PRNDL position is calibratable

to second or drive using the MLPS\_2 parameter discussed later.

The analog MLPS input is decoded into IPDL to give one of six positions. In

this decoding, deadbands can be calibrated between each position range. The

calibration constants PARKHI, PARKLO, REVHI, REVLO, NEUHI, NEULO, ODHI, ODLO,

MLPS\_2HI, MLPS\_2LO, MAN1HI, and MAN1LO are the parameters for each

corresponding PRNDL position band.

DEFINITIONS

INPUTS

Registers:

- INDS = Input from manual lever position sensor (MLPS) in counts.

- IPDL = Unverified PRNDL position.

- IPDL\_LST = Last unverified PRNDL position.

- PDL = Verified PRNDL position.

- TM\_PDL\_RES = Input residence timer.

Bit Flags:

- FLG\_TCS = Transmission control switch flag.

- PARK\_ERR = High vehicle speed in park error flag; 1 -> High vehicle speed

in park band error, 0 -> Vehicle speed in park range.

- PDL\_ERROR = PRNDL error flag; 1 -> PRNDL error, 0 -> PRNDL in range.

Calibration Constants:

- FMMMLP = IPDL value when PDL\_ERROR is present.

- MAN1HI = MLPS manual 1 position band high limit.

- MAN1LO = MLPS manual 1 position band low limit.

- MLPS\_2 = IPDL value when MLPS is in the second to last position; 2 ->

Manual 2 has been selected (TCS present), 3 -> Drive mode/Overdrive

cancel has been selected (no TCS present).

20-67

TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - LHBH0

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- MLPS\_2HI = MLPS second to last position band high limit.

- MLPS\_2LO = MLPS second to last position band low limit.

- NEUHI = MLPS neutral position band high limit.

- NEULO = MLPS neutral position band low limit.

- ODHI = MLPS overdrive position band high limit.

- ODLO = MLPS overdrive position band low limit.

- PARKHI = MLPS park position band high limit.

- PARKLO = MLPS park position band low limit.

- PDLTIM = PRNDL load residence time.

- REVHI = MLPS reverse postion band high limit.

- REVLO = MLPS reverse position band low limit.

OUTPUTS

Registers:

- IPDL = Unverified PRNDL value.

- IPDL\_LST = Last unverified PRNDL value.

- PDL = Verified PRNDL value.

- PDL\_LST = Last verified PRNDL value.

Bit Flags:

- PARK\_ERR = See above.

- PDL\_ERROR = See above.

20-68

TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - LHBH0

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PROCESS

STRATEGY MODULE: INTRN\_MLPS\_CONV\_COM1

As the PRNDL switch moves from position to position, the next contact is made

before the current contact is broken. This prevents sensing an open circuit

condition during PRNDL transitions.

To convert voltage to counts in the INDS register:

TSTRAT >= 4 -----------------------------| Exit Module

(transmission |

without MLPS) | --- ELSE ---

|

| INDS = PRNDL voltage \* (1023/VREF)

| (where VREF = 5 Volts +/- 5%)

To record the last PDL and IPDL before processing a new one.

always ----------------------------------| PDL\_LST = PDL

| IPDL\_LST = IPDL

20-69

TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - LHBH0

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To verify the INDS signal is in an allowable range and convert the counts

into a PRNDL position.

PARKLO < INDS < PARKHI ------------|

|AND -| ipdl = FMMMLP

VS > VSPMIN -----------------------| | PDL\_ERROR = 1

| PARK\_ERR = 1

|

| --- ELSE ---

|

PARKLO < INDS < PARKHI ------------------| (PARK position)

| ipdl = 7

| PDL\_ERROR = 0

|

| --- ELSE ---

|

REVLO < INDS < REVHI --------------------| (REVERSE position)

| ipdl = 6

| PDL\_ERROR = 0

|

| --- ELSE ---

|

NEULO < INDS < NEUHI --------------------| (NEUTRAL position)

| ipdl = 5

| PDL\_ERROR = 0

|

| --- ELSE ---

|

ODLO < INDS < ODHI ----------------------| (OVERDRIVE position)

| ipdl = 4

| PDL\_ERROR = 0

|

| --- ELSE ---

|

MLPS\_2LO < INDS < MLPS\_2HI --------------| (MLPS\_2 postion)

| ipdl = MLPS\_2

| PDL\_ERROR = 0

|

| --- ELSE ---

|

MAN1LO < INDS < MAN1HI ------------------| (MANUAL 1 postion)

| ipdl = 1

| PDL\_ERROR = 0

|

| --- ELSE ---

|

| (ERROR detected)

| ipdl = FMMMLP

| PDL\_ERROR = 1

| PARK\_ERR = 0

20-70

TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

To perform fault filtering and set SELF TEST code:

PDL\_ERROR = 1 ---------------------|

|AND -| error\_detected = 1

PARK\_ERR = 1 ----------------------| | CALL FAULT FILTER 659

| (HIGH VEHICLE SPEED IN PARK

| FAULT FILTERING)

|

| --- ELSE ---

|

PDL\_ERROR = 1 ---------------------------| error\_detected = 1

| CALL FAULT FILTER 634

| (MLPS FAULT FILTERING)

|

| --- ELSE ---

|

| CALL FAULT FILTER 634

| CALL FAULT FILTER 659

To check if a TCS has been calibrated in and if Overdrive cancel has

been selected:

MLPS\_2 = 2 ------------------------|

(TCS present) |

|

FLG\_TCS = 1 -----------------------|AND -| IPDL = 3

(Overdrive canceled) | | (Overdrive cancel/Drive

| | position selected)

ipdl = 4 --------------------------| |

(Overdrive mode selected) |

| --- ELSE ---

|

| IPDL = ipdl

| (let input pass through)

To verify that a new PRNDL position has been commanded:

IPDL <> IPDL\_LST ------------------------| TM\_PDL\_RES = PDLTIM

| (load residence timer)

TM\_PDL\_RES = 0 --------------------------| PDL = IPDL

(MLPS reading is stable) | (let input value pass through)

20-71

TRANSMISSION INPUT CONVERSIONS, MLPS CONVERSION - LHBH0

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20-72

CHAPTER 21

TIMERS

21-1

TIMERS - LHBH0

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TIMER SUMMARY

TIMER DESCRIPTION

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

A3CTMR Time between A3C state changes.

ADPTMR Adaptive fuel timer (seconds)

ATMR1 Time since start (time since exiting CRANK mode) (seconds)

ATMR2 Time since engine coolant temperature became greater than

TEMPFB (seconds)

ATMR3 Time since entering run mode (seconds)

AWOTMR Time in wide open throttle (seconds)

BYPTMR Thermactor air bypass-enable timer (seconds)

CRKPIP\_CTR PIP Counter for Cranking fuel

CTTMR Time at closed throttle timer (0.125 seconds)

EGRTMR EGR enabled timer (seconds)

HLTMR High load timer (0.125 seconds)

HMUTMR High MAPPA upstream air timer.

HTPTMR Heat protection timer (seconds)

IDLTMR Idle time (seconds)

ISCTMR RPM Sample/KAM Update Delay Timer (seconds)

LMBTMR Low MAP bypass timer (seconds)

LUTIMR Transmission lock-up control timer (0.125 seconds)

MPGTMR MPG mode control timer (seconds)

MULTMR Time since incrementing LAMMUL (0.001 seconds)

NACTMR Time not at closed throttle (seconds)

NDDTIM Time since neutral/drive switch state change (0.125 seconds)

OSCTMR OSCMOD delay timer (0.125 seconds)

PUTMR Time since CPU power-up (0.001 seconds)

SETTMR RPM Control Entry Delay Timer (0.125 seconds)

SHFTMR Shift in progress timer (0.125 seconds)

TARTMR Time since OLDTP was updated (0.001 seconds)

21-2

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TSLEGO Time since last EGO switch (0.001 seconds)

TSLPIP Time since last PIP (0.001 seconds)

V\_NACTMR\_CUM Accumulative time at part WOT

VOLTMR Time of low battery voltage

WOTTMR Time at wide open throttle

21-3

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINTIONS

INPUTS

Registers:

- A3C = A/C clutch.

- APT = Register indicating throttle mode.

- ATMR1\_LST = Last calculated value of ATMR1.

- BP = Barometric Pressure, in. Hg.

- CRKPIP\_CTR = Foreground register to count PIPs for CRANK fuel.

- CRKPIP\_CTR\_BG = Background register equivalent of CRKPIP\_CTR.

- DASPOT = Dashpot desired mass air flow.

- ECT = Engine Coolant Temperature, deg F.

- GEAR\_CUR = Register indicating current transmission gear.

- MAPPA = MAP/BP, unitless

- MAP = Manifold Absolute Pressure, in. Hg.

- N = RPM.

- NEW\_PIP = New high PIP has occurred.

- NOVS = Engine speed over vehicle speed ratio, rpm/mph.

- N\_BYTE = Byte form of engine speed, rpm.

- NLAST = RPM at P.T.; differentiates decel/idle.

- RPMERR\_A = RPMERR(DESIRED RPM - N) filtered for ISC.

- TPDLBR = Filtered change of TP.

- VBAT = Rolling average of IKYPWR.

- VSBAR = Rolling average of Vehicle Speed, mph.

- WRMEGO = EGO sensor should be warm flag.

21-4

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- CFMFLG = Flag indicating the ECT sensor is out of range.

- CRKFLG = Crank flag.

- FLG\_STALL = Indicated a stall has occured.

- IDLFLG = Flag which is set to 1 when at closed throttle and below "IDLRPM"

rpm. See IDLTMR logic in this chapter.

- ISCFLG = Mode indicator flag.

- LESFLG = 1 -> EGO is not switching.

- MFMFLG = Flag indicating the MAP sensor has failed.

- MPGFLG = Flag that indicates Fuel Economy Mode if set to 1.

- OLFLG = Flag indicating open loop fuel control.

- UNDSP = Underspeed flag.

Calibration Constants:

- AFECT1 = Min. ECT for starting the adaptive fuel timer

- AFECT2 = Overtemp. ECT to disable adaptive learning

- BYRPM = Maximum RPM for closed throttle bypass.

- BYRPMH = Hysteresis for BYRPM.

- CHGTM = Time delay after leaving closed throttle to permit VOLTMR to

decrement, sec.

- CRKCTR\_RESET = CRKPIP\_CTR reset switch; 1 -> reset CRKPIP\_CTR upon stall.

- CRKPIPCNT2 = CRKPIP\_CTR reset value for UNDERSPEED to CRANK transitions,

sec.

- CRKTM1 = Time in RUN or UNDERSPEED below which CRKPIP\_CTR is reset to

CRKPIPCNT2, sec.

- CRKTMR\_INC = Calibration switch which determines whether CRKPIP\_CTR counts

when the engine state is out of CRANK.

- DASCTL = Lower daspot limit to allow RPM control (PPM).

- EGRTD7 = Time delay to ramp EGR turn on.

- FN900(VSBAR) = Time delay before enabling MPG Mode as a function of vehicle

speed. NOTE: Vehicle Speed is always ZERO if a Vehicle Speed Sensor is not

present.

- FN1360 = Stabilized Open Loop Fuel 8 X 10 table of lambda values as a

function of N and PERLOAD.

21-5

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- HIMAPF = Highest MAP that allows BYPTMR to count down.

- HMUMAP = A calibratable minimum MAPPA to increment HMUTMR for upstream air.

- HMUMPH = HMUMAP hysteresis term.

- IDLRPM = Max RPM for closed throttle mode idle, RPM.

- IDRPMH = Hysteresis for IDLRPM, RPM.

- ISCTM = Pacing to evaluate rate of change of engine speed.

- LAMRHYS = Hysteresis for LAMRICH.

- LAMRICH = Minimum lambse value for enrichment.

- LESTM = Time delay before forced open loop fuel after last ego switch

(seconds).

- LMBMAP = Minimum decel MAP to increment LMBTMR.

- LOMAPF = Lowest MAP that allows BYPTMR to count up.

- LOWVOL = System voltage level, below which the battery is discharging,

volts.

- MAPAHI = Maximum MAPPA value for MPG mode, unitless.

- MAPLO = Minimum MAP value for MPG mode, in. Hg.

- MAPLOH = Hysteresis for MAPLO, in. Hg.

- MAXTIM = Maximum time to wait for TAR change on SW TAR.

- MPAHIH = Hysteresis for MAPAHI, unitless.

- MPGCTH = Maximum ECT for Fuel Economy Mode, deg F.

- MPGCTL = Minimum ECT for Fuel Economy Mode, deg F.

- MPGGR = Minimum gear for Fuel Economy Mode.

- MPGNOV = Maximum NOV for Fuel Economy Mode, rpm/mph.

- MPGRPH = Hysteresis for MPGRPM, rpm.

- MPGRPM = Minimum RPM for Fuel Economy Mode, rpm.

- MPGRT = Minimum delay time to re-enter MPG mode once exited, sec.

- MPMNBP = Minimum BP for Fuel Economy Mode, in. Hg.

- MPNBPH = Hysteresis for MPMNBP, in. Hg.

- MPNOVH = Hysteresis term for MPGNOV, rpm/mph.

- NACTMR = Time at P.T. or WOT.

21-6

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- NDIF = Time dependent RPM limit to differentiate decel from idle.

- O\_8500\_SW = Calibration switch to select vehicle speed or transmission gear

for Fuel Economy Mode determination. "0" selects vehicle speed; "1" selects

transmission gear. Set to "1" only for over 8500 GVW aplications with E4OD

transmission.

- OLITD3 = Time to go back to closed loop fuel control (see Closed Loop/ Open

Loop Logic). Closed loop from IDLTMR = 0 to OLITD1, open loop fuel from

IDLTMR = OLITD1 to OLITD3, then back to closed loop fuel when IDLTMR reset

to

0 at OLITD3. Closed loop/Open loop feature can be calibrated out by setting

OLITD3 to 255 sec.

- RAMPSW = Ramp EGR on switch; 0 -> ramp on every EGR turn on, 1 -> ramp

first egr turn on only.

- RPMDED = RPM deadband - C/L ISC.

- SHFDLT = a calibration parameter giving TP change to infer M/T shift.

- TEMPFB = Warm Engine Temperature

- VOLHYS = Hysteresis term for LOWVOL, volts.

- VOLTCLP = Maximum clip value to freeze VOLTMR at upper threshold.

- VSMPG = Minimum vehicle speed value for MPG mode, mph.

- VSMPGH = Hysteresis for VSMPG, mph.

- VSTYPE = Must be set to 1 if Vehicle Speed Sensor is present.

OUTPUTS

Registers:

- ATMR1\_LST = See above.

- CRKPIP\_CTR = See above.

- CRKPIP\_CTR\_BG = See above.

- NEW\_PIP = See above.

21-7

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- IDLFLG = See above.

- LESFLG = See above.

- MPGFLG = See above.

- MPGTFG = Flag indicating a transition from Fuel Economy Mode is in progress.

21-8

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: TIMER\_LH

A3CTMR - A3C TRANSITION TIMER (0.001 sec)

The A3CTMR measures the time between A3C state changes.

always ------------------------------------------| Increment A3CTMR

A3CTMR is reset to 0 on any A3C transition - (LSTA3C - A3C <> 0 in successive

background passes).

LSTA3C - A3C <> 0 -------------------------------| LSTA3C = A3C

(A3C state changed) | A3CTMR = 0

Where, LSTA3C is the last pass A3C flag.

ADPTMR - ADAPTIVE FUEL ENABLE TIMER

RUN mode ---------------------------------|

|AND -| Increment ADPTMR

AFECT1 <= ECT <= AFECT2 ------------------| |

| --- ELSE ---

|

| ADPTMR = 0

NOTE: These coolant temperature parameters should bracket normal engine coolant

temperature range.

21-9

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ATMR1 - TIME SINCE ENGINE START-UP

CRKFLG = 0 -----------------------------------| ATMR1\_LST = ATMR1

(run OR underspeed) | (save last calculated

| value of ATMR1)

| Increment ATMR1

| (calculate new value)

|

| --- ELSE ---

|

| ATMR1\_LST = ATMR1

| (save last calculated

| value of ATMR1)

| ATMR1 = 0

21-10

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ATMR2 - TIME SINCE ENGINE COOLANT TEMPERATURE BECAME GREATER THAN TEMPFB

ECT > TEMPFB----------------------------|S Q -| Increment ATMR2

| |

| | --- ELSE ---

NEVER ----------------------------------|C |

| ATMR2 = 0

NOTE: Except at power-up initialization; timer is used to delay closed loop

fuel and EGR after a cold start.

21-11

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ATMR3 - TIME SINCE ENTERING RUN MODE

UNDSP = 0 ------------------------------------| Increment ATMR3

(RUN mode)

AWOTMR - TIME AT WIDE OPEN THROTTLE

APT = 1 --------------------------------------| Increment AWOTMR

(wide open throttle mode) |

| --- ELSE ---

|

| AWOTMR = 0

BYPTMR - THERMACTOR AIR BYPASS-ENABLE TIMER

LOMAPF < MAPPA < HIMAPF ----------------|

|

APT >= 0 -------------------------------|AND -| Increment BYPTMR

(part or wide open throttle) | | Clip at BYMAP

| |

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

|

| Decrement BYPTMR

| Clip at 0

21-12

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CRKPIP\_CTR - PIP COUNTER FOR CRANKING FUEL

CRKPIP\_CTR is used as a Crank Fuel Multiplier to do a lean-out or fuel shut-off

during sub-zero cold operation. Some calibrators are using the logic to improve

restarts following a stall during -20 deg F testing by turning off the fuel

during the first seconds of crank. This allows the engine to restart on the

residual fuel remaining in the manifold after the stall.

CRKCTR\_RESET = 1 ------------------|

|

FLG\_STALL = 1 ---------------------|AND -| Reset counter part way

| | CRKPIP\_CTR = CRKPIPCNT2

ATMR1\_LST <= CRKTM1 ---------------| | CRKPIP\_CTR\_BG = CRKPIPCNT2

(in run or underspeed less |

than CRKTM1 seconds) |

| --- ELSE ---

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

(in crank) |OR --| Increment CRKPIP\_CTR every

| | rising edge of PIP

CRKTMR\_INC > 0 --------------------| | CRKPIP\_CTR\_BG = CRKPIP\_CTR

|

| --- ELSE ---

|

| Freeze CRKPIP\_CTR

| CRKPIP\_CTR = CRKPIP\_CTR\_BG

In Foreground PIP\_DATA Module:

always ---------------------------------------| Increment CRKPIP\_CTR every

| rising edge of PIP

| Clip CRKPIP\_CTR at 255

| as a maximum

21-13

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

CTTMR - TIME AT CLOSED THROTTLE

APT = -1 -------------------------------------| Increment CTTMR

(closed throttle mode) |

| --- ELSE ---

|

| CTTMR = 0

EGRTMR - EGR ENABLED TIMER

EGR ENABLED ----------------------------------| Increment EGRTMR

| Clip at EGRTD7

|

| --- ELSE ---

|

RAMPSW = 0 -----------------------------------| EGRTMR = 0

(ramp EGR on every time) | (prepare for next ramp)

|

| --- ELSE ---

|

RAMPSW = 1 -----------------------------------| Freeze EGRTMR

(ramp EGR on first time only) | (do not ramp next time)

HLTMR - HIGH LOAD TIMER

The HLTMR delays Open Loop fuel control during crowds. Running Closed Loop fuel

during crowds eliminates the need for Upstream Air during those conditions.

FN1360 <= LAMRICH ----------------------|S Q -| Increment HLTMR

| |

FN1360 > LAMRICH + LAMRHYS -------------|C | --- ELSE ---

|

| HLTMR = 0

HMUTMR - HIGH MAPPA UPSTREAM AIR TIMER

MAPPA >= HMUMAP + HMUMPH ---------------|S Q -| Increment HMUTMR

| | HUMTMR\_FLG = 1

MAPPA < HMUMAP -------------------------|C |

| --- ELSE ---

|

| HMUTMR = 0

| HMUTMR\_FLG = 0

21-14

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HTPTMR - HEAT PROTECTION TIMER (BANKLINE)

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

(closed throttle mode) |

|AND -| Increment HTPTMR

N\_BYTE < BYRPM -------------------|S Q -| | (clipped at BYSTM4)

| |

N\_BYTE > BYRPM + BYRPMH ----------|C | --- ELSE ---

|

| Decrement HTPTMR

| (clipped at 0)

IDLTMR - TIME AT IDLE

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

(closed throttle mode) |

|AND -| Increment IDLTMR

N < IDLRPM -----------------------|S Q--| | IDLFLG = 1

| |

N > IDLRPM + IDRPMH---------------|C | --- ELSE ---

|

| IDLTMR = 0

| IDLFLG = 0

IDLTMR > OLITD3 ------------------------------| IDLTMR = 0

21-15

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ISCTMR - RPM SAMPLE / KAM UPDATE DELAY TIMER (seconds)

This timer is used for two separate purposes in the normal idle speed control

strategy. It is always cleared in dashpot-preposition mode.

- In RPM conrol mode, it is used to prevent ISCKAM updates while RPMERR\_A is

outside the deadband allowed for ISCKAM learning.

- In dashpot mode, it is used to pace the rate of change of RPM checks to

determine whether or not to go to lockout mode.

In Mode Select Logic -------------|

|AND -|

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

(preposition mode) |

|

In ISCKAM Update Logic -----------| |

|AND -|OR --| ISCTMR = 0

|RPMERR\_A| > RPMDED --------------| | |

(outside deadband) | | --- ELSE ---

| |

In Lockout Logic -----------------| | | Increment ISCTMR

| |

ISCFLG < 1 -----------------------| |

(not RPM Control or Lockout) | |

|AND -|

ISCTMR >= ISCTM ------------------|

(time to check RPM) |

|

|N - NLAST| > NDIF ---------------|

(RPM changing too fast)

LMBTMR - LOW MAP BYPASS TIMER

MAP <= LMBMAP --------------------------------| Increment LMBTMR

|

| --- ELSE ---

|

| LMBTMR = 0

LUTIMR - TRANSMISSION LOCK-UP CONTROL TIMER

Refer to the desired transmission section (AXOD or A4LD) for the LUTIMR logic.

21-16

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MPGTMR - MPG MODE CONTROL TIMER

MPGTMR enables Fuel Economy Mode as a function of Vehicle Speed or Transmission

gear, provided the Engine is operating in a steady state mode (cruise) within a

limited range of Manifold Pressures and Engine Coolant Temperatures. MPGTMR is

used to control the Fuel Economy Mode Flag (MPGFLG), which is used to select the

Fuel Economy Mode calibrations for Fuel, Spark, EGR and Thermactor.

CFMFLG = 0 --------------------------------|

|

MFMFLG = 0 --------------------------------|

|

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

|OR --|

MPGFLG = 1 --------------------------| |

|

IDLFLG = 0 --------------------------------|

|

APT < 1 -----------------------------------|

|

ECT >= MPGCTL -----------------------------|

|

ECT <= MPGCTH -----------------------------|AND -| Increment MPGTMR

| | Clip to FN900(VSBAR) as

GEAR\_CUR >= MPGGR -------------------| | | a maximum

|OR --| |

O\_8500\_SW = 0 -----------------------| | | --- ELSE ---

| |

N\_BYTE >= MPGRPM + MPGRPH -----| | | Decrement MPGTMR

| | | Clip to FN900(VSBAR) -

MAP >= MAPLO + MAPLOH ---------| | | MPGRT as a maximum

| | | Clip to ZERO as a minimum

MAPPA <= MAPAHI - MPAHIH ------| |

| |

BP >= MPMNBP + MPNBPH ---------|AND -|S Q -|

| |

NOVS <= MPGNOV - MPNOVH -------| |

| |

VSBAR >= VSMPG + VSMPGH -| | |

| | |

VSTYPE = 0 --------------|OR --| |

| |

O\_8500\_SW = 1 -----------| |

|

(continued on next page)

21-17

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

N\_BYTE < MPGRPM ---------------| |

| |

MAP < MAPLO -------------------| |

| |

MAPPA > MAPAHI ----------------| |

|OR --|C

BP < MPMNBP -------------------|

|

NOVS > MPGNOV -----------------|

|

VSBAR < VSMPG -----------------|

MPG MODE FLAG LOGIC (MPGFLG)

MPGTMR >= FN900(VSBAR) -----------------------| MPGFLG = 1

|

| --- ELSE ---

|

| MPGFLG = 0

MPG MODE TRANSITION FLAG SET LOGIC (MPGTFG)

Previous MPGFLG = 1 --------------------|

|AND -| MPGTFG = 1

Current MPGFLG = 0 ---------------------| | (transition from MPG Mode)

21-18

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MULTMR - TIME SINCE INCREMENTING LAMMUL

always ---------------------------------------| Increment MULTMR

NOTE: MULTMR is periodically set to 0 within the Open Loop Fuel Logic.

NACTMR - NOT AT CLOSED THROTTLE TIMER

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

(part throttle mode) |

|OR --| Increment NACTMR

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

(wide open throttle mode) | --- ELSE ---

|

| NACTMR = 0

NDDTIM - TIME SINCE NEUTRAL/DRIVE SWITCH STATE CHANGE

NEUTRAL/DRIVE SWITCH STATE CHANGE ------------| NDDTIM = 0

|

| --- ELSE ---

|

| Increment NDDTIM

OSCTMR - OSCMOD DELAY TIMER (0.125 SEC)

This timer is used to prevent OSCMOD spark feedback during manual transmission

shifts.

TPDLBR >= SHFDLT -----------------------------| Increment OSCTMR

|

| --- ELSE ---

|

| OSCTMR = 0

PUTMR - TIME SINCE CPU POWER-UP

CPU POWER ON ---------------------------------| Increment PUTMR

21-19

TIMERS - LHBH0

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SETTMR - RPM CONTROL ENTRY DELAY TIMER (0.125 seconds)

This timer is used to delay entry into RPM control for a time which corresponds

to the manifold stabilization time. SETTMR is cleared in Idle Speed Control

MODE\_SELECT.

In mode select -------------------------|

|

APT >= 0 -------------------------| |AND -| SETTMR = 0

(not Closed Throttle) |OR --| |

| | --- ELSE ---

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

|AND -| | Increment SETTMR

DASPOT > DASCTL ------------|

(daspot too large)

SHFTMR - SHIFT IN PROGRESS TIMER

always ---------------------------------------| Decrement SHFTMR

(free running)

NOTE: SHFTMR is loaded with SHFTTM when any 3-4 or 4-3 shift is made. Thus

when SHFTMR = 0, no shift is in progress.

TARTMR - TIME SINCE OLDTP WAS UPDATED

always ---------------------------------------| Increment TARTMR

| Clip at MAXTIM

NOTE: TARTMR is reset within the software TAR logic.

21-20

TIMERS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TSLEGO - TIME SINCE LAST EGO SWITCH

OPEN LOOP FUEL CONTROL -----------------|

|AND -| TSLEGO = 0

LESFLG = 0 -----------------------------| | Freeze TSLEGO

(ego switching) |

| --- ELSE ---

|

EGO SWITCH -----------------------------------| LESFLG = 0

| (EGO switching)

| Increment TSLEGO

|

| --- ELSE ---

|

TSLEGO > LESTM -------------------------------| LESFLG = 1

| (EGO not switching)

| Increment TSLEGO

|

| --- ELSE ---

|

| Increment TSLEGO

NOTE: TSLEGO is also set to zero within the closed loop fuel logic after the

jumpback is calculated following an EGO switch.

TSLPIP - TIME SINCE LAST PIP

NEW\_PIP = 1 ----------------------------------| TSLPIP = 0

| NEW\_PIP = 0

|

| --- ELSE ---

|

| Count up TSLPIP

NOTE: NEW\_PIP is set equal to 1 upon a PIP interrupt.

V\_NACTMR\_CUM - SELF TEST CUMULATIVE NOT A CLOSED THROTTLE TIMER

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

|OR --| Increment V\_NACTMR\_CUM

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

| --- ELSE ---

|

| Freeze V\_NACTMR\_CUM

21-21

TIMERS - LHBH0

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VOLTMR - LOW VOLTAGE TIMER

Low voltage timer (VOLTMR) represents the amount of time that battery voltage,

as indicated by the VBAT calculation, is lower than a calibrated threshold

voltage LOWVOL. VOLTMR is referenced by FN821A to determine the increase in

engine speed necessary to provide battery charge compensation (see Desired RPM

calculation in the Idle Speed Control Chapter).

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

(run/underspeed mode) |

|

VBAT < LOWVOL --------------------|S Q -|AND -| Count up VOLTMR

| | | Clip VOLTMR to VOLTCLP

VBAT >= LOWVOL + VOLHYS ----------|C | |

| |

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

| --- ELSE ---

NACTMR >= CHGTM ------------------------| |

|AND -| Count down VOLTMR

VBAT >= LOWVOL + VOLHYS ----------------| |

| --- ELSE ---

|

| Freeze VOLTMR

WOTTMR - TIME AT WIDE OPEN THROTTLE

APT = 1 --------------------------------------| Increment WOTTMR

|

| --- ELSE ---

|

| Decrement WOTTMR

21-22

CHAPTER 22

FAILURE MODE MANAGEMENT

22-1

FAILURE MODE MANAGEMENT, OVERVIEW - LHBH0

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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 five sensors: MAP, TP, ECT, ACT and EGR(EVP/PFE). 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 | MAP | TP | ECT | ACT | EGR |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|\_\_\_\_\_|\_\_\_\_|\_\_\_\_\_|\_\_\_\_\_|\_\_\_\_\_|

Transmission - Do not Lock Up | X | X | X | X | |

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

Inferred BP - No PT/WOT Update | X | X | X | X | |

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

Adaptive Fuel - No Update | X | X | X | X | |

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

Idle Speed - Fixed Duty Cycle | X | X | X | X | |

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

EGR - Disabled | X | X | X | X | X |

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

THERMACTOR - Bypass Air | X | X | X | X | |

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

MPG MODE - Do Not Enter | X | | X | | |

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

DECEL FUEL S/O - Disable | \* | \* | | | |

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

NOTE: DFSO is disabled only if both the MAP and TP sensors have failed.

22-2

FAILURE MODE MANAGEMENT, FAILURE RECOGNITION - LHBH0

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FAILURE RECOGNITION

OVERVIEW

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 APPROXIMATELY describes the Fault recognition and value

substitution strategy. However, to more effectively use the Self Test Fault

filters, the logic is divided into two sections; the Fault Flag logic and the

Sensor input process logic. (See Specific Sensor FMEMs.)

DEFINITIONS

INPUTS

Bit Flags:

- CRKFLG = Flag indicating Crank mode.

Calibration Contants:

- FILHYS = Hysteresis term to permit normal TP update, if sensor is

functioning properly.

22-3

FAILURE MODE MANAGEMENT, FAILURE RECOGNITION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_FAIL\_REC\_COM1

SENSOR >= SENSORMIN -----------| | SENSOR WITHIN

(sensor OK) | | ACCEPTABLE RANGE

C\*\*\*FIL < C\*\*\*LVL - FILHYS ----| | UPDATE SENSOR INPUT

(sensor high fault |AND -|

filter OK) | | Failure Flags = 0

SENSOR <= SENSORMAX -----------| |

(sensor OK) | |

C\*\*\*FIL < C\*\*\*LVL - FILHYS ----| | --- ELSE ---

(sensor low fault filter OK) |

| SENSOR OUTSIDE

CRANK MODE (CRKFLG = 1) -------------| RANGE

(Optional) | SENSOR = INITIAL VALUE

|

| --- ELSE ---

|

C\*\*\*FIL > C\*\*\*LVL -------------| | SENSOR OUTSIDE

(sensor high fault) |OR --| RANGE - NOT DUE TO

C\*\*\*FIL > C\*\*\*LVL -------------| | LOW BATTERY VOLTAGE

(sensor low fault) | Failure Flags = 1

|

| ALTERNATE STRATEGY

| SENSOR = SUBSTITUTED

| VALUE

|

| --- ELSE ---

|

| SENSOR DATA NOT

| RELIABLE - DO NOT

| UPDATE UNTIL CHECK

| PROVES VALUE VALID.

NOTE: MAP Failure Mode Recognition is described in the MAP

calculation (See INPUT CONVERSIONS AND FILTERS Chapter).

Should this strategy be implemented in the Continuous Self Test Strategy, the

following specifications must be met:

- FMEM Code must be executed following the A/D conversion.

- FMEM Code must be executed, once per background loop, during ALL Engine

Modes (CRANK, UNDERSPEED, RUN, KEYON).

- Continuous Self Test Check provides two functions: It does Normal Fault

Filtering for ALL sensors checked by the continuous Self Test; and, it

also executes the FMEM\_FLAG logic.

22-4

FAILURE MODE MANAGEMENT, ACT SENSOR UPDATE - LHBH0

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ACT SENSOR UPDATE

OVERVIEW

DEFINITIONS

INPUTS

Registers:

- C112FIL = Self Test Register which counts the number of ACT high

failures.

- C113FIL = Self Test Register which counts the number of ACT low failures.

- ECT = Engine Coolant Temperature, deg F.

- IACT = A/D conversion of ACT sensor input, counts.

- IECT = A/D conversion of ECT sensor, counts.

Bit Flags:

- AFMFLG = Flag indicating that ACT sensor has failed.

- CFMFLG = Flag indicating that ECT sensor is in/out of range.

- WRMEGO = Ego sensor should be warm flag; 1 -> Ego warm, 0 -> Ego is

Calibration Constants:

- ACTFMM = FMEM default value for ACT.

- ACTMAX = Maximum ACT (ACT Open), Counts.

- ACTMIN = Minimum ACT (ACT Shorted), Counts.

- C112LVL = Threshold for ACT short fault, unitless.

- C113LVL = Threshold for ACT Open fault, unitless.

- FILHYS = Hysteresis term to prevent spurious exit of Failure Mode

strategy.

- FN703 = ECT/ACT transfer function.

OUTPUTS

Registers:

- ACT = Air Charge Temperature, deg F.

22-5

FAILURE MODE MANAGEMENT, ACT SENSOR UPDATE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- AFMFLG = Flag indicating that ACT sensor has failed.

PROCESS

STRATEGY MODULE: INPUT\_ACT\_COM2

This module is performed during engineering units conversion.

AFMFLG = 0 --------------------|

|

IACT <= ACTMAX -----------------|AND -| ACT = FN703(IACT)

| | (sensor OK)

IACT >= ACTMIN -----------------| |

| --- ELSE ---

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

(start up Open Loop) | |

| |

CFMFLG = 0 ---------------------| |

|AND -| ACT = FN703(IECT)

IECT <= ECTMAX -----------------| | (sensor bad, use ECT if OK)

| |

IECT >= ECTMIN -----------------| |

| --- ELSE ---

|

AFMFLG = 1 ---------------------------| ACT = ACTFMM

|

| --- ELSE ---

|

| Do not update ACT

22-6

FAILURE MODE MANAGEMENT, ACT SENSOR UPDATE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

AFMFLG LOGIC (FOR ACT SENSOR)

CONTINUOUS SELF TEST

C112FIL > C112LVL --------------------| afmlo = 1

|

| --- ELSE ---

|

C112FIL < C112LVL - FILHYS -----------| afmlo = 0

C113FIL > C113LVL --------------------| afmhi = 1

|

| --- ELSE ---

|

C113FIL < C113LVL - FILHYS -----------| afmhi = 0

afmhi --------------------------|

|OR --| AFMFLG = 1

afmlo --------------------------| |

| --- ELSE ---

|

| AFMFLG = 0

22-7

FAILURE MODE MANAGEMENT, ADAPTIVE FUEL TABLE FMEM - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ADAPTIVE FUEL TABLE FMEM

OVERVIEW

This module sets and clears two adaptive fuel failure mode flags; one flag

for each adaptive table in a two EGO control system.

DEFINITIONS

INPUTS

Registers:

\_ C179FIL = At adaptive fuel limit, system lean fault filter.

\_ C181FIL = At adaptive fuel limit, system rich fault filter.

\_ C182FIL = At adaptive fuel limit, system lean at idle fault filter.

\_ C183FIL = At adaptive fuel limit, system rich at idle fault filter.

\_ C188FIL = At adaptive fuel limit (EGO #2), system lean fault filter.

\_ C189FIL = At adaptive fuel limit (EGO #2), system rich fault filter.

\_ C191FIL = At adaptive fuel limit (EGO #2), system lean at idle fault

filter.

\_ C192FIL = At adaptive fuel limit (EGO #2), system rich at idle fault

filter.

Bit Flags:

\_ NUMEGO = Number of EGO sensors.

Calibration Constants:

\_ C179LVL = At adaptive fuel limit, system lean fault filter threshold.

\_ C181LVL = At adaptive fuel limit, system rich fault filter threshold.

\_ C182LVL = At adaptive fuel limit, system lean at idle fault filter

threshold.

\_ C183LVL = At adaptive fuel limit, system rich at idle fault filter

threshold.

\_ C188LVL = At adaptive fuel limit (EGO #2), system lean fault filter

threshold.

\_ C189LVL = At adaptive fuel limit (EGO #2), system rich fault filter

threshold.

\_ C191LVL = At adaptive fuel limit (EGO #2), system lean at idle fault

filter threshold.

22-8

FAILURE MODE MANAGEMENT, ADAPTIVE FUEL TABLE FMEM - LHBH0

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\_ C192LVL = At adaptive fuel limit (EGO #2), system rich at idle fault

filter threshold.

\_ FILHYS = Hysteresis term to prevent spurious exit of Failure Mode

strategy.

OUTPUTS

Bit Flags:

\_ ADT1FMFLG = Adaptive table 1 failure mode.

\_ ADT2FMFLG = Adaptive table 2 failure mode.

22-9

FAILURE MODE MANAGEMENT, ADAPTIVE FUEL TABLE FMEM - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_ADAPT\_COM1

C179FIL > C179LVL ----------------|

(adapt lean clip, ego 1) |

|

C181FIL > C181LVL ----------------|

(adapt rich clip, ego 1) |

|OR --| ADT1FMFLG = 1

C182FIL > C182LVL ----------------| |

(adapt lean clip at idle, ego 1) | |

| |

C183FIL > C183LVL ----------------| |

(adapt rich clip at idle, ego 1) |

| --- ELSE ---

C179FIL < C179LVL - FILHYS -------| |

| |

C181FIL < C181LVL - FILHYS -------| |

|AND -| ADT1FMFLG = 0

C182FIL < C182LVL - FILHYS -------|

|

C183FIL < C183LVL - FILHYS -------|

22-10

FAILURE MODE MANAGEMENT, ADAPTIVE FUEL TABLE FMEM - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

For Stereo EGO systems:

NUMEGO = 2 -----------------------|

|

C188FIL > C188LVL ----------| |

(adapt lean clip, ego 2) | |

| |AND -| ADT2FMFLG = 1

C189FIL > C189LVL ----------| | |

(adapt rich clip, ego 2) | | |

|OR --| |

C191FIL > C191LVL ----------| |

(adapt lean clip at idle, | |

ego 2) | |

| |

C192FIL > C192LVL ----------| |

(adapt rich clip at idle, |

ego 2) |

| --- ELSE ---

NUMEGO = 2 -----------------------| |

| |

C188FIL < C188LVL - FILHYS -| | |

| |AND -| ADT2FMFLG = 0

C189FIL < C189LVL - FILHYS -| |

| |

C191FIL < C191LVL - FILHYS -|AND -|

|

C192FIL < C192LVL - FILHYS -|

22-11

FAILURE MODE MANAGEMENT, ECT SENSOR UPDATE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ECT SENSOR UPDATE

OVERVIEW

DEFINITIONS

INPUTS

Registers:

\_ ACT = Air Charge Temperature, deg F.

\_ C117FIL = Self Test Register which counts the number of ECT high

failures.

\_ C118FIL = Self Test Register which counts the number of ECT low failures.

\_ ECT = Engine Coolant Temperature, deg F.

\_ ECTCNT = ECT counter used in TCSTRT average.

\_ FMECTR = Background loop counter used to ramp failed ECT from ACT in

crank

mode to ECTFMM.

Bit Flags:

\_ CFMFLG = Flag indicating that ECT sensor is in/out of range.

\_ CRKFLG = Crank flag.

\_ IECT = A/D conversion of ECT sensor, counts.

Calibration Constants:

\_ C117LVL = Threshold for ECT Short Fault, unitless.

\_ C118LVL = Threshold for ECT Open fault, unitless.

\_ ECTFMM = FMEM default value for ECT, deg F.

\_ ECTMAX = Maximum engine ECT, Counts.

\_ ECTMIN = Minimum engine ECT, Counts.

\_ FILHYS = Hysteresis term to prevent spurious exit of Failure Mode

strategy.

\_ FMECNT = Number of background loops between incrementing/decrementing ECT

register by 2 deg.F. A good estimate of The ECT ramp is 2 deg.F/6

seconds,

therefore, FMECNT = 6 sec./.030 sec. per background loop = 200.

\_ FN703 = ECT/ACT transfer function.

22-12

FAILURE MODE MANAGEMENT, ECT SENSOR UPDATE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

\_ TCECT = Time constant for ECT, sec.

OUTPUTS

Registers:

\_ ECT = Engine Coolant Temperature, deg F.

\_ FMECTR = Background loop counter used to ramp failed ECT from ACT in

crank

mode to ECTFMM.

Bit Flags:

\_ CFMFLG = Flag indicating that ECT sensor is in/out of range.

22-13

FAILURE MODE MANAGEMENT, ECT SENSOR UPDATE - LHBH0

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PROCESS

STRATEGY MODULE: INPUT\_ECT\_COM2

This module is performed during engineering units conversion.

CFMFLG = 0 ----------------------|

|

IECT <= ECTMAX ------------------|

|AND -| ECT = FN703(IECT)

IECT >= ECTMIN ------------------| | (sensor OK)

| |

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

| --- ELSE ---

|

ECTCNT = 0 ----------------------------| ECT = ACT

| (sensor bad, start rolling

| average at ACT)

|

| --- ELSE ---

CFMFLG = 0 ----------------------| |

| |

IECT <= ECTMAX ------------------|AND -| ECT = ROLAV(FN703(IECT),TCECT)

| | (sensor OK)

IECT >= ECTMIN ------------------| |

| --- ELSE ---

|

CRKFLG = 1 ----------------------------| ECT = ROLAV(ACT),TCECT)

(crank mode) | (sensor bad, infer ECT from ACT)

|

| --- ELSE ---

|

CFMFLG = 1 ----------------------------| Increment FMECTR

(every background loop) | (clip at 255 as a max)

| Perform ECT RAMP LOGIC

|

| --- ELSE ---

|

| Do not update ECT

22-14

FAILURE MODE MANAGEMENT, ECT SENSOR UPDATE - LHBH0

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ECT RAMP LOGIC

ECT > ECTFMM --------------|

|AND -| ECT = ECT - 2 deg. F

FMECTR >= FMECNT ----------| | FMECTR = 0

| (ramp down to ECTFMM)

|

| --- ELSE ---

ECT < ECTFMM --------------| |

|AND -| ECT = ECT + 2 deg. F

FMECTR >= FMECNT ----------| | FMECTR = 0

| (ramp up to ECTFMM)

|

| --- ELSE ---

|

ECT = ECTFMM --------------------| Do not update ECT

| (ECT is already ECTFMM)

CFMFLG LOGIC (FOR ECT SENSOR)

CONTINUOUS SELF TEST

C117FIL > C117LVL ---------------| cfmlo = 1

|

| --- ELSE ---

|

C117FIL < C117LVL - FILHYS ------| cfmlo = 0

C118FIL > C118LVL ---------------| cfmhi = 1

|

| --- ELSE ---

|

C118FIL < C118LVL - FILHYS ------| cfmhi = 0

cfmhi = 1 -----------------|

|OR --| CFMFLG = 1

cfmlo = 1 -----------------| |

| --- ELSE ---

|

| CFMFLG = 0

22-15

FAILURE MODE MANAGEMENT, EVP SENSOR FMEM - LHBH0

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EVP SENSOR FMEM (PFEHP = 0)

OVERVIEW

The EVP sensor failure Mode strategy will force the EGR valve to close and

will have no adverse impact on Spark or Fuel.

DEFINITIONS

INPUTS

Registers:

\_ C327FIL = Self Test Register which counts the number of EVP low failures.

\_ C337FIL = Self Test Register which counts the number of EVP high

failures.

\_ EOFF = The EGR valve reading when the valve is fully closed in A/D

counts.

\_ IEGR = A/D conversion of EVP or EPT sensor, counts.

Bit Flags:

\_ EFMFLG = Flag indicating that EVP EGR sensor has failed. (This flag

performs for both Sonic and PFE EGR.)

Calibration Constants:

\_ C327LVL = Threshold for EVP fault, unitless.

\_ C337LVL = Threshold for (PFE) EVP fault, unitless.

\_ EVPMAX = Maximum EGR Valve position, counts.

\_ EVPMIN = Minimum EGR Valve position, counts.

\_ FILHYS = Hysteresis term to prevent spurious exit of Failure Mode

strategy.

OUTPUTS

Registers:

\_ EVP = EGR valve position reading in A/D counts.

Bit Flags:

\_ EFMFLG = Flag indicating that EVP EGR sensor has failed. (This flag

performs for both Sonic and PFE EGR.)

22-16

FAILURE MODE MANAGEMENT, EVP SENSOR FMEM - LHBH0

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PROCESS

STRATEGY MODULE: INPUT\_EVP\_COM2

This module is performed during engineering units conversion.

EFMFLG = 0 ---------------|

|

IEGR <= EVPMAX -----------|AND -| EVP = IEGR

| |

IEGR >= EVPMIN -----------| | --- ELSE ---

|

EFMFLG = 1 ---------------------| EVP = EOFF

|

| --- ELSE ---

|

| Do NOT update EVP

EFMFLG LOGIC (FOR EVP SENSOR)

CONTINUOUS SELF TEST

C337FIL > C337LVL --------------| efmhi = 1

|

| --- ELSE ---

|

C337FIL < C337LVL - FILHYS -----| efmhi = 0

C327FIL > C327LVL --------------| efmlo = 1

|

| --- ELSE ---

|

C327FIL < C327LVL - FILHYS -----| efmlo = 0

efmhi = 1 ----------------|

|OR --| EFMFLG = 1

efmlo = 1 ----------------| |

| --- ELSE ---

|

| EFMFLG = 0

22-17

FAILURE MODE MANAGEMENT, TOT SENSOR FMEM - CAAJ0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TOT SENSOR FMEM

DEFINTIONS

INPUTS

Registers:

\_ ECT = Engine Coolant Temperature, deg F.

\_ ECTCNT = ECT counter used in TCSTRT average.

\_ ITOT = Transmission Oil temperature, counts.

Bit Flags:

Calibration Constants:

\_ FN703D(ITOT) = TOT transfer function; purpose: convert ITOT A/D counts

into deg. F, counts.

\_ TCTOT = Time constant for filtered TOT, sec.

\_ TOTMAX = Maximum allowable TOT counts, counts.

\_ TOTMIN = Minimum allowable TOT counts, counts.

OUTPUTS

Registers:

\_ TOT = Transmission Oil Temperature, deg F.

22-18

FAILURE MODE MANAGEMENT, TOT SENSOR FMEM - CAAJ0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: INPUT\_TOT\_COM1

This module is performed during engineering units conversion.

ITOT <= TOTMAX -----------|

|

ITOT >= TOTMIN -----------|AND -| TOT = FN703D(ITOT)

| | (sensor OK, start rolling

ECTCNT = 0 ---------------| | average at actual value)

|

| --- ELSE ---

ITOT <= TOTMAX -----------| |

|AND -| TOT = ROLAV(FN703D(ITOT),TCTOT)

ITOT >= TOTMIN -----------| | (sensor OK)

|

| --- ELSE ---

|

| TOT = ECT

| (sensor bad, use ECT)

22-19

FAILURE MODE MANAGEMENT, TP SENSOR FMEM - LHBH0

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TP SENSOR FMEM

OVERVIEW

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, the FMEM strategy will infer throttle position

based upon a load parameter (usually MAP). [NOTE: The load parameters has

protective logic in the event of a load sensor failure. See the MAP

calculation in the Systems Equation Chapter.

DEFINITIONS

INPUTS

Registers:

\_ C122FIL = Throttle Position(TP) sensor circuit below minimum voltage

fault filter.

\_ C123FIL = Throttle Position(TP) sensor circuit above maximum voltage

fault filter.

\_ MAP = Manifold absolute pressure.

\_ RATCH = Closed throttle position, counts.

Bit Flags:

\_ CRKFLG = Crank Flag.

\_ ITP = Throttle position value from A/D conversion, counts.

\_ TFMFLG = Flag indicating that TP sensor has failed.

Calibration Constants:

\_ C122LVL = Throttle Position(TP) sensor circuit below minimum voltage

threshold.

\_ C123LVL = Throttle Position(TP) sensor circuit above maximum voltage

threshold.

\_ FILHYS = Hysteresis term to prevent spurious exit of Failure Mode

strategy.

\_ FN090 = Change in TP as a function of MAP. This function is designed to

permit Closed and Part Throttle operation.

\_ TAPMAX = Maximum valid TP value, counts. (Calibrated by Self Test Design

Section)

\_ TAPMIN = Minimum valid TP value, counts. (Calibrated by Self Test Design

Section)

22-20

FAILURE MODE MANAGEMENT, TP SENSOR FMEM - LHBH0

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OUTPUTS

Registers:

\_ RATCH = Closed throttle position, counts.

\_ TP = Throttle position, counts.

Bit Flags:

\_ TFMFLG = Flag indicating that TP sensor has failed.

22-21

FAILURE MODE MANAGEMENT, TP SENSOR FMEM - LHBH0

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PROCESS

STRATEGY MODULE: INPUT\_TP\_COM3

This module is performed during engineering units conversion.

TFMFLG = 0 ------------------|

|

ITP >= TAPMIN ---------------|AND -| TP = ITP

| | (TP sensor within

ITP <= TAPMAX ---------------| | acceptable range)

|

| --- ELSE ---

|

CRKFLG = 1 ------------------------| TP = RATCH

(crank mode) | (TP sensor out of limits)

|

| --- ELSE ---

|

TFMFLG = 1 ------------------------| TP = RATCH + FN090(MAP)

| RATCH = RACHIV

| (TP sensor out of limits

| but NOT due to Low

| battery voltage)

|

| --- ELSE ---

|

| No change to TP

| (TP sensor data unreliable

| DO NOT update until

| confident data valid)

22-22

FAILURE MODE MANAGEMENT, TP SENSOR FMEM - LHBH0

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TFMFLG LOGIC (FOR TP SENSOR)

CONTINUOUS SELF TEST CHECK

C122FIL > C122LVL -----------------| tfmlo = 1

|

| --- ELSE ---

|

C122FIL < C122LVL - FILHYS --------| tfmlo = 0

C123FIL > C123LVL -----------------| tfmhi = 1

|

| --- ELSE ---

|

C123FIL < C123LVL - FILHYS --------| tfmhi = 0

tfmhi = 1 -------------------|

|OR --| TFMFLG = 1

tfmlo = 1 -------------------| |

| --- ELSE ---

|

| TFMFLG = 0

22-23

FAILURE MODE MANAGEMENT, TP SENSOR FMEM - LHBH0

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22-24

CHAPTER 23

INFERRED BAROMETRIC PRESSURE STRATEGY

23-1

INFERRED BAROMETRIC PRESSURE STRATEGY - LHBH0

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INFERRED BAROMETRIC PRESSURE STRATEGY

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

BACKGROUND:

Earlier EEC systems used two pressure sensors (manifold absolute and

barometric absolute pressure) to provide full altitude capability. Since

both sensors perform the same function (i.e. measure pressure), elimination

of one sensor, via time sharing or software inference was considered a

significant system cost reduction. Since MAP is a primary input for both

spark and fuel control and BAP is a secondary modifier, elimination of BAP

sensor resulted in cost reduction.

In the Inferred Barometric Pressure strategy, the BAP sensor is replaced by a

software algorithm which uses available inputs (i.e. MAP, RPM, Throttle

Position, ECT) to infer the Barometric Pressure. The EEC-IV Barometric

Pressure (BP) is saved in Keep Alive Memory (KAM) to bridge the power-down to

power-up sequence.

DEFINITIONS

- ATMR1 = Time since engine start-up, sec.

- BPKAM = Barometric pressure stored in KAM.

- BPKFLG = KAM flag indication state of BPKYON. If it is equal to zero,

normal KEY-ON is assumed.

- BPKYON = Calculated BP while KEY ON.

- BPPTWT = Barometric pressure calculated during part throttle or WOT.

- BPUFLG = Flag which indicates that BP update is or is not permitted.

- CFMFLG = Flag indicating state of ECT sensor.

- CRKFLG = State of engine mode; 0 -> Run/Underspeed.

- ECT = Engine Coolant Temperature, deg F.

- KAM = Keep Alive Memory.

- KAMOK = Flag indicating whether KAM error exists or not.

- MAP = Manifold absolute pressure.

- MAPBAR = Calculated as rolling average filter of MAP.

- MFMFLG = Flag indicating state of MAP sensor.

- PIP = Profile ignition pickup (rpm input).

- PTPFLG = Flag indicating engine is running.

23-2

INFERRED BAROMETRIC PRESSURE STRATEGY - LHBH0

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- PUTMR = Power up timer.

- RATCH = Lowest throttle position since start.

- TFMFLG = Flag indicating state of TP sensor.

- TP = Throttle position.

- TP\_REL = Relative Throttle Position, TP - RATCH.

CALIBRATION CONSTANTS:

- ECTBP = Temperature at which inferred BP is enabled.

- FKBP = BPPTWT filter constant.

- FN046A = Normalizing function for AM/BP as Y-input to FN1033.

- FN047A = Normalizing function for relative TP input to FN1033.

- FN069A = The minimum relative throttle angle (TP\_REL) for Inferred BP

update. This function prevents BP updates when the airflow becomes sonic

at a particular throttle area (constant airflow for constant throttle

angle and increasing rpm).

- FN1033 = The pressure drop/BP table as a function of relative throttle

position (TP\_REL) and air mass flow (AM/BP). The normalizing function

for AM/BP is FN046A. The normalizing function for TP\_REL is FN047A.

- SSMAP = Steady state MAP.

- TKYON1 = Time at which PIP sensing is enabled. (NOT calibratable)

- TKYON2 = Time at which BPKYON update begins. (NOT calibratable)

- TKYON3 = Maximum time at which BPKYON update may begin. (NOT

calibratable)

- TKYON4 = Locks out additional KEYON inferred BP updates. (NOT

calibratable)

SUMMARY:

Barometric Pressure is inferred by two methods:

1. KEY ON - ENGINE OFF condition (BPKYON).

2. PART THROTTLE/WIDE OPEN THROTTLE condition (BPPTWT).

The BP calculation uses Keep Alive Memory to maintain accuracy. During Key

on engine off condition, MAP is read and stored in KAM to be used as BP after

start. During Part Throttle and Wide Open Throttle conditions, BP is

calculated using MAP and the pressure drop across the air inlet.

23-3

INFERRED BAROMETRIC PRESSURE STRATEGY - LHBH0

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The inferred Barometric Pressure Strategy is described in the following

pages.

The Barometric Pressure from each method is saved separately in Keep Alive

Memory (KAM). When Barometric Pressure is updated its value is also saved in

the Keep Alive Memory Register called BPKAM. This register will always

contain the most recent update of Barometric Pressure.

BPKYON updated ----------------------------------| BPKAM = BPKYON

|

| --- ELSE ---

|

BPPTWT updated ----------------------------------| BPKAM = BPPTWT

|

| --- ELSE ---

|

| BPKAM not updated

23-4

INFERRED BAROMETRIC PRESSURE STRATEGY - LHBH0

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BPKYON - KEY ON BAROMETRIC PRESSURE UPDATE PROCEDURE:

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

During key-on engine-off, the Manifold Absolute Pressure is filtered and

saved as Barometric Pressure in the Keep Alive Memory. The Key On BP Value

BPKYON is updated as follows:

Consider the time period immediately after power up.

TKYON1 TKYON2 TKYON3

| 50msec | 60msec | 400msec |

0------------+---------------+------------------+--------------+->TIME

| | | | |

POWER PIP START END MAX

UP SENSING BPKYON BPKYON BPKYON

ENABLED UPDATE UPDATE UPDATE

IF PIP TIME

OCCURS

1) During the 50 millisecond period after power up:

PIP signals are ignored by the BP strategy. Power up noise transients

can create false PIP signals.

The MAPBAR filter is continuously initialized at the current IMAP value.

The KAM flag BPKFLG is checked. This flag bridges the reset (loss of

computer control) that can occur with starter engagement. The flag is

set when the BPKYON value is actually updated. If BPKFLG is clear, a

normal key-on power up is assumed. The BPKYON update will be permitted

(later on). If BPKFLG is set, a starter engagement is assumed (engine

cranking). The BPKYON update will not be permitted.

2) During the 50 to 110 millisecond period after power up:

MAPBAR is calculated as a rolling average filter of MAP.

PIP sensing is enabled. This time period allows the BP strategy 1) to

detect engine cranking after a reset due to starter engagement or 2) to

detect engine running after a spurious reset during normal operation.

If the engine is turning with a PIP period less than 60 millisecond, a

PIP signal should occur during this time period. (The equivalent RPM

values are 500 for 4-cylinder, 333 for 6-cylinder, and 250 for

8-cylinder.)

23-5

INFERRED BAROMETRIC PRESSURE STRATEGY - LHBH0

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3) During the 110 to 510 millisecond period after power up:

MAPBAR is calculated as a rolling average filter of MAP.

PIP sensing is enabled.

If a PIP has not been sensed yet and if the BPKYON update is permitted

from step 1), MAPBAR is saved as barometric pressure in KAM (as both

BPKAM and BPKYON). The BPKYON update continues until a PIP occurs or

the time limit is reached.

23-6

INFERRED BAROMETRIC PRESSURE STRATEGY - LHBH0

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4) After 10 seconds of normal run mode operation, the BPKFLG is cleared to

get ready for the next power down/power up sequence.

KEY-ON BAROMETRIC PRESSURE UPDATE LOGIC

PUTMR > TKYON1 -------------------|

|AND -| PTPFLG = 1

PIP OCCURRED AFTER TKYON1 --------|

KAMOK = 0 ------------------------|

(KAM DATA BAD) |OR --| Permit KEY-ON BP update

| | BPUFLG = 1

BPKFLG = 0 -----------------------|

LAST\_MAP2 <> LAST\_MAP ------------|

|

BPUFLG = 1 -----------------------|

|

PUTMR > TKYON2 -------------------|

|AND --| Update KEY-ON BP

PUTMR < TKYON3 -------------------| | BPKFLG = 1

|

PTPFLG = 0 -----------------------|

(NO PIP'S YET)

BPKFLG = 1 -----------------------|

|AND -| BPKAM = MAPBAR

MAPBAR > 16" Hg ------------------| | BPKYON = MAPBAR

|

| --- ELSE ---

|

BPKFLG = 1 -----------------------------| BPKAM = 29.875

| BPKYON = 29.875

CRKFLG = 0, UNDSP = 0 ------------|

(RUN MODE) |AND -| Enable KEY-ON BP update

| | for next START-UP

ATMR1 > TKYON4 -------------------| | Clear BPKFLG = 0

NOTE:

1) BPKAM, BPKYON are restricted from 16" Hg to 31.875" Hg.

2) BPKAM is saved first in KAM , followed by BPKYON. Since a reset can

occur between these saves, BPKAM (used by strategy) will have the

highest chance to be current and correct.

23-7

INFERRED BAROMETRIC PRESSURE STRATEGY - LHBH0

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BPPTWT - PART THROTTLE/WIDE OPEN THROTTLE BAROMETRIC PRESSURE UPDATE :

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

During Part Throttle and Wide Open Throttle conditions, Barometric Pressure

is calculated as Manifold Absolute Pressure plus the pressure drop through

the throttle body. This is saved as BPPTWT and BPKAM in the Keep Alive

Memory.

MFMFLG = 0 -------------------|

(MAP sensor OK) |

|

CRKFLG = 0, UNDSP = 0 --------|

(RUN mode) |

|

CFMFLG = 0 -------------------|

(ECT OK) |

|

ECT > ECTBP ------------------|

|

TP\_REL > FN069A(AM/BP) -------|AND -| Calculate BPPTWT as

| | a rolling average

MAP >= MAPBAR ----------------| | filter of Manifold

| | Absolute Pressure

MAP - MAPBAR <= SSMAP --------| | plus the Pressure Drop

| | across the throttle.

ATMR1 > TKYON4 ---------------| | BPPTWT = UROLAV[MAP +

| | FN1033(TP\_REL,AM/BP)\*BP,TCBP]

TFMFLG = 0 -------------------| | BPKAM = BPPTWT

(TP sensor OK) |

|

AFMFLG = 0 -------------------|

(ACT sensor OK)

FN1033 is the pressure drop/BP table as a function of relative throttle

position (TP\_REL) and air mass flow (AM/BP), clipped to 0.996 as a minimum.

The normalizing function for AM/BP is FN046A. The normalizing function for

TP\_REL is FN047A.

FN069A defines the minimum relative throttle angle [(TP\_REL) clipped at 0 as

a minimum] for Inferred BP update. This function prevents BP updates when

the airflow becomes sonic at a particular throttle area (constant airflow for

constant throttle angle and increasing rpm).

Note: BPKAM, BPPTWT are restricted from 16" Hg to 31.875" Hg. TKYON4 is

also used in the key-on BP logic. It is a fixed 10 seconds.

23-8

INFERRED BAROMETRIC PRESSURE STRATEGY - LHBH0

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BAROMETRIC PRESSURE PIP COUNTER CONTROL LOGIC :

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

PUTMR > TKYON1 ---------------------------| Increment PTPCNT

| as PIPs occur

|

| --- ELSE ---

|

| PTPCNT = 0

23-9

INFERRED BAROMETRIC PRESSURE STRATEGY - LHBH0

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23-10

CHAPTER 24

KEEP ALIVE MEMORY

24-1

KEEP ALIVE MEMORY - LHBH0

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KEEP ALIVE MEMORY (KAM) QUALIFICATION TEST

OVERVIEW

Each time the vehicle is started, the data stored in KAM may not be valid.

Power interruptions, noise, etc., may have altered KAM contents. Or, the

computer may not be reading KAM registers correctly because of a hardware

fault. When the KAM registers are initialized, 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 initial values are also used in place of

the KAM data when the strategy references KAM.

The KAM registers KAMQA, KAMQB, and KAMQC are assigned to different areas of

the KAM. This will help protect for partial KAM failures. The assignments

are:

KAM KAM

Register Address

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

KAMQA LOWEST ADDRESS OF KAM

KAMQB MIDDLE ADDRESS OF KAM

KAMQC HIGHEST ADDRESS OF KAM

The KAM qualification test is normally performed each background loop when

the computer is running.

24-2

KEEP ALIVE MEMORY - LHBH0

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KAM QUALIFICATION TEST LOGIC

(Performed each background loop)

KAMQA = 10101010 BINARY----------------|

|

KAMQB = 11000110 BINARY----------------|AND -| KAM\_ERROR = 0

| | Assume KAM DATA is VALID

KAMQC = 01110101 BINARY----------------| | ALL Strategy references to

| | KAM will use KAM DATA.

RT\_NOVS\_KAM >= RTNVMN -----------------| | BP = BPKAM

| |

RT\_NOVS\_KAM <= RTNVMX -----------------| | --- ELSE ---

| | KAM\_ERROR = 1

BPKAM >= 16 ---------------------------| | VIP\_KAM = 1

| | Assume KAM DATA is BAD

BPKYON >= 16 --------------------------| | Initialize all KAM

| | locations used in the

BPPTWT >= 16 --------------------------| | strategy

| Clear all VIP CODES

| Write the special

| BINARY PATTERNS to KAM:

| KAMQA = 10101010 BINARY

| KAMQB = 11000110 BINARY

| KAMQC = 01110101 BINARY

| LTMTBLrc = 0.5

| CHKSUM = 13568

| ISCKAMn = 0.0 (n=0-5)

| ISKSUM = 0.0

| BPKAM = 29.875

| BPKYON = 29.875

| BPPTWT = 29.875

| BP = 29.875

| BPKFLG = 0

| KWUCTR = 0

| NOVCTR = 0

| RT\_NOV\_KAM = 1.0

| FLG\_FRST\_NOV = 0

| FLG\_NOV\_KAM = 0

| LESFLG = 0

24-3

KEEP ALIVE MEMORY - LHBH0

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ISCKAM VALIDATION PROCEDURE

(Performed during power up sequence)

|ISCKAM0 + ISCKAM1 + | | ASSUME THE ISCKAMs ARE VALID

ISCKAM2 + ISCKAM3 + |----------| ISKSUM = ISCKAM0 + ISCKAM1 +

ISCKAM4 + ISCKAM5 - | | ISCKAM2 + ISCKAM3

ISKSUM| <= 1 BIT ------| | ISCKAM4 + ISCKAM5

|

| --- ELSE ---

|

| ASSUME ISCKAMs DATA ARE INVALID

| RE-INITIALIZE THE ISCKAM

| ISCKAM0 = 0

| ISCKAM1 = 0

| ISCKAM2 = 0

| ISCKAM3 = 0

| ISCKAM4 = 0

| ISCKAM5 = 0

| ISKSUM = 0

VIP THROTTLE MODE SET

(Done each background loop in running VIP)

V\_MODE\_SETUP = 1 ------------------| Re-initialize the ISCKAM

(VIP Throttle Adjust Mode) | ISCKAM0 = 0

| ISCKAM1 = 0

| ISCKAM2 = 0

| ISCKAM3 = 0

| ISCKAM4 = 0

| ISCKAM5 = 0

| ISKSUM = 0

24-4

KEEP ALIVE MEMORY - LHBH0

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ADAPTIVE FUEL TABLE VALIDATION PROCEDURE

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.

Or, 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. Based on the result, KAM can be initialized as required. See the KAM

section for more details on the KAM qualification test.

Based on the results of the KAM qualification test, validate the adaptive

fuel table as follows;

|(SUM OF ALL KAM CELLS)------| | ASSUME THE ADAPTIVE FUEL

- CHKSUM| <= 1 BIT |AND -| DATA IN KAM IS VALID.

| | CHKSUM = SUM OF ADAPTIVE FUEL CELLS

CHKFLG = 0 ------------------| |

| --- 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 LTMTBLrc = 0.5

| 2) SET CHKSUM = 13568

| KWUCTR = 0

CHKSUM is a KAM memory word containing the sum of the LTMTBL contents.

CHKSUM is incremented or decremented each time any LTMTBL 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.

24-5

KEEP ALIVE MEMORY - LHBH0

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24-6

CHAPTER 25

EEC-IV SELF TEST

25-1

ENGINE OFF SELF TEST, EEC-IV SELF TEST OVERVIEW - LHBH0

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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 "111"

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 538)

will be sent to indicate that the test was incorrectly performed. 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. 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 STI

is latched or 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 80 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.

25-2

ENGINE OFF SELF TEST, EEC-IV SELF TEST BLOCK DIAGRAMS - LHBH0

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EEC-IV SELF TEST BLOCK DIAGRAMS

PROCESS

STRATEGY MODULE: VO\_BLOCKDIAG\_COM1

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 !

!-------------! | !--------------!

| | |

!-------------! | !--------------!

! 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 !--------------!

25-3

ENGINE OFF SELF TEST, EEC-IV SELF TEST BLOCK DIAGRAMS - LHBH0

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"CONTINUOUS" TESTS (STI=OPEN)

ENGINE-OFF: ENGINE-RUNNING:

!-------------! !---------------!

! "WIGGLE" ! ! CONTINUOUS !

! TEST ! ! TEST MODE !

!-------------! !---------------!

25-4

CHAPTER 26

SELF TEST ENTRY/EXIT LOGIC

26-1

SELF TEST ENTRY/EXIT LOGIC, SELF TEST ENTRY/EXIT LOGIC - LHBH0

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SELF TEST ENTRY/EXIT LOGIC

OVERVIEW

This logic checks for entry and exit conditions for the various self test

modes described below:

Engine Off Test

Engine Off Wiggle Mode

Engine Running Test

Engine Running Wiggle Mode

Continuous Self Test

Engine Running Test is disabled if an automatic transmission is put into

drive or if vehicle speed is above MINMPH. This is done for safety reasons.

If STI is ungrounded during the output of codes in Engine Off Test, all

continuous self test codes are erased from KAM. This allows for repair

verification by the mechanic.

DEFINITIONS

INPUTS

Registers:

- IEGR = EGR sensor input.

- PUTMR = Time after CPU power up.

- TSSTIL\_TMR = Time since STI low timer.

- VSBAR = Filtered vehicle speed.

Bit Flags:

- CRANKING = Engine Cranking Flag.

- DISABLE\_NOSTART = NST VIP disable flag.

- DISABLE\_RUNNING = RVIP disable flag.

- NDSFLG = Neutral/Drive flag; 1 -> Drive.

- NO\_START = NST VIP enable flag.

- RUNNING = RVIP Enable Flag.

- STIFLG = Self Test Input (demultiplexed); 1 -> STI grounded.

26-2

SELF TEST ENTRY/EXIT LOGIC, SELF TEST ENTRY/EXIT LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- STI\_RESET = 1 -> Operator requested Throttle Plate.

- STO\_TRIGGER = Trigger indicates STO output requested.

- STO\_WORKING = Self Test Output in use.

- UNDSP = Underspeed Flag.

- VIP\_ENABLE = VIP enable flag.

Calibration Constants:

- TRLOAD = Transmission load switch: See Base Strategy

- VSTYPE = Integrated vehicle speed/cruise control system present switch; 0

-> no MPH and no VSC, 1 -> MPH and no VSC.

- VTCEPT = EPT Time constant.

OUTPUTS

Registers:

- FIEPT = VIP EPT filter.

Bit Flags:

- DISABLE\_NOSTART = See above.

- DISABLE\_RUNNING = See above.

- NO\_START = See above.

- RUNNING = See above.

- VFS\_OUT\_FLG = 1 -> VFS output requested.

- VIP\_ENABLE = See above.

- VIP\_FP\_OVERRIDE = 1 -> regular strategy controls fuel pump.

- WIGFLG = Indicates Vip wiggle test.

26-3

SELF TEST ENTRY/EXIT LOGIC, SELF TEST ENTRY/EXIT LOGIC - LHBH0

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PROCESS

STRATEGY MODULE: VO\_I\_EXEC\_COM2

For application with EPC VFS SOLENOID, SONIC EGR

always ---------------------------------| VIP\_FP\_OVERRIDE = 0

| (make sure base strategy can

| control pump)

| Call LOADPOINT

always ---------------------------------| WIGFLG = 0

PUTMR >= 4 SEC -------------------------| VIP\_ENABLE = 1

NO\_START = 1 ---------------------|

(the KOEO mode) |

|

STIFLG = 1 -----------------------|AND -| (continue in Engine Off Test

(STI grounded) | | continue executing NO START VIP

| | background sequence, and

CRANKING = 1 ---------------------| | outputting codes)

(engine stopped) | VFS\_OUT\_FLG = 1

| (output TV pressure)

|

| --- ELSE ---

NO\_START = 1 ---------------------| |

| |

STIFLG = 1 -----------| | |

|AND -| | |

CRANKING = 0 ---------| | |AND -| (exit Engine Off Test)

|OR --| | Call RAM\_INIT

STIFLG = 0 -----------| | | NO\_START = 0

| | | DISABLE\_NOSTART = 1

STO\_WORKING = 0 ------|AND -| | VIP\_ENABLE = 0

| | (turn STO off)

STO\_TRIGGER = 0 ------| | (return to Background)

(not outputting codes) |

| --- ELSE ---

NO\_START = 1 ---------------------| |

| |

STIFLG = 0 -----------------------|AND -| Call VIP\_CODE\_ERASE

| | (erase all continuous codes

STO\_WORKING = 1 ------------| | | from KAM)

|OR --| | (exit Engine Off Test)

STO\_TRIGGER = 1 ------------| | Call RAM\_INIT

(outputting codes) | NO\_START = 0

| DISABLE\_NOSTART = 1

| VIP\_ENABLE = 0

| (turn STO off,

| return to Background)

|

| --- ELSE ---

(continued on next page)

26-4

SELF TEST ENTRY/EXIT LOGIC, SELF TEST ENTRY/EXIT LOGIC - LHBH0

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(continued from previous page)

RUNNING = 1 ----------------------| |

(in KOER mode) | |

| |

STI\_RESET = 1 --------------| | |

|OR --| |

STI\_RESET = 0 --------| | | |

|AND -| | |

STIFLG = 1 -----------| | |

| |

TRLOAD < 3 -----------------| | |

|OR --| |

TRLOAD >= 3 ----------| | |AND -| FIEPT = ROLAV(IEGR,VTCEPT)

(auto trans) | | | | (continue in Engine Running

|AND -| | | Test - continue executing

NDSFLG = 0 -----------| | | Engine Running background

(in neutral) | | sequence and outputting codes)

| |

VSTYPE <> 0 ----------| | |

(VSS present) |AND -| | |

| | | |

VSBAR <= MINMPH ------| | | |

|OR --| |

VSTYPE = 0 -----------------| |

(no VSS) |

| --- ELSE ---

|

RUNNING = 1 ----------------------------| (vehicle is moving, in gear,

| or exit requested)

| (exit Engine Running Test)

| Call RAM\_INIT

| RUNNING = 0

| DISABLE\_RUNNING = 1

| VIP\_ENABLE = 0

| DISABLE\_NOSTART = 1

|

| --- ELSE ---

CRANKING = 1 ---------------------| |

| |

STIFLG = 1 -----------------------|AND -| (enter Engine Off Test)

| | NO\_START = 1

DISABLE\_NOSTART = 0 --------------| |

| --- ELSE ---

CRANKING = 1 ---------------------| |

| |

STIFLG = 1 -----------------------|AND -| (enter Engine Off Wiggle Mode)

| | WIGFLG = 1

DISABLE\_NOSTART = 1 --------------| |

| --- ELSE ---

(continued on next page)

26-5

SELF TEST ENTRY/EXIT LOGIC, SELF TEST ENTRY/EXIT LOGIC - LHBH0

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(continued from previous page)

CRANKING = 0 ---------------------| |

| |

UNDSP = 0 ------------------------| |

(run mode) | |

| |

STIFLG = 1 -----------------------| |

(STI grounded) | |

| |

VIP\_ENABLE = 1 -------------------| |

| |

PUTMR >= 6 SEC -------------------| |

(time since powerup) | |

| |

TSSTIL\_TMR >= 1 SEC --------------|AND -| (enter Engine Running Test)

(time since STI grounded) | | RUNNING = 1

| |

DISABLE\_RUNNING = 0 --------------| |

| |

TRLOAD < 3 -----------------| | |

|OR --| |

TRLOAD => 3 ----------| | | |

(auto trans) |AND -| | |

| | |

NDSFLG = 0 -----------| | |

(in neutral) | |

| |

VSTYPE = 0 -----------------| | |

(no VSS) | | |

|OR --| |

VSTYPE <> 0 ----------| | |

|AND -| |

VSBAR <= MINMPH ------| |

| --- ELSE ---

CRANKING = 0 ---------------------| |

| |

UNDSP = 0 ------------------------| |

(run mode) | |

| |

STIFLG = 1 -----------------------| |

(STI grounded) |AND -| (Engine Running Test

| | should not be entered

VIP\_ENABLE = 1 -------------------| | because vehicle is

| | moving or is in gear)

PUTMR >= 6 SEC -------------------| | DISABLE\_RUNNING = 1

(time since powerup) | |

| |

TSSTIL\_TMR >= 1 SEC --------------| |

(time since STI grounded) | |

| |

DISABLE\_RUNNING = 0 --------------| |

| --- ELSE ---

(continued on next page)

26-6

SELF TEST ENTRY/EXIT LOGIC, SELF TEST ENTRY/EXIT LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

CRANKING = 0 ---------------------| |

| |

UNDSP = 0 ------------------------| |

| |

STIFLG = 1 -----------------------| |

| |

VIP\_ENABLE = 1 -------------------|AND -| (enter Engine Running

| | Wiggle Mode)

PUTMR >= 6 SEC -------------------| | WIGFLG = 1

| |

TSSTIL\_TMR >= 1 SEC --------------| |

| |

DISABLE\_RUNNING = 1 --------------| |

| --- ELSE ---

|

VIP\_ENABLE = 1 -------------------------| Enter Continuous Test

NOTE:

- The flag NO\_START is set immediately after the two 2msec pulses are

output on STO. The two 2msec pulses indicate that the module test and

RAM test were successfully completed.

- A RAM\_INIT sets CRKFLG=1 which causes WIGFLG to toggle during engine

run-up if STI was grounded prior to cranking.

26-7

SELF TEST ENTRY/EXIT LOGIC, SELF TEST ENTRY/EXIT LOGIC - LHBH0

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26-8

CHAPTER 27

ENGINE OFF SELF TEST

27-1

ENGINE OFF SELF TEST, ENGINE OFF SELF TEST SEQUENCE - LHBH0

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ENGINE OFF SELF TEST SEQUENCE

PROCESS

STRATEGY MODULE: VO\_EOTS\_COM1

-----------

( 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 |

| NO/----------\ |

|-----/ PUTMR => \ SEE NOTE 1 |

\ V\_LANSDTM ?/ |

\----------/ |

|YES |

|----------->| |

| v |

| NO/----------\ |

|-----/TSSTIL\_TMR \ SEE NOTE 1 |

\V\_HICKOKTM ?/ |

\----------/ |

| YES |

v |

(B) (A)

27-2

ENGINE OFF SELF TEST, ENGINE OFF SELF TEST SEQUENCE - LHBH0

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(B) (A)

| |

v |

!--------------------------! |

!SEND TWO 2MS PULSES ON STO! |

!2MS BETWEEN PULSES ! |

!--------------------------! |

| |

|----------->|<---------------------------|

| v

| /---------\

| NO / PUTMR > \ SEE NOTE 1

|------\ 4 SEC /

\---------/

|

|----------->|YES

| v

| /---------\

| /FUEL PUMP \ SEE NOTE 1

| NO / TURNED OFF \

|-----\ (TIMED OUT) /

\ /

\---------/

|YES

v

/-----------\ !-----------------!

/ TEST \ FAIL ! SET !

/ A/D'S AND \------------>! SERVICE CODE(S) !

\ SWITCHES / !-----------------!

\ / |

\-----------/PASS |

|<------------------------------|

v

(C)

NOTE:

- Execute normal background until conditions are met.

- Calibration Recommendation: Since TSSTIL\_TMR update may lag PUTMR by one

background, V\_LANSDTM should be calibrated to .275 sec. and V\_HICKOKTM

should be

calibrated to .180 sec to insure delay integrity.

27-3

ENGINE OFF SELF TEST, ENGINE OFF SELF TEST SEQUENCE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(C)

|

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 !---------------!

/VIP\_KAM =1 \------------->! SEND CODE 512\*!

\ ? / !---------------!

\---------/ |

| NO |

v |

!-------------------! |

! . SEND CODES FROM ! |

! CONTINUOUS TEST ! |

!-------------------! |

|<----------------------------|

v

!----------------------------!

! . ENTER OUTPUT TEST MODE !

!----------------------------!

\*See Normal Strategy KAM qualification test logic for setting of VIP\_KAM=1.

Code 512 is output during continuous code output.

\*\* NOTE: Fuel pump check test must be performed after OCC test.

27-4

ENGINE OFF SELF TEST, KAM/RAM TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

KAM/RAM TEST

PROCESS

STRATEGY MODULE: VO\_KAMRAM\_COM1

-----------

( ENTER )

-----------

|

v

!-----------------------------------!

! SET POINTER TO BEGINNING OF !

! EXT\_RAM !

!-----------------------------------!

|-------------------->|

| v

| !-------------------------!

| ! SAVE REGISTER CONTENTS !

| !-------------------------!

| |

| !-------------------------!

| ! WRITE HEX AAAA TO !

| ! REGISTER !

| !-------------------------!

| |

| !-------------------------!

| ! READ REGISTER CONTENTS !

| !-------------------------!

| |

| /-------------\

| / IS CONTENTS \ NO

| \ = AAAA /-------------|

| \-------------/ |

| | YES |

| v |

| !------------------------! |

| ! WRITE HEX 5555 TO ! |

| ! REGISTER ! |

| !------------------------! |

| | |

| !------------------------! |

| ! READ REGISTER CONTENTS ! |

| !------------------------! |

| | |

| /---------\ |

| / IS \ NO |

| / CONTENTS \------------->|

| \ = 5555 / |

| \ / v

| \---------/ !-----------!

| | YES !TURN STO ON!

| v ! EXIT !

| (A) !-----------!

27-5

ENGINE OFF SELF TEST, KAM/RAM TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(A)

|

| v

| !------------------!

| ! RESTORE REGISTER !

| ! CONTENTS !

| !------------------!

!-----------! |

!INCREMENT ! |

! POINTER ! |

!-----------! |

^ |

| NO /-------------\

|<-----------/ END OF 2K \

\ EXT-RAM ? /

\-------------/

| YES

|

v

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

( GO TO ROM\_TEST )

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

27-6

ENGINE OFF SELF TEST, READ-ONLY MEMORY TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

READ-ONLY MEMORY TEST

PROCESS

STRATEGY MODULE: VO\_ROM\_COM1

-----------

( 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 511!

\---------/ !---------!

| 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".

27-7

ENGINE OFF SELF TEST, ENGINE COOLANT TEMPERATURE SENSOR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE COOLANT TEMPERATURE SENSOR

OVERVIEW

The ECT sensor test checks the ECT sensor and associated circuitry in four

specific areas.

- Low voltage output such as short circuits. -Service code 117.

- High voltage output. i.e. open circuits, disconnects. -Service code

118.

- Lower ECT range fault. -Service code 116.

- Upper ECT range fault. -Service code 116.

The analog signal from the ECT sensor undergoes A/D conversion and IECT is

compared to four calibration parameters; ECTMIN, ECTMAX, VIECT1, and VIECT2.

Cross checks are made first to direct service to a hard fault. -i.e. short

circuits or simple disconnects. Shorts are tested first determined by

ECTMIN, then open circuits determined by ECTMAX.

VIECT1 and VIECT2 define low and high range values and are subsequently

compared to IECT to evaluate normal sensor readings.

Specific vehicle preparation must be performed to establish a standard

against which the range is checked.

The calibration values are established by PEDD/EED and should not be changed.

DEFINITIONS

INPUTS

Registers:

- ECT

- IECT

Calibration Constants:

- ECTMIN; Minimum Engine off ECT -COUNTS

- ECTMAX; Maximum Engine off ECT -COUNTS

- VIECT1; Minimum Engine off ECT (RANGE) -COUNTS

- VIECT2; Maximum Engine off ECT (RANGE) -COUNTS

27-8

ENGINE OFF SELF TEST, ENGINE COOLANT TEMPERATURE SENSOR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VO\_ECT\_COM1

-----------

( ENTER )

-----------

|

v

/---------\ NO !---------!

/ IECT >= \---------->! CODE 117!-->|

\ ECTMIN ? / !---------! |

\---------/ |

| YES |

| |

v |

/---------\ NO !---------! |

/ IECT <= \---------->! CODE 118!-->|

\ ECTMAX ? / !---------! |

\---------/ |

| YES |

v |

/---------\ |

/ VIECT1 \ NO !---------! |

/ >=IECT >= \--------->! CODE 116!-->|

\ VIECT2 ? / !---------! |

\ / |

\---------/ |

| YES |

|<------------------------------|

v

-----------

( EXIT )

-----------

27-9

ENGINE OFF SELF TEST, MANIFOLD ABSOLUTE PRESSURE SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MANIFOLD ABSOLUTE PRESSURE SENSOR TEST

OVERVIEW

The MAP sensor test has been designed to test three conditions:

- MAP signal presence.

- Low MAP signal (BP lower range fault)

- High MAP signal (BP upper range fault)

To verify if a MAP signal is present, MAPTMR, a 1/8 second timer which counts

up time since last scap edge, is compared to parameter VMPMAX. If MAPTMR

exceeds VMPMAX it is ascertained that no MAP signal is present and service

code 126 is output.

MAP (in this case BP) range is checked by utilizing the MAP sensors' digital

frequency output. This output is translated into computer ticks and compared

to parameters VMDEL1 and VMDEL2. If the signal doesn't meet or exceeds these

calibratable values, service code 126 is output.

Notice that all three failure conditions will produce the same service code.

Calibration of VMPMAX is dependant on the microprocessor background loop time

and the time elapsed to detect an open sensor.

VMDEL1 AND VMDEL2 must take into account running Self-Test at altitude (low

BP), sea level (high BP) and tolerance stack-ups.

27-10

ENGINE OFF SELF TEST, MANIFOLD ABSOLUTE PRESSURE SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- MAP

- MAPTMR

- MDELTA

Calibration Constants:

- VMPMAX; Max. time since last MAP update. -MSEC

- VMDEL1; Min. MAP during engine-off Self-Test. -TICKS

- VMDEL2; MAX. MAP during engine-off Self-Test. -TICKS

27-11

ENGINE OFF SELF TEST, MANIFOLD ABSOLUTE PRESSURE SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VO\_MAP\_COM2

-----------

( ENTER )

-----------

|

v

/---------\ NO

/ MAPTMR <=\----------------|

\ VMPMAX ? / |

\---------/ |

| YES |

v |

/---------\ v

/ VMDEL1 \ NO !---------!

/<= MDELTA <= \--------->! CODE 126!

\ VMDEL2 / !---------!

\ ? / |

\---------/ |

| YES |

|<---------------------|

v

-----------

( EXIT )

-----------

27-12

ENGINE OFF SELF TEST, THROTTLE POSITION SENSOR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

THROTTLE POSITION SENSOR

PROCESS

STRATEGY MODULE: VO\_TP\_COM1

-----------

( ENTER )

-----------

|

v

/---------\ NO !---------!

/ ITP >= \---------->! CODE 122!-->|

\ TAPMIN ? / !---------! |

\---------/ |

| YES |

| |

v |

/---------\ NO !---------! |

/ ITP <= \---------->! CODE 123!-->|

\ TAPMAX ? / !---------! |

\---------/ |

| YES |

v |

/---------\ |

/ VTAP1 \ NO !---------! |

/ <=ITP <= \--------->! CODE 121!-->|

\ VTAP2 ? / !---------! |

\ / |

\---------/ |

| YES |

|<------------------------------|

v

-----------

( EXIT )

-----------

27-13

ENGINE OFF SELF TEST, AIR CHARGE TEMPERATURE SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ACT SENSOR TEST

PROCESS

STRATEGY MODULE: VO\_ACT\_COM1

-----------

( ENTER )

-----------

|

v

/---------\ NO !---------!

/ IACT >= \---------->! CODE 112!---|

\ ACTMIN ? / !---------! |

\---------/ |

| YES |

| |

v |

/---------\ NO !---------! |

/ IACT <= \---------->! CODE 113!---|

\ ACTMAX ? / !---------! |

\---------/ |

| YES |

v |

/---------\ |

/ VIACT1 \ NO !---------! |

/ =>IACT => \--------->! CODE 114!-->|

\ VIACT2 ? / !---------! |

\ / |

\---------/ |

| YES |

|<------------------------------|

v

-----------

( EXIT )

-----------

27-14

ENGINE OFF SELF TEST, TRANSMISSION OIL TEMPERATURE SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TRANSMISSION OIL TEMPERATURE SENSOR TEST

OVERVIEW

The TOT (Transmission Oil Temp) sensor test checks the TOT sensor and

associated circuitry in four specific areas.

- Low voltage output such as short circuits. -Service code 638

- High voltage output. i.e. open circuits, disconnects. -Service code

637.

- Lower TOT range fault. -Service code 636.

- Upper TOT range fault. -Service code 636.

The analog signal from the TOT sensor undergoes A/D conversion and ITOT is

compared to four calibration parameters; TOTMIN, TOTMAX, VITOT1, and VITOT2.

Gross checks are made first to direct service to a hard fault. -i.e. short

circuits or simple disconnects. Shorts are tested first determined by

TOTMIN, then open circuits determined by TOTMAX.

VITOT1 and VITOT2 define low and high range values and are subsequently

compared to ITOT to evaluate normal sensor readings.

Specific vehicle preparation must be performed to establish a standard

against which the range is checked. Refer to section entitled; Initiating

Self-Test.

The calibration values are established by ESD/EED and should not be changed.

27-15

ENGINE OFF SELF TEST, TRANSMISSION OIL TEMPERATURE SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

INPUTS

Registers:

- TOT

- ITOT

Calibration Constants:

- TOTMIN; Maximum Engine off TOT -COUNTS

- TOTMAX; Minimum Engine off TOT -COUNTS

- VITOT1; Minimum Engine off TOT (RANGE) -COUNTS

- VITOT2; Maximum Engine off TOT (RANGE) -COUNTS

27-16

ENGINE OFF SELF TEST, TRANSMISSION OIL TEMPERATURE SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VO\_TOT\_COM2

-----------

( ENTER )

-----------

|

v

/---------\ NO !---------!

/ ITOT>= \---------->! CODE 638!-->|

\ TOTMIN ? / !---------! |

\---------/ |

| YES |

| |

v |

/---------\ NO !---------! |

/ ITOT <= \---------->! CODE 637!-->|

\ TOTMAX ? / !---------! |

\---------/ |

| YES |

v |

/---------\ |

/ VITOT1 \ NO !---------! |

/ >=ITOT >= \--------->! CODE 636!-->|

\ VITOT2 ? / !---------! |

\ / |

\---------/ |

| YES |

|<------------------------------|

v

-----------

( EXIT )

-----------

27-17

ENGINE OFF SELF TEST, EXHAUST GAS RE-CIRCULATION SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EXHAUST GAS RE-CIRCULATION SENSOR TEST

PROCESS

STRATEGY MODULE: VO\_EGR\_COM5

-----------

( ENTER )

-----------

|

v

/---------\ NO

/ PFEHP=0 \-------------------|

\ ? / |

\---------/ |

| YES |

v |

/---------\ YES !---------! |

/ IEGR <= \--->! CODE 327!--->|

\ EVPMIN / !---------! |

\---------/ |

|NO |

v |

/---------\ YES !---------! |

/ IEGR >= \--->! CODE 337!--->|

\ EVPMAX / !---------! |

\---------/ |

|NO |

v |

/---------\ YES !---------! |

/ IEGR < \--->! CODE 328!--->|

\ VEVPLL ? / !---------! |

\---------/ |

|NO |

v |

/---------\ YES !---------! |

/ IEGR > \--->! CODE 334!--->|

\ VEVPHL ? / !---------! |

\---------/ |

|NO |

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

v

-----------

( EXIT )

-----------

27-18

ENGINE OFF SELF TEST, A/C SWITCH TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

A/C SWITCH TEST

OVERVIEW

This test determines whether the A/C is on or the A/C input is high when the

A/C switch is in the off position.

DEFINITIONS

Bit Flags:

- A3C

PROCESS

STRATEGY MODULE: VO\_ACCS\_COM2

A3C = 1 --------------------------------| Set code 539 (A/C on indicated)

27-19

ENGINE OFF SELF TEST, MANUAL LEVER POSITION SENSOR INPUT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MANUAL LEVER POSITION SENSOR INPUT TEST (E40D)

OVERVIEW

The Manual Lever Position Sensor (MLPS) Input Test is to be performed with

the transmission selector lever in the PARK position (when V\_SW\_PARK = 1).

The voltage input, INDS (in counts), is checked to verify that all 6

resistances in series (Park, Reverse, Neutral, Overdrive, Manual 2, and

Manual 1) are within the range VND1 to VND2. The values for the range are

determined by the tolerances of the 6 MLPS resistance to VREF and a 560 OHM

resistance to VREF as the voltage divider. For vehicles without the PARK

position, V\_SW\_PRK is set to zero and the test is run in NEUTRAL. In this

case, INDS must be within the range VND3 to VND4.

The divider network consists of the input to the EEC (INDS), divided by the

560 OHM resistance to VREF and the 6 resistors in series (MLPS) to signal

return.

The INDS register is in "counts". To convert voltage to counts:

INDS counts = MLPS voltage \* (VREF/1023)

DEFINITIONS

Registers:

- INDS = Input Neutral/drive switch. -counts

Calibration Constants:

- VND1 = Lower limit for MLPS test. -counts

- VND2 = Upper limit for MLPS test. -counts

- VND3 = Lower limit for MLPS test in neutral. -counts

- VND4 = Upper limit for MLPS test in neutral. -counts

- V\_SW\_PRK = Calibration switch to select PARK (=1) or NEUTRAL (=0) test.

27-20

ENGINE OFF SELF TEST, MANUAL LEVER POSITION SENSOR INPUT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VO\_MLPS\_INPUT\_COM1

V\_SW\_PRK = 1 ---------------------|

(test in park) |AND -| Set code 654

| | Not in park

INDS < VND1 ----------------| | |

|OR --| |

INDS > VND2 ----------------| |

| --- ELSE ---

V\_SW\_PRK = 0 ---------------------| |

(test in neutral) |AND -| Set code 655

| | Not in neutral

INDS < VND3 ----------------| | |

|OR --| | --- ELSE ---

INDS > VND4 ----------------| |

| Exit this test

27-21

ENGINE OFF SELF TEST, 4X4L SWITCH INPUT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

4X4L SWITCH INPUT TEST

PROCESS

STRATEGY MODULE: VO\_4X4L\_SWITCH\_COM2

-------

( ENTER )

-------

|

v

/----------\ NO

/ TSTRAT =4 \-------------------------|

\ / |

\----------/ |

| YES |

/----------\ |

/ I4X4L = 0 \ NO !--------! |

/(NOT IN 4X4 \------>!CODE 633!---| |

\ LOW) / !--------! | |

\ / | |

\----------/ | |

|YES | |

|<---------------------------| |

| |

|<-------------------------------|

|

v

--------

( EXIT )

--------

27-22

ENGINE OFF SELF TEST, POWER STEERING PRESSURE SWITCH TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

POWER STEERING PRESSURE SWITCH TEST

PROCESS

STRATEGY MODULE: VO\_PSPS\_COM1

----------

( ENTER )

----------

|

|

v

/---------\ NO

/ PSPSHP=1 ?\----->( GO TO NEXT TEST )

\ /

\---------/

| YES

v

/-----------\

/ POWSFG = 1 \ YES !---------!

/ ? \-------->!CODE 519 !----|

\ (SWITCH OPEN) / !---------! |

\ / |

\-----------/ |

| NO |

|<-------------------------------|

v

-----------

( EXIT )

-----------

27-23

ENGINE OFF SELF TEST, IVPWR INPUT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

IVPWR INPUT TEST

PROCESS

STRATEGY MODULE: VO\_IVPWR\_COM1

----------

( ENTER )

----------

|

v

/---------\

/ IIVPWR \ YES !---------!

\ < VKYPWR /--------->!CODE 513 !

\---------/ !---------!

| NO |

|<--------------------|

v

---------

( EXIT )

---------

NOTE: This test is designed to check continuity of the IVPWR circuit

internal to the EEC module and can be used as a battery voltage check, if the

parameter VKYPWR is calibrated to the minimum voltage to prevent occurrence

of false codes.

COUNTS = IIVPWR \*.1786 \* 1023

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

VREF

IIVPWR = VREF \* COUNTS

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

.1786 \* 1023

NOTE: Recommended VKYPWR value: 400 counts (10.9 volts)

27-24

ENGINE OFF SELF TEST, OUTPUT CIRCUIT CHECK - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUT CIRCUIT CHECK

OVERVIEW

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.

PROCESS

STRATEGY MODULE: VO\_OCC\_COM12

OC# | CIRCUIT FUNCT. | CAL. PARAMETER | ERROR CODE

\_\_\_\_|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_\_\_\_

1 | AM2 1) | OCCDT1 | 553

2 | AM1 1) | OCCDT2 | 552

4 | EVR 2) | OCCDT4 | 558

5 | CANP 3) | OCCDT5 | 565

7 | FP | OCCDT7 | 556

10 | SS-1 4) | OCCSS1 | 621

11 | SS-2 4) | OCCSS2 | 622

12 | CCS 4) | OCCCCS | 626

13 | CCC 4) | OCCCCC | 629

14 | TCIL 4) | OCCTCIL | 631

NOTES: 1) ONLY IF THRMHP=1

2) ONLY IF PFEHP=0

3) ONLY IF CANPHP=1

4) ONLY IF TSTRAT= 4

AM1 - AIR MANAGEMENT 1 (BYPASS)

AM2 - AIR MANAGEMENT 2 (DIVERT)

EVR - ELECTRONIC VACUUM REG.

CANP - CANISTER PURGE

FP - FUEL PUMP

SS-1 - SHIFT SOLENOID #1

SS-2 - SHIFT SOLENOID #2

CCS - COAST CLUTCH SOLENOID

CCC - CONVERTER CLUTCH SOLENOID

TCIL - TRANSMISSION CONTROL INDICATOR LIGHT

27-25

ENGINE OFF SELF TEST, OUTPUT CIRCUIT CHECK TEST STRUCTURE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUT CIRCUIT CHECK TEST STRUCTURE

PROCESS

STRATEGY MODULE: VO\_OCCTS\_COM4

-----------

( ENTER )

-----------

|

!-------------------------!

! DE-ENERGIZE ALL OUTPUTS !

! . OC=1 !

!-------------------------!

|

!----------------!

! DELAY 50 MSEC. !

!----------------!

|---------------------->|

| !---------------------!

| ! SAVE IOCC IN OCCSAV !

| !---------------------!

| |

| !-----------------------!

| ! ENERGIZE OUTPUT #(OC) !

| !-----------------------!

| |

| !----------------!

| ! DELAY 50 MSEC. !

| !----------------!

| |

| /-------------\ !-------------!

| / ABS[OCCSAV- \ NO ! SET !

| / IOCC] >= \-------->! APPROPRIATE !

| \ OCCDT(OC) COUNTS/ ! FAIL CODE !

| \ ? / ! (SEE TABLE) !

| \-------------/ YES !-------------!

| |<------------------------|

| v

| !--------------------------!

| ! DE-ENERGIZE OUTPUT #(OC) !

| !--------------------------!

| |

| !----------------!

| ! DELAY 50 MSEC. !

!----------! !----------------!

! OC= OC+1 ! |

!----------! /---------\

| NO / IS \

|<---------------/ OC= LASTOC ?\

\ /

\ /

\---------/

| YES

v

-----------

( EXIT )

-----------

27-26

ENGINE OFF SELF TEST, OUTPUT CIRCUIT CHECK TEST STRUCTURE - LHBH0

PED-PTE, 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

27-27

FUEL PUMP MONITOR TEST (K.O.E.O.) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FUEL PUMP MONITOR TEST

OVERVIEW:

This test determines if the proper FPM input is received by the

processor as the fuel pump is commanded on and off.

DEFINTIONS:

Self Test Calibration Constants:

- V\_FPMDLY = Fuel Pump Monitor test fuel pump on-to-off/off-

to-on stabilization delay time.

- V\_FPMFLG = Fuel Pump Monitor test enable switch, 1 = enable.

Self Test Flags:

- FPM = State of the FPM input 1 = high, implying pump on.

- CODE\_556 = Primary fuel pump circuit failure (from OCC test)

- CODE\_543 = Fuel pump circuit open-battery to ECA

- CODE\_542 = Fuel pump circuit open-ECA to motor ground

Self-Test Registers:

- VIP\_CNT\_EX Self test executive pointer

Base Strategy Flags:

- PUMP = Controls state of fuel pump control output 1 =

commanded on.

PROCESS

STRATEGY MODULE: VO\_FPM\_COM2

VIP\_CNT\_EX = fpm\_test\_1 ------| DO: FPM TEST 1 PROCESS

| (If test is enabled, start

| pump, initialize delay

| timer.)

|

| ---ELSE---

|

VIP\_CNT\_EX = fpm\_test\_2 ------| DO: FPM TEST 2 PROCESS

| (Check for FPM = 1, if not,

| set code 543. Stop pump,

| initialize delay timer.)

|

| ---ELSE---

|

VIP\_CNT\_EX = fpm\_test\_3 ------| DO: FPM TEST 3 PROCESS

| (Check for FPM = 0, if not,

| set code 542. End of test)

27-28

FUEL PUMP MONITOR TEST (K.O.E.O.) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FPM TEST 1 PROCESS

VFPMFLG = 1 -------| | (Start test)

(Test enabled) |AND ----| VIP\_TIMER\_EX = 0

| | (Initialize delay timer)

CODE\_556 = 0 ------| |

(No fuel pump OCC | PUMP = 1

failure) | (Command fuel pump on)

|

| VIP\_CNT\_EX = fpm\_test\_2

| (Set up for next process)

|

| ---ELSE---

|

| (Skip to next test)

| VIP\_CNT\_EX = fpm\_test\_3 + 1

| (Next test)

END: FPM TEST 1 PROCESS

BEGIN: FPM TEST 2 PROCESS

VIP\_TIMER\_EX > V\_FPMDLY -| | (pass code 543 test)

(time delay) |AND ----| VIP\_TIMER\_EX = 0

| | (re\_init timer for next

FPM = 1 -----------------| | delay)

(Indicates pump on) |

| PUMP = 0

| (command pump off)

|

| VIP\_CNT\_EX = fpm\_test\_3

| (Set up for next process)

|

| ---ELSE---

|

VIP\_TIMER\_EX > V\_FPMDLY -| | SET CODE\_543 = 1

(Time delay) |AND ----| (fail test)

| |

FPM = 0 -----------------| | VIP\_TIMER\_EX = 0

(Indicates pump off) | (re-init timer for next

| delay)

|

| PUMP = 0

| (command pump off)

|

| VIP\_CNT\_EX = fpm\_test\_3

| (Set up for next process)

END: FPM TEST 2 PROCESS

27-29

FUEL PUMP MONITOR TEST (K.O.E.O.) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FPM TEST 3 PROCESS

VIP\_TIMER\_EX > V\_FPMDLY -| | (pass code 542 test)

(time delay) |AND ----| VIP\_CNT\_EX = fpm\_test\_3+1

| | (next test)

FPM = 0 -----------------| |

(indicates pump off) |

| ---ELSE---

|

VIP\_TIMER\_EX > V\_FPMDLY -| | SET CODE\_542 = 1

(time delay) | | (fail test)

|AND ----|

FPM = 1 -----------------| | VIP\_CNT\_EX = fpm\_test\_3+1

(indicates pump on) | (next test)

END: FPM TEST 3 PROCESS

27-30

ENGINE OFF SELF TEST, ELECTRONIC PRESSURE CONTROL SOLENOID TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ELECTRONIC PRESSURE CONTROL SOLENOID TEST

PROCESS

STRATEGY MODULE: VO\_EPC\_SOLENOID\_COM1

------

( ENTER )

------

|

v

/--------\ NO

/TSTRAT =4 \-------------------------------------->|

\ / |

\--------/ |

|YES |

/--------\NO |

/V\_ETV\_TEST\-------------------------------------->|

\ = 1 ? / |

\--------/ |

| YES |

!-----------------------------! |

!SET TV\_COUNTS = TV1CNTS\_TEST ! |

!-----------------------------! |

| |

!-------------------------! |

!RUN TV VFS OUTPUT ROUTINE! |

!-------------------------! |

|NOTE: Refer to Transmission Strategy to |

| perform this routine. |

v |

!-----------------! |

!WAIT ETV\_TEST\_SEC! |

!-----------------! |

| |

| |

!-----------------! |

!SAVE ETVOCM -> ! |

!V\_ETVOCM\_SAV ! |

!-----------------! |

| |

v |

!---------------------------------------------------! |

!COMPUTE: ! |

! Clip to zero if negative ! |

!ETV\_OCM\_MIN = (ETV\_BIAS - (ETV\_GAIN \* TV\_COUNTS)) ! |

! + ((VBAT - 10.0)\*ETV\_GAIN\_BAT) ! |

! Clip to zero if negative ! |

!---------------------------------------------------! |

| |

v |

(A) (B)

27-31

ENGINE OFF SELF TEST, ELECTRONIC PRESSURE CONTROL SOLENOID TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(A) (B)

| |

v |

/---------------\YES !--------! |

/ ETVOCM < \------->!CODE 624!-------| |

\ ETV\_OCM\_MIN ? / !--------! | |

\---------------/ | |

|NO | |

| | |

v | |

!-----------------------------! | |

!SET TV\_COUNTS =TV2CNTS\_TEST ! | |

!-----------------------------! | |

| | |

v | |

!-----------------------------! | |

!RUN TV VFS OUTPUT ROUTINE ! | |

!-----------------------------! | |

| | |

v | |

!------------------! | |

!WAIT ETV\_TEST\_SEC ! | |

!------------------! | |

| | |

v | |

/--------------\ | |

/ABS (V\_ETVOCM\_ \NO !---------! | |

/SAV-ETVOCM) => \---->! CODE 625! | |

\ VETVDT ? / !---------! | |

\ / | | |

\--------------/ | | |

| YES v | |

|<---------------------------------| |

v |

!-----------------! |

!SET TV\_COUNTS =0 ! |

!-----------------! |

| |

|<--------------------------------------------|

v

------

( EXIT )

------

27-32

ENGINE OFF SELF TEST, OUTPUT TEST MODE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUT TEST MODE

OVERVIEW

In this mode, outputs are turned on/off based on operator requests which

consist of throttle position moving above an upper limit, then below a lower

limit. A timeout is used when outputs are turned on to protect module

circuity.

ONLY OUTPUTS IN THE FOLLOWING TABLE WILL BE FUNCTIONED:

1989 EFI-SD

-----------

STO

WAC

AM1

AM2

EVR

CCC

CANP

ISC

SS-2

CCS

OCIL

SS-1

PROCESS

STRATEGY MODULE: VO\_OTM\_LH\_COM1

ON ENTRY TO THIS MODE, DE-ENERGIZE THE ABOVE OUTPUTS

ITP > VTAP5 ----------------------------| Set REQFLG

REQFLG SET -----------------------|

|AND -| Reverse state of outputs

ITP <= VTAP6 ---------------------| | (OFF-->ON or ON-->OFF)

| Clear REQFLG

| Start OUTTMR

OUTTMR >= 10 MINUTES -------------------| Turn outputs off

27-33

ENGINE OFF SELF TEST, OUTPUT TEST MODE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

27-34

CHAPTER 28

ENGINE RUNNING SEQUENCE

28-1

ENGINE RUNNING SEQUENCE, ENGINE RUNNING TEST STRUCTURE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE RUNNING TEST STRUCTURE

PROCESS

STRATEGY MODULE: VR\_ERTS\_LH\_COM1

-----------

( ENTER )

-----------

|

!---------------------!

! ENGINE-RUNNING !

! TEST INITIALIZATION !

!---------------------!

|

!---------------------!

!GENERIC IDLE SPEED !

! CONTROL !

!---------------------!

|

/----------\

/ HIGH RPM \

\ ISC TEST /

\----------/

|

/---------------\

/ A/D AND \

\ SWITCH TESTS /

\---------------/

|

/---------\

/EGO SWITCH-\

\ ING TEST /

\---------/

|

/---------\

/ AIR TEST \

\ /

\---------/

|

/----------\

/ SPARK \

\CONTROL TEST/

\----------/

|

/---------\

/EGR SYSTEM \

\ TEST /

\---------/

|

(A)

28-2

ENGINE RUNNING SEQUENCE, ENGINE RUNNING TEST STRUCTURE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(A)

|

/-----------\

/ LOW RPM ISC \

\ TEST /

\-----------/

|

/---------\

/GOOSE TEST \

\ /

\---------/

|

!--------------------!

! SEND SERVICE CODES !

!--------------------!

|

!-------------------!

! 2 MINUTE DELAY !

! FOR TIMING CHECK !

!-------------------!

|

!-------------------! \*

! THROTTLE PLATE !

! ADJUST MODE !

!-------------------!

|

-----------

( EXIT )

-----------

The Throttle Plate Adjust Mode Entry is dependent upon operator action as

described in it's documentation unit.

28-3

ENGINE RUNNING SELF TEST, EGOBAR FILTER AND STATE FLAGS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGOBAR FILTER AND STATE FLAGS

STRATEGY MODULE: VR\_EGOBAR\_COM1

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)

28-4

ENGINE RUNNING SELF TEST, DELAY LOGIC CLARIFICATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DELAY LOGIC CLARIFICATION

PROCESS

STRATEGY MODULE: VR\_DELAYLOGIC\_COM1

Delay VDLY(x) means:

!----------!

! SET !

! VIPTMR=0 !

!----------!

|

|<-------------|

v |

/---------\ YES |

/ VIPTMR < \--------|

\ VDLY(x) ? /

\---------/

| NO

|

v

CONTINUE

NOTE: "RESTART VIPTMR" means "SET VIPTMR = 0".

28-5

ENGINE RUNNING SELF TEST, ENGINE RUNNING INITIALIZATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ENGINE RUNNING INITIALIZATION

OVERVIEW

The Engine Running Initialization sets specific inputs and outputs as

required in preparation for performing the Engine Running On-demand Test.

The inputs and outputs are determined based on the Strategy application.

Part of the initialization process is to check the FMEM failure flags for any

hard fault present. These flags would have been set from the VIP EXECUTIVE

when a 2 second time period is allowed to do Continuous testing prior to

entry into the Engine Running Test.

If any of the failure flags are present, the test is aborted and a service

code 998 and the corresponding fault code(s) will be output on STO as

notification that a hard fault currently exists.

DEFINITIONS

INPUTS

Registers:

- VIP\_CNT\_EX = Vip State Counter.

- VIP\_TIMER\_EX = VIP state timer.

Bit Flags:

- AFMFLG = ACT FMEM Flag.

- CFMFLG = ECT failure mode (FMEM) flag.

- DIS\_FMFLG = Dual Plug DIS FMEM flag.

- MFMFLG = MAP/MAF FMEM flag.

- TFMFLG = TP FMEM flag.

Calibration Constants:

- VIPSPK = Vip Spark advance units are Deg.

- VISCN = Extended idle CLISC desired RPM.

- VRLAM = Rich LAMBDA for EGO test units are LAMBDAS.

28-6

ENGINE RUNNING SELF TEST, ENGINE RUNNING INITIALIZATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

OUTPUTS

Registers:

- EFTR = Equil fuel transfer rate BIN 16 LBM.

- EGRDC = EGR duty cycle.

- KAMREF = Adaptive Fuel correction.

- KAMRF1 = EGO-1 Adaptive fuel correction.

- KAMRF2 = EGO-2 Adaptive fuel correction.

- LAMBSE = Closed loop desired equivalence rate.

- LAMBSE1 = LAMBDA equivalence ratio (EGO-1).

- LAMBSE2 = LAMBDA equivalence ratio (EGO-2).

- PURGDC = Purge duty cycle (FN600 output).

- RVIPRPM = RVIP "desired RPM" to CLISCP.

- SAF = Spark advance Bin 2.

- VCUTOUT = Number of injector cutout during Cylinder Bal Test.

- VIP\_CNT\_EX = Vip state counter.

Bit Flags:

- ACR = --

- AM1 = Air Management 1 solenoid.

- AM2 = Air Management 2 = TAD.

- BRK\_NEVER\_OFF = Brake always on during RVIP test.

- BRK\_NEVER\_ON = Brake not applied during RVIP test.

- ERROR 543 = Fuel pump fault in running VIP; Impacts EGO2.

28-7

ENGINE RUNNING SELF TEST, ENGINE RUNNING INITIALIZATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- OCS\_OPEN = Overdrive cancel switch set to open.

- OCS\_SHORT = Overdrive cancel switch set to close.

- POWOFF = 1 -> power steering is OFF.

- POWON = 1 -> power steering is ON.

- RVIP\_CYL\_BAL = Indicates running VIP cylinder.

- RVIP\_CYL\_QUIT = 1 -> cyl balance test aborted.

- STI\_RESET = 1 -> Operator requested Throttle Plate Adjust Mode.

- VRUN\_ISCFLG = RVIP idle speed control flag.

- V\_LOW\_FAN\_ON = 1 -> turn on low speed fan during K.O.E.R. VIP.

- V\_MODE\_SETUP = 1 -> Use throttle mode VIP constants.

- WAC = --

PROCESS

STRATEGY MODULE: VR\_RUN\_INIT\_COM8

always ---------------------------------| Turn STO off

(when in VR\_RUN\_INIT) | CODE COUNT = 0

| STI\_RESET = 0

| V\_MODE\_SETUP = 0

28-8

ENGINE RUNNING SELF TEST, ENGINE RUNNING INITIALIZATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FMEM FAULT PRESENT AND INITIALIZATION LOGIC

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

|

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

| |

TFMFLG = 1 -----------------| |

|AND -| (output Code 998 and the corres-

MFMFLG = 1 -----------------| | | ponding FMEM fault codes(s)

|AND -| | except replace service code 126

V\_VACFLG = 1----------------| | with 128)

| (exit Engine Running Self Test

| sequence)

|

| --- ELSE ---

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

|AND -| (output Code 998 and Code 128)

V\_VACFLG = 1 ---------------------| | (exit Engine Running Self Test

| sequence)

|

| --- ELSE ---

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

| |

CFMFLG = 1 -----------------------|OR --| (output Code 998 and the corres-

| | ponding FMEM fault code(s)

TFMFLG = 1 -----------------------| | (exit Engine Running Self Test

| | sequence)

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

| --- ELSE ---

|

(continued on next page)

28-9

ENGINE RUNNING SELF TEST, ENGINE RUNNING INITIALIZATION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

| VRUN\_ISCFLG = 1

| LAMBSE = VRLAM

| RVIPRPM = VISCN

| KNOCK\_ENABLED = 0

| EFTR = 0

| KAMREF = 1.0

| SAF = VIPSPK

| EGRDC = 0

| WAC = 1

| AM1 = 0

| AM2 = 0

| PURGDC = 0

| BRK\_NEVER\_ON = 1

| BRK\_NEVER\_OFF = 1

| POWON = 0

| POWOFF = 0

| OCS\_OPEN

| OCS\_SHORT

| VIP\_TIMER\_EX = 0

| VIP\_CNT\_EX = VR\_OUT\_ENGCYL

The following logic outputs engine ID pulses on STO. ID code equals 1/2

number of cylinders in engine.

always ---------------------------------| Output ENGCYL pulses for the

(when in VR\_OUT\_ENGCYL) | engine I.D. code on STO

| (I.D. code = of CYL/2)

| Wait until pulsing is complete

| VIP\_TIMER\_EX = 0

| VIP\_CNT\_EX = VR\_HICAM\_ISC

28-10

ENGINE RUNNING SELF TEST, GENERIC IDLE SPEED CONTROL - LHBH0

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GENERIC IDLE SPEED CONTROL

OVERVIEW

The ISC is an adaptive air bypass system designed to regulate the duty cycle

to the air bypass solenoid to obtain a desired engine speed for all idle

operating conditions and provide a dashpot action. Predicted airflow is

adaptively corrected to minimize the impact of hardware variability.

The Self Test ISC test is designed to check control of the ISC system at an

extended RPM or high cam condition, as well as a low RPM relative to, but not

equal to, normal base idle. Self Test uses the base control system

algorithm, but substitutes certain calibration parameters in order to

maintain Self Test commonality among the many engine calibrations. The

following documentation describes the Self Test portion of ISC. See the base

strategy chapter on Generic ISC for detailed information.

PROCESS

STRATEGY MODULE: VR\_GENISC\_COM1

VIP Strategy: (VRUN\_ISCFLG = 1)

DSDRPM CALCULATION

DSDRPM = RVIPRPM [+DNAC] [+DNPOWS] [+HEDFRPM]

DSDRPM is allowed to rise instantaneously, but any decreasing value is

filtered to prevent a sudden drop in DSDRPM. DESNLO is the filtered value of

the DSDRPM register.

DSDRPM < DESNLO ------------------------| Filter DSDRPM

| DESNLO = UROLAV\_TC(DESNLO,VTCDSN)

| (TCDESN is used when VTCDSN = 0)

The flag, HCAMFG, is set when in VIP. HCAMFG is used to prevent adaptive

airflow updates (ISCKAM).

RVIPRPM <> NUBASE ----------------------| HCAMFG = 1

| (disable adaptive airflow update)

NOTE: A/C [DNAC], Power Steering [DNPOWS] and electrodrive fan [HEDFRPM]

adders are also included in the final equation; see base strategy logic for

conditions.

28-11

ENGINE RUNNING SELF TEST, GENERIC IDLE SPEED CONTROL - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DESMAF CALCULATION

DESMAF = DESMAF\_PRE(predicted air flow) + IPSIBR + DASPOT + ISCKAMn

DESMAF\_PRE = FN875N \* FN1861(ECT,ATMR3) [+ACPPM] [+PSPPM] [+EDFPPM] [+HWPPM]

FN875N is the air flow required, closed throttle, in neutral, for the desired

engine speed.

[ACPPM],[PSPPM],[EDFPPM] and [HWPPM] represent the airflow needed in

DESMAF\_PRE for the increased load due to rpm adders.

IPSIBR adjusts DESMAF for load changes. Changes in IPSIBR results in

corresponding change to bypass valve duty cycle.

IPSIBR = IPSIBR + ISCPSI

(clipped to VSIBRN as a minimum and VSIBRM as a maximum.)

Where ISCPSI is calculated as:

ISCPSI = RPMERR\_A \* (DESMAF\_PRE/DSDRPM) \* BG\_TIMER/VTC\_UNDER OR VTC\_OVER \*\*\*

\*\*\*

RPMERR\_A >= 0 --------------------------| Use VTC\_UNDER

(RPM error for air flow correction) |

| --- ELSE ---

|

| Use VTC\_OVER

RPMERR\_A = ROLAV(RPMERR,TCBPA) where RPMERR = DSDRPM - N

DASPOT is the air flow to provide a preposition at open throttle positions

(APT = 0 OR 1). It is bled off after a closed throttle transition allowing a

smooth transition to RPM control.

28-12

ENGINE RUNNING SELF TEST, GENERIC IDLE SPEED CONTROL - LHBH0

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DASPOT DECREMENT

VRUN\_ISCFLG = 1 ------------------------| DASPOT = DASPOT -

| (FN879(DASPOT) \* V\_879\_MULT)

|

| --- ELSE ---

|

| DASPOT = DASPOT - FN879(DASPOT)

ISCKAMn = Adaptive correction for load condition, where n is the value of

ISFLAG (see base strategy for load state definition).

ISCDTY CALCULATION

The mass air flow through the ISC actuator (DEBYMA) is calculated as the mass

air flow at idle (DESMAF), less the flow through the throttle plate,

corrected for altitude (FN890).

ISCDTY = FN800(DEBYMA) \* V820A \* IDCMUL + IDCOFS

DEBYMA = (DESMAF - ITHBMA) \* (29.92/BP) - FN890(BP)

ITHBMA is the air flow through the throttle plate at idle.

V820A is the ISC duty cycle multiplier used to replace base strategy FN820A,

usually set to 1.

IDCMUL is a multiplier for development, usually set to 1.

IDCOFS is the ISCDTY adder for development, usually set to 0.

28-13

ENGINE RUNNING SELF TEST, HIGH RPM ISC TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

HIGH RPM ISC TEST

PROCESS

STRATEGY MODULE: VR\_HICAM\_ISC\_COM2

VIP\_TIMER\_EX < VISDL1 ------------------| RETURN

| (delay VISDL1 seconds

| for engine to stabilize

| at DSDRPM)

|

| --- ELSE ---

|

|DSDRPM - NBAR| > ISUBND ---------------| Set CODE\_412

| (RPM out of range)

| DISABLE\_ISC = 1

| (freeze ISC duty cycle)

| VIP\_TIMER\_EX = 0

| VIP\_CNT\_EX = VR\_SENSOR\_CHK

|

| --- ELSE ---

|

| DISABLE\_ISC = 1

| VIP\_TIMER\_EX = 0

| VIP\_CNT\_EX = VR\_SENSOR\_CHK

28-14

ENGINE RUNNING SELF TEST, ECT SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ECT SENSOR TEST

PROCESS

STRATEGY MODULE: VR\_ECT\_COM1

-----------

( ENTER )

-----------

|

v

/---------\

/ VIECT3 \ NO !---------!

/ >=IECT>= \---------->! CODE 116!

\ VIECT4 ? / !---------!

\ / |

\---------/ |

| YES |

|<----------------------|

v

----------

( EXIT )

----------

28-15

ENGINE RUNNING SELF TEST, MAP SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MAP SENSOR TEST

PROCESS

STRATEGY MODULE: VR\_MAP\_COM1

-----------

( ENTER )

-----------

|

v

/---------\ NO

/ MAPTMR <=\----------------|

\ VMPMAX ? / |

\---------/ |

| YES |

v |

/---------\ v

/ VMDEL3 \ NO !---------!

/ <=MDELTA<= \--------->! CODE 126!

\ VMDEL4 / !---------!

\ / |

\---------/ |

| YES |

|<---------------------|

v

-----------

( EXIT )

-----------

28-16

ENGINE RUNNING SELF TEST, THROTTLE POSITION SENSOR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

THROTTLE POSITION SENSOR

PROCESS

STRATEGY MODULE: VR\_TPS\_COM1

-----------

( ENTER )

-----------

|

v

/---------\

/ VTAP3 \ NO !---------!

/ <=ITP <= \--------->! CODE 121!

\ VTAP4 ? / !---------!

\ / |

\---------/ |

| YES |

|<---------------------|

v

-----------

( EXIT )

-----------

28-17

ENGINE RUNNING SELF TEST, AIR CHARGE TEMPERATURE SENSOR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

AIR CHARGE TEMPERATURE SENSOR

PROCESS

STRATEGY MODULE: VR\_ACT\_COM1

-----------

( ENTER )

-----------

|

v

/---------\

/ VIACT3 \ NO !---------!

/ >=IACT >= \---------->! CODE 114!

\ VIACT4 ? / !---------!

\ / |

\---------/ |

| YES |

|<----------------------|

v

-----------

( EXIT )

-----------

28-18

ENGINE RUNNING SELF TEST, TRANSMISSION OIL TEMPERATURE SENSOR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TRANSMISSION OIL TEMPERATURE SENSOR

PROCESS

STRATEGY MODULE: VR\_TOT\_COM1

-----------

( ENTER )

-----------

|

v

/---------\

/ VITOT3 \ NO !---------!

/ >=ITOT >= \---------->! CODE 636!

\ VITOT4 ? / !---------!

\ / |

\---------/ |

| YES |

|<----------------------|

v

----------

( EXIT )

----------

28-19

ENGINE RUNNING SELF TEST, BRAKE ON/OFF TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BRAKE ON/OFF TEST

OVERVIEW

The BRAKE ON/OFF test checks the integrity of the brake switch input to the

processor. This test requires the operator to depress the brake pedal any

time during the ENGINE RUNNING test, from the I.D. code to the service code

output, (including the GOOSE test). This will toggle the input, BIFLG, when

the switch opens and closes. The BIFLG check is done every background pass

and the service code setup is done just prior to the code output routine.

DEFINITIONS

Bit Flags:

- BIFLG = Brake input signal.

- BRK\_NEVER\_OFF = Brake always on during test; initialized to 1 in engine

running initialization.

- BRK\_NEVER\_ON = Brake not applied during test; initialized to 1 in engine

running initialization.

Calibration Constants:

- BIHP = Base strategy hardware present indicator; 1 = switch present.

- VBISW = Brake input test enable switch; 1 = enable test.

28-20

ENGINE RUNNING SELF TEST, BRAKE ON/OFF TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VR\_BOO\_COM1

BIFLG CHECK

BIFLG = 1 ------------------------------| BRK\_NEVER\_ON = 0

(brake on, Boo high) |

| --- ELSE ---

|

| BRK\_NEVER\_OFF = 0

SERVICE CODE SET-UP

VBISW = 1 ------------------|

|AND -|

BIHP = 1 -------------------| |

|AND -| SET CODE 536

BRK\_NEVER\_ON = 1 -----------| |

|OR --|

BRK\_NEVER\_OFF = 1 ----------|

28-21

ENGINE RUNNING SELF TEST, POWER STEERING PRESSURE SWITCH TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

POWER STEERING PRESSURE SWITCH TEST

OVERVIEW

The PSPS (power steering pressure switch) test is a functional check of the

pressure switch input to the processor. The power steering system must be

filled with fluid, and pressurized by the operator turning the steering wheel

fully in one direction to the stop and then releasing. This will toggle the

input, POWSFG, as the switch opens and closes. This input is used in

strategy as a power steering load adder for idle speed control. The POWSFG

check is done every background pass and the service code setup is done just

prior to the code output routine.

DEFINITIONS

Bit Flags:

- POWOFF = Power steering was never off; initialized to 0 in engine running

initialization.

- POWON = Power steering was never on; initialized to 0 in engine running

initialization.

- POWSFG = Power steering pressure switch input signal.

Calibration Constants:

- PSPSHP = Base strategy hardware present indicator; 1 -> switch present

- VPSSW = PSPS input test enable switch; 1 -> enable test.

28-22

ENGINE RUNNING SELF TEST, POWER STEERING PRESSURE SWITCH TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VR\_PSPS\_COM2

POWSFG CHECK

POWSFG = 1 -----------------------------| POWON = 1

(power steering is on) |

| --- ELSE ---

|

| POWOFF = 1

SERVICE CODE SET-UP

VPSSW = 1 ------------------------|

|AND -|

PSPSHP = 1 -----------------------| |

|AND -| Set Code 521

POWON = 0 ------------------------| |

|OR --|

POWOFF = 0 -----------------------|

28-23

ENGINE RUNNING SELF TEST, TRANSMISSION CONTROL SWITCH TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TRANSMISSION CONTROL SWITCH CIRCUIT TEST

OVERVIEW

The Transmission Control (TCS) switch circuit test checks the integrity of

the circuit from the switch to the processor. This test requires the

operator to manually depress and release the switch at any time during the

KOER test from the I.D. code to the service code output, (including the

GOOSE test). This action will cause the input, ITCS to toggle, setting flags

as shown in the logic below. The ITCS input check is done every background

pass and the service code set-up is done just prior to the code output

routine.

DEFINITIONS

INPUTS

Bit Flags:

- ITCS = Switch input signal.

- TCS\_SHORT = Transmission Control switch on state (ITCS = 1) initialized

to 0 in engine running initialization.

- TCS\_OPEN = Transmission Control switch off state (ITCS = 0) initialized

to 0 in engine running initialization.

Calibration Constants:

- TSTRAT = Transmission Strategy Switch. The TSTRAT software switch

selects which transmission control strategy is to be executed;

0 -> No transmission control, (Manual trans., AOD, ATX, C6, C3,

etc.),

1 -> SIL (Shift Indicator Light),

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

3 -> AXOD,

4 -> E4OD,

5 -> A4LD-E,

6 -> AXOD-E,

7 -> AOD-I,

8 -> F4E,

9 -> CD4E,

10 -> JATCO

OUTPUTS

Bit Flags:

- TCS\_SHORT = See above.

- TCS\_OPEN = See above.

28-24

ENGINE RUNNING SELF TEST, TRANSMISSION CONTROL SWITCH TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VR\_TCS\_COM4

ITCS = 1 -------------------------------| TCS\_SHORT = 1

(TCS button depressed, 12 volts) |

| --- ELSE ---

|

| TCS\_OPEN = 1

SERVICE CODE SET-UP

TSTRAT = 4 -----------------------|

|AND -| Set Code 632

TCS\_OPEN = 0 ---------------| |

|OR --|

TCS\_SHORT = 0 --------------|

28-25

ENGINE RUNNING SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO SWITCHING TEST

OVERVIEW

The Ego switching test has been designed to check the switching capability of

the Ego sensor, Ego circuit continuity and connections. Hego heater supply

voltage is not addressed.

Test preconditioning is done during the initialization sequence where engine

rpm is adjusted to an upper level and lambda is set to a slightly rich

condition (VRLAM). Spark advance is fixed to VIPSPK and selected items such

as canister purge, thermactor air, and egr are de-activated to eleminate

interaction with engine A/F ratio.

An Ego warm-up delay (VISDL1) is used to help warm-up the Ego sensor before

entering the test. This delay is also used to allow the ISC circuit to

settle.

The test begins by comparing NBAR (filtered rpm) to VNMIN. If engine rpm is

below VNMIN, the test is aborted and jumps to the goose test section. A

service code 416 will be output to indicate a low rpm condition at the end of

the Engine-Running test.

If the engine rpm is above VNMIN, the test continues by ramping fuel lean

from VRLAM to the clip LEQV at the rate of VIPLR1. Ego state is monitored

during this ramping sequence and a time constraint (VIPTM3) is used to

determine the maximum time allowed. If VIPTM3 is calibrated larger than the

time needed to reach LEQV, a dwell time at the clip will result.

If an Ego switch has not occured within this time period, a service code 173

(fuel always rich) is set and the test exits under a specific set of

conditions. Lambse jumps back to VRLAM and AM1 and AM2 is turned off. A

delay (VISDL8) is used just prior to entering the egr test for stabilization.

If a lean Ego switch has occured, fuel is ramped rich from the lean switch

point to the rich clip REQV at the rich rate VIPRR1. Again, Ego state is

monitored during this process and a dwell timer VIPTM4 is used at the rich

clip.

If a rich ego switch has not occured within the VIPTM4 dwell, a service code

172 (fuel always lean) is set and the test exits under the same conditions as

in the code 173 failure.

If a rich Ego switch has occured within the allowable time, the test exits

with the next path being either the thermactor air test and/or the egr test.

It should be noted that in a correctly operating system the maximum timers

VIPTM3/VIPTM4 may never be realized if the Ego responds quickly. The test

therefor takes only as long as necessary to verify ego switches.

Calibration of the timers and clips have to take into account how accurate

the fuel strategy volumetric efficiency tables are calibrated atthe

speed/load point the Ego switching test is performed. Wider fuel ramp

excursions may be necessary if stoichiometry is observed at a lambda of 1.25

for example.

28-26

ENGINE RUNNING SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

The following is a list of Ego switching test calibration parameters and

recommended values.

PARAMETER RECOMMENDED VALUE

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

VNMIN 1000 rpm

VIPLR1 .05 lambda/sec.

LEQV 1.3 lambda

VIPTM3 13 sec.

VIPRR1 .075 lambda/sec.

REQV .75 lambda

VIPTM4 5 sec.

28-27

ENGINE RUNNING SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VR\_EGO\_COM1

----------- /-----------\ YES ----

( ENTER )--->/ V\_EGOHP = 0 \---->( EXIT )

----------- \ / ----

| \-----------/

| |NO

|<----------------|

|

v

/---------\ NO

/ NBAR >= \------>(EXIT TO LOWER RPM TEST)

\ VNMIN ? /

\---------/

| YES

v

!---------------! !----------!

!.RAMP FUEL ! ! CONTINUE !

! LEAN AT VIPLR1!<----! RAMPING !

!.CLIP AT LEAN ! !----------!

! LIMIT LEQV ! ^

!---------------! |

| |

v | NO !---------!

/---------\ NO /---------\ YES ! SET !

/ EGOSTE=1 ?\------>/VIP\_TIMER\_EX------>! CODE 173!----->( AA )

\ (LEAN) / \>= VIPTM3 ?/ !---------!

\---------/ \---------/

| YES

v |<------------------------------|

!---------------! v |

!.RAMP LAMBSE ! /---------\ YES ---- |

! RICH AT VIPRR1!-------->/ EGOSTE=0 \------> ( EXIT ) |

! CLIP AT RICH ! \ (RICH) ? / ---- |

! LIMIT REQV ! \---------/ |

!---------------! | NO |

^ | |

| v |

!-------------! NO /---------\ YES /---------\ NO |

!.CONTINUE !<----------/ IS LAMBSE \------>/ VIPTMR >= \-----|

! RAMPING ! \ <= REQV ? / \ VIPTM4 ? /

!.ZERO ! \---------/ \---------/

! VIP\_TIMER\_EX! | YES

!-------------! v

!---------!

! SET !

! CODE 172!

!---------!

|

v

-----------

( EXIT TO AA )

-----------

28-28

ENGINE RUNNING SELF TEST, THERMACTOR AIR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

THERMACTOR AIR TEST

PROCESS

STRATEGY MODULE: VR\_THERMAIR\_COM2

-------

( ENTER )

-----

|

v

/---------\ NO

/ THRMHP=1? \------>( GO TO AA )

\ /

\---------/

| YES

v

/---------\ NO

/ VAIRFL=1 ?\------>( AA )

\ /

\---------/

| YES

v

!---------------!

! RAMP FUEL !

! RICH AT VIPRR1!

! FOR VDLY1 SEC !

!---------------!

|

v

!---------------------!

! .AIR UPSTREAM !

!---------------------!

|

|<------------------|

v | NO

/---------\ NO /---------\ YES !-------------!

/ EGOSTE=1 ?\------>/VIP\_TIMER\_EX------>! SET CODE 311!

\ (LEAN) / \>= VIPTM2 ?/ !-------------!

\---------/ \---------/ |

| YES v

v ( AA )

!-----------------------!

! .AIR DOWNSTREAM !

!-----------------------!

|

|<------------------|

v | NO

/---------\ NO /---------\ YES !-------------!

/ EGOSTE=0 ?\------>/VIP\_TIMER\_EX------>! SET CODE 312!------|

\ (RICH) / \>= VATMR2 ?/ !-------------! |

\---------/ \---------/ |

| YES |

|<-----------------------------------------------------|

v

( F2 )

28-29

ENGINE RUNNING SELF TEST, THERMACTOR AIR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

( F2 )

|

v

/---------\ NO

/ VTABFL=1 ?\------>( AA )

\ /

\---------/

| YES

v

!--------------!

! AIR UPSTREAM !

! AND BYPASSED !

!--------------!

|

v

!--------------!

! DELAY VDLY2 !

! SEC !

!--------------!

|

v

/---------\ NO !-------------!

/ EGOSTE=0 ?\------>! SET CODE 313!

\ (RICH) / !-------------!

\---------/ |

| YES |

|<-------------------|

v

( AA )

|

v

!--------------!

! .SET LAMBSE= !

! VRLAM !

! .AM1 AND AM2 !

! OFF !

!--------------!

|

v

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

(GO TO SPARK CNTRL TEST )

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

28-30

ENGINE RUNNING SELF TEST, SPARK CONTROL TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SPARK CONTROL TEST

OVERVIEW

The Spark Control Test provides verification that the EEC spark output is

actually controlling by means of using the engine RPM as feedback while other

parameters are held constant. The ISC duty cycle is held constant to prevent

engine speed correction and LAMBSE is fixed to VRLAM as the spark output is

ramped from an initial starting point to a final spark and the engine speed

(NBAR) input is compared to a calibrated delta for the expected change. The

delta distance to be ramped divided by the spark ramp rate plus the delay

times result in total test time required when there is a failure. However,

when the delta is reached, indicating the system is controlling, the test

time is less.

DEFINITIONS

Registers:

- NSAV = Temporary register to store current NBAR.

- NBAR = Filtered engine speed input used to compare to NSAV.

- SAF = Final spark advance output to spark controller.

- VIP\_TIMER\_EX = VIP execution time; 1/8 second later, also used as medium

for ramping spark advance.

Calibration Constants:

- V\_SPK\_ENABL = Calibration switch to enable/disable test, flag bit 0 =

bypass test; 1 = do test.

- V\_SPK\_INIT = Initial spark starting point to begin ramping from.

- VDLY8 = Delay time used before beginning spark ramp or used as delay

before entering the EGR TEST when the SPARK TEST is bypassed.

- V\_SPK\_RATE = Spark ramp rate required during test.

- V\_SPK\_FINAL = Final spark for spark ramp to end.

- VIPSPK = Normal VIP spark (30 deg's BTC).

- VSPTDL = Delay time before exiting test after setting SAF = VIPSPK.

- CODE 213 = Service code which indicated spark control fault present.

28-31

ENGINE RUNNING SELF TEST, SPARK CONTROL TEST - LHBH0

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PROCESS

STRATEGY MODULE: VR\_SPARK\_COM1

-----

( ENTER )

-----

|

v

/-----------\NO !-------! -----

/ V\_SPK\_ENABL \--->! DELAY !-->( EXIT )

\ = 1 / ! VDLY8 ! -----

\-----------/ !-------!

|YES

v

!---------------!

! SAF=V\_SPK\_INIT!

!---------------!

|

!------------!

! DELAY VDLY8!

!------------!

|

!-----------------!

! . NSAV = NBAR !

! . VIPTMR = 0 !

!-----------------!

|

|--------------->|

| !-----------------!

| !SAV=V\_SPK\_INIT - !

| !V\_SPK\_RATE\*VIPTMR!

| !-----------------!

| |

| /--------------\YES

| /ABS(NSAV-NBAR) \------------------------|

| \ => VSPRPM / |

| \--------------/ |

| |NO |

| YES /------------\NO !---------! |

|--------/ SAF > \---->! SET ! |

\ V\_SPK\_FINAL / !CODE 213 ! |

\------------/ !---------! |

| |

v |

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

v

!----------!

!SAF=VIPSPK!

!----------!

|

!--------------! -----

! DELAY VSPTDL !-----> ( EXIT )

!--------------! -----

28-32

ENGINE RUNNING SELF TEST, EXHAUST GAS RE-CIRCULATION SYSTEM TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EXHAUST GAS RE-CIRCULATION SYSTEM TEST (SONIC)

PROCESS

STRATEGY MODULE: VR\_EGR\_COM6

---------

( ENTER )

---------

|

v

/---------\ NO

/ PFEHP=0 \--------------------|

\ ? / |

\---------/ |

| YES |

v |

/---------\ YES !---------! |

/ IEGR <= \---->! CODE 327!--->|

\ EVPMIN ? / !---------! |

\---------/ |

| NO |

v |

/---------\ YES !---------! |

/ IEGR >= \---->! CODE 337!--->|

\ EVPMAX ? / !---------! |

\---------/ |

| NO |

v |

/---------\ YES !---------! |

/ IEGR < \---->! CODE 328!--->|

\ VEVPLL ? / !---------! |

\---------/ |

| NO |

v |

/---------\ YES !---------! |

/ IEGR > \---->! CODE 334!--->|

\ VEVPHL ? / !---------! |

\---------/ |

| NO |

v ---- |

( B ) ( EXIT )<-----|

----

28-33

ENGINE RUNNING SELF TEST, EXHAUST GAS RE-CIRCULATION SYSTEM TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

( B )

|

v

!---------------------!

!.SET VIP\_TIMER\_EX = 0!

!.SAVE IEGR -> TPSAV !

!---------------------!

|

|------------>|

| v

| !----------------------!

| !.RAMP EGRDC AT VEGRAT !

| ! START FROM VDCMIN TO !

| ! VDCMAX. !

| !.EGRDC=VDCMIN + !

| ! VEGRAT\*VIP\_TIMER\_EX !

| !----------------------!

| |

| |

| |

| v

| /-----------\ YES

| / IEGR-IEVPSV \----|

| \ > VEVPDL ? / |

| \-----------/ |

| | NO |

| | |

| v |

| NO /---------\ |

|-------/ EGRDC >= \ |

\ VDCMAX / |

\---------/ |

| |

| |

| YES |

v |

!----------! |

! CODE 332 ! |

!----------! |

| |

| |

|<----------|

v

!---------------------!

!.SET EGRDC=0 !

!.SET VIP\_TIMER\_EX= 0 !

!---------------------!

|

|

v

---------

( EXIT )

---------

28-34

ENGINE RUNNING SELF TEST, LOW RPM ISC TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

LOW RPM ISC TEST

PROCESS

STRATEGY MODULE: VR\_LOW\_ISC\_COM4

VIP\_CNT\_EX = VR\_LOW\_ISC ----------------| DISABLE\_ISC = 0

| RVIPRPM = NGOOSE

| VIP\_TIMER\_EX = 0

| (continue with ISC test)

VIP\_TIMER\_EX < VISDL3 ------------------| RETURN

| (delay VISDL3 seconds

| for engine to stabilize

| at DSDRPM)

|

| --- ELSE ---

|

|DSDRPM - NBAR| > ISLBND ---------------| Set CODE\_411

| (RPM out of range)

| VIP\_TIMER\_EX = 0

| VIP\_CNT\_EX = VR\_GOOSE

|

| --- ELSE ---

|

| VIP\_TIMER\_EX = 0

| VIP\_CNT\_EX = VR\_GOOSE

28-35

ENGINE RUNNING SELF TEST, GOOSE TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

GOOSE TEST

SPEED DENSITY, MONO EGO

OVERVIEW

Test operator is directed to Goose the throttle as soon as he sees the single

pulse (readout of 10 on Star unit) so that dynamic response can be tested.

The test will end when one of the following conditions are met.

- V\_GOOS\_DELAY seconds elapse after the RPM response occurs

- Time in test exceeds VGOOSEC seconds.

In the second case, a code 538 is sent to indicate that the test was

incorrectly performed.

DEFINITIONS

Registers:

- NSAV = Temporary register to store current NBAR.

- TPSAV = Temporary register to store current TP value.

- MAPSAV = Temporary register to store current MAP value.

Bit Flags:

- VF1 = Flag indicating VIPTMR has been loaded with a new value,

(VGOOS\_DELAY), based on an RPM response.

- CODE\_225 = Flag bit for error code 225, to be cleared during the test if

knock is present.

- CODE\_129 = Flag bit for error code 129, to be cleared during the test

when the MAP indicates movement beyond a calibrated target.

- CODE\_167 = Flag bit for error code 167, to be cleared during the test

when the TP indicates movement beyond a calibrated target.

- CODE\_538 = Flag bit for error code 538, to be cleared during the test

when the RPM has increased above a calibrated target.

Calibration Constants:

- V\_GOOSW = Flag to enter GOOSE test (1=enter;0-bypass).

- V\_GOOSPK = Spark advance for knock sensing (50 deg's BTC) NOTE: V\_GOOSPK

is limited by normal strategy parameter SPUCLP.

- V\_GOOSN = RPM change to determine GOOSE test has been performed (400

RPM).

- V\_GOOSTP = TP change required in GOOSE test (200 cnts).

28-36

ENGINE RUNNING SELF TEST, GOOSE TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- V\_GOOSMP = MAP change required in GOOSE test (10in.Hg).

- V\_GOOSEC = Time in GOOSE test loop (15 sec's).

- V\_GOOS\_DELAY = Time elapse after RPM change to exit test (min. 1.5

sec's).

- VIPSPK = Normal VIP spark (30 deg's BTC).

- V\_KNK\_DLY = Delay time for GOOSE initialization ( 1 sec).

- V\_KNK\_FUEL = New LAMBSE setting for engine knock enhancement (0.8

LAMBDAS).

- V\_KTS = Knock threshold pulse time (25 ticks).

- VRLAM = Normal LAMBSE setting from EGO switching test (0.9 LAMBDAS).

28-37

ENGINE RUNNING SELF TEST, GOOSE TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VR\_GOOSE\_SD\_COM1

-------

( ENTER )

-------

|

v

/---------\ YES ----

/V\_GOOSW=0 ?\-------->( EXIT )

\ / ----

\---------/

| NO

| !--------------------------!

v ! .SET SAF TO V\_GOOSPK !

/---------\ YES ! .SET LAMBSE = V\_KNK\_FUEL !

/ KIHP=1 ? \-------->! WINDOW\_DELTA = V\_KTS !

\ / ! (OVERIDE NORMAL STRATEGY !

\---------/ ! KTS PULSE WIDTH) !

| NO !--------------------------!

| |

| !---------------!

| !DELAY V\_KNK\_DLY!

| !---------------!

|<----------------------------|

v

!----------------------------!

! .SET CODE\_225, CODE\_129, !

! CODE\_167, CODE\_538 !

! .SAVE CURRENT NBAR-->NSAV !

! .SAVE CURRENT TP-->TPSAV !

! .SAVE CURRENT MAP-->MAPSAV !

! VIP\_KNOCK = 0 !

! (begin sensing for knock) !

!----------------------------!

|

v

!----------------------------!

! SEND SINGLE 0.5 SEC PULSE !

! ON STO !

!----------------------------!

|

v

!--------------!

!VIP\_TIMER\_EX=0!

!--------------!

|

v

( G1 )

28-38

ENGINE RUNNING SELF TEST, GOOSE TEST - LHBH0

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( G1 )

|--------->|

| v /----------------\

| /---------\ YES /VIP\_KNOCK = 1 \YES !---------------!

| / KIHP=1 ? \-----> \(KNOCK DETECTED?) /---->! CLEAR CODE\_225!

| \ / \----------------/ !---------------!

| \---------/ | |

| | NO | NO |

| |<-------------------------------------------|

| v

| /---------\

| / \ YES !---------------!

| / (N-NSAV) >= \------>! CLEAR CODE\_538!

| \ V\_GOOSN ? / !---------------!

| \ / |

| \---------/ |

| | NO |

| |<---------------------|

| v

| /---------\

| / ABS \ YES !----------------!

| / (TP-TPSAV) \------>! CLEAR CODE\_167 !

| \ >= / !----------------!

| \ V\_GOOSTP ?/ |

| \---------/ |

| | NO |

| |<-----------------------|

| v

| /---------\

| / ABS \ YES !----------------!

| /(MAP-MAPSAV) \------>! CLEAR CODE\_129 !

| \ >= V\_GOOSMP?/ !----------------!

| \ / |

| \---------/ |

| | NO |

| |<-----------------------|

| v

| /---------\

| / IS \ YES /---------\ YES !--------------!

| / CODE\_538 \------>/ VF1 \------>! .SET VF1 !

| \ CLEAR ? / \ CLEAR ? / ! VIP\_TIMER\_EX=!

| \ / \---------/ ! (V\_GOOSEC- !

| \---------/ | NO ! V\_GOOS\_DELAY)!

| | NO v !--------------!

| |<-----------------------------------------|

| v

| NO /-----------\YES /--------\YES !------------------!

|----/VIP\_TIMER\_EX \--->/ KIHP=1? \--->!.SET LAMBSE =VRLAM!---|

\ > V\_GOOSEC ?/ \ / !------------------! |

\-----------/ \--------/ |

|NO v

|------------------------------->(G2)

28-39

ENGINE RUNNING SELF TEST, GOOSE TEST - LHBH0

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( G2 )

|

v

YES/--------\

|-----------/ CODE\_ 538\

| \ SET ? /

v \--------/

!----------------! |NO

!CALL SETUP\_CODE ! |

! ! /--------\ YES !------------------!

!ENTER ERROR INTO! / CODE\_129 \---->!CALL SETUP\_CODE !

!SERVICE CODE ! \ SET ? / !ENTER ERROR INTO !

! TABLE ! \--------/ !SERVICE CODE TABLE!

!----------------! |NO !------------------!

| | |

| |<------------------|

| v

| /--------\ YES !------------------!

| / CODE\_167 \--->!CALL SETUP\_CODE !

| \ SET ? / !ENTER ERROR INTO !

| \--------/ !SERVICE CODE TABLE!

| |NO !------------------!

| | |

| |<------------------|

| v

| NO /--------\

|<-----------/IS KIHP = \

| \ 1 ? /

| \--------/

| |YES

| |

| /--------\ YES !------------------!

| / CODE\_225 \---->!CALL SETUP\_CODE !

| \ SET ? / !ENTER ERROR INTO !

| \--------/ !SERVICE CODE TABLE!

| |NO !------------------!

| | |

|---------------->|<--------------------|

v

!------------!

!SAF = VIPSPK!

!------------!

|

v

!------------------!

! GO TO SERVICE !

! OUTPUT ROUTINE !

! !

! SEND ALL SERVICE !

! CODES NOT CLEARED!

!------------------!

28-40

ENGINE RUNNING SELF TEST, THROTTLE PLATE ADJUSTMENT MODE - LHBH0

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THROTTLE PLATE ADJUSTMENT MODE

OVERVIEW

The THROTTLE ADJUST MODE allows checking and if necessary adjustment of the

throttle hard set at the desired rpm V\_RPM\_SET.

NOTE: The ignition timing should be checked and adjusted to

specification prior to any adjustment of the throttle.

The operator can enter the throttle adjust mode any time during the 2 minute

timing check by ungrounding and again grounding STI within a 4 second lapsed

time (STI\_RESET).

STI\_RESET is cleared on entry to Engine Running when VRUN\_ISCFLG is set to 1.

Exit from Engine Running Test will only be allowed when STI\_RESET is 0.

STI\_RESET can only be set to 1 during the 2 minute timing check. See exit

logic page for other conditions which will cause exit from Engine Running

Test.

Once the mode is entered the preset engine conditions are allowed to

stabilize for a calibrated period of time. To signal that this time has

elapsed and throttle adjustment may proceed, a seperator pulse is output on

Self Test Output (STO). The MODE SET UP LOGIC can be exited by ungrounding

the STI.

NOTE: Applications which have electrodrive fan require low

speed fan operation during this mode. (Flag V\_LOW\_FAN\_ON

= 1)

VIP flags, RUNNING and VRUN\_ISCFLG, remain set (=1)

during this mode.

The STO is also used as feedback to the operator during the adjust mode. If

the idle speed is within the range the STO will be "on" constantly, otherwise

it will "flash" at a rate of 1 Hz when below the range or at a rate of 4 Hz

when above the range. If at anytime during this mode the TP sensor goes out

of range the STO will flash at a rate of 8 Hz.

The Adjustment Mode ends when a calibrated time period (V\_MODE\_END), or a

maximum of 10 minutes (600 sec's) is reached. As long as the time period is

less than (V\_MODE\_END) the mode can be re-entered by ungrounding STI and

again grounding STI within 4 sec's. The re-entry point is at the MODE SET UP

LOGIC where all the parameters are set up and the STO signals that the mode

is entered.

28-41

ENGINE RUNNING SELF TEST, THROTTLE PLATE ADJUSTMENT MODE - LHBH0

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DEFINITIONS

INPUTS

Registers:

- VIP\_TIMER\_EX = VIP execution time; timer (eighths of sec).

- OUTTMR = VIP output test timer (sec's); revised from flag driven to free

running timer.

Bit Flags:

- DISABLE\_ISC = Flag used for idle fuel modulation determination 1 = disable,

0 = enable.

- OLFLG = Base Strategy flag which indicates type of fuel control, 0 = closed

loop control, 1 = open loop control.

- V\_MODE\_SETUP = Flag indicates entry in the Throttle Adjust Mode, 1 =

enabled.

- STIFLG = Self Test input which indicates VIP testing requested, 1 = tester

input is grounded.

- STI\_RESET = STI status flag during 2 minute timing check. See STI\_RESET

LOGIC and TIMER LOGIC within the process.

Calibration Constants:

- VDLY\_ENTER = Delay time to stabilize engine before sending pulse on STO

which indicates adjust mode entered, base value = 4 sec's.

- V\_ISCMOD\_MAX = Lean limit clip on idle fuel modulation, base value = 1.1.

- V\_ISCMOD\_MIN = Rich limit clip on idle fuel modulation, base value = 0.9.

- V\_KDNDT = VIP gain for idle fuel modulation, base value = 0.0005.

- V\_MODE\_END = Time to allow in service mode, base value = 300 sec's.

- V\_MODE\_OPT = Enable flag for throttle plate adjust mode, 1 = enable.

28-42

ENGINE RUNNING SELF TEST, THROTTLE PLATE ADJUSTMENT MODE - LHBH0

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- V\_NHIGH = Maximum range of rpm set, base value = 50 rpm.

- V\_NLOW = Minimum range of rpm set, base value = 30 rpm.

- V\_RPM\_SET = Desired rpm to be used in DSDRPM calculation, base value = 1000

rpm. Note: Must be above NUBASE rpm.

- V\_STO\_DELAY = Time delay to allow the tester to clear after sending the l/2

second pulse on STO, base value = 4 sec's. Note: clipped to a minimum of 4

seconds.

OUTPUTS

Registers:

- VIP\_TIMER\_EX = See above.

- OUTTMR = See above.

Bit Flags:

- STI\_RESET = See above.

- V\_MODE\_SETUP = See above.

- OLFLG = See above.

- DISABLE\_ISC = See above.

28-43

ENGINE RUNNING SELF TEST, THROTTLE PLATE ADJUSTMENT MODE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VR\_TPADJ\_MODE\_COM1

This logic is performed once STI\_RESET = 1 from the 2 min. delay logic. The

purpose is to allow a 4 second time period to enter the TP ADJUST MODE by

again grounding STI. If the 4 seconds elapses without action on STI the

result is to exit RUNNING VIP. When TP ADJUST MODE is requested, DSDRPM is

calculated based on the calibration parameter V\_RPM\_SET and fuel control is

forced closed loop.

VIP\_CNT\_EX = STI\_RESET TIMER LOGIC -----| PROCESS: STI\_RESET TIMER

| LOGIC

STI\_RESET TIMER LOGIC

| Allow 1/4 second for switch

VIP\_TIMER\_EX < .25 seconds -------------| debounce to prevent clearing

| ISCKAM when not entering the

| THROTTLE ADJUST MODE

|

| --- ELSE ---

|

VIP\_TIMER\_EX < 4 seconds ---------| | Allow 4 seconds to determine

|AND -| if THROTTLE ADJUST MODE

STIFLG = 0 -----------------------| | entry is selected.

(STI not grounded) |

| --- ELSE ---

|

VIP\_TIMER\_EX < 4 seconds ---------| | V\_MODE\_SETUP = 1

|AND -| RVIPRPM = V\_RPM\_SET

STIFLG = 1 -----------------------| | OLFLG = 0 (closed loop fuel)

(STI is grounded) | VIP\_TIMER\_EX = 0

| VIP\_CNT\_EX = MODE SETUP

| LOGIC

|

| --- ELSE ---

|

VIP\_TIMER\_EX >OR= 4 seconds ------| | STI\_RESET = 0

|AND -| VIP\_CNT\_EX = VIP\_REINIT

STIFLG = 0 ----------------------- | (TP ADJUST MODE not

(STI not grounded) | selected)

|

| ---ELSE---

|

VIP\_TIMER\_EX >OR= 4 seconds ------| | STI\_RESET = 0

|AND -| VIP\_CNT\_EX = VIP\_REINIT

STIFLG = 1 -----------------------| | (TP ADJUST MODE has been

( STI is grounded) | bypassed and WIGGLE TEST

| is requested)

28-44

ENGINE RUNNING SELF TEST, THROTTLE PLATE ADJUSTMENT MODE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

This logic sets up the conditions for the test and allows the engine to

stabilize. Feedback spark is locked at the mean idle spark value and Kam is

disabled from learning by clearing each background loop. The total airflow

becomes the predicted airflow by ignoring airflow correction factor IPSIBR

AND DASPOT.

Idle Fuel Modulation is used for idle stability of speed density systems.

Most MAF systems do not need Idle Fuel Modulation and can be disabled by

setting the gain term V\_KDNDT = 0. Certain MAF configurations may require

compensation which is opposite of what is required for speed density. In

these cases the gain term V\_KDNDT can be made negative.

Please note that Engine Running VIP also has Idle Fuel Modulation capability

and if it was necessary to use it there, then it is needed here also.

VIP\_CNT\_EX = MODE SET UP LOGIC ---------| OUTTMR = 0

| PROCESS: MODE SET UP LOGIC

MODE SET UP LOGIC

STIFLG = 0 -----------------------------| VIP\_CNT\_EX = STI\_RESET TIMER

| LOGIC

|

| --- ELSE ---

|

| RETURN TO BACKGROUND

| Wait for engine to stabilize

| Base strategy actions:

| DESMAF = DESMAF\_PRE

VIP\_TIMER\_EX < VDLY\_ENTER --------------| (ISCKAM is cleared each

| background loop. IPSIBR

| is ignored)

| SPK\_FBS = SPK\_IDLE

| (KSPARK = 0; mean idle spark)

|

| --- ELSE ---

|

| Send single 0.5 sec. pulse on STO

| VIP\_TIMER\_EX = 0

28-45

ENGINE RUNNING SELF TEST, THROTTLE PLATE ADJUSTMENT MODE - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TP ADJUST MODE FEEDBACK LOGIC

VIP\_TIMER\_EX < V\_STO\_DELAY -------------| Delay to clear tester after

(Clipped to 4 sec's min.) | 0.5 sec. pulse on STO

|

| --- ELSE ---

|

| Test has timed out

OUTTMR => V\_MODE\_END -------------------| STO = 0

(Vector clipped at 600 sec's max.) | VIP\_TIMER\_EX = 0

| VIP\_CNT\_EX = (VIP\_REINIT)

|

| --- ELSE ---

|

STI\_FLG = 0 ----------------------------| VIP\_CNT\_EX = STI\_RESET TIMER

| LOGIC

|

| --- ELSE ---

|

ITP < VTAP3 ----------------------| |

|OR --| Pulse STO at 8 Hz

ITP > VTAP4 ----------------------| |

| --- ELSE ---

|

NBAR <= (DSDRPM - V\_NLOW) --------------| Pulse STO at 1 Hz

|

| --- ELSE ---

NBAR > (DSDRPM - V\_NLOW) ---------| |

|AND -| Turn STO on continuous

NBAR < (DSDRPM + V\_NHIGH) --------| |

| --- ELSE ---

|

NBAR >= (DSDRPM + V\_NHIGH) -------------| Pulse STO at 4 Hz

NOTE: VIP flags V\_MODE\_SETUP and STI\_RESET are cleared on exit

from the TP ADJUST MODE during the re-init procedure.

28-46

CHAPTER 29

CONTINUOUS TEST STRUCTURE

29-1

CONTINUOUS TEST STRUCTURE, FILTERING LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FILTERING LOGIC

OVERVIEW

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. Whenever the wiggle test mode is active

and any one of the fault filters active during the wiggle mode exceeds its

threshold (WIGLVL), STO is turned "on" (otherwise it will be "off").

PROCESS

STRATEGY MODULE: VC\_FILTER\_COM2

-----------

( ENTER )

-----------

|

v

NO /---------\ YES

|-------------/ FAULT (N) \-------------|

| \ DETECTED ?/ |

v \---------/ v

!--------------! !--------------!

! CXXXFIL = ! ! CXXXFIL = !

! CXXXFIL -1 ! ! CXXXFIL + !

!--------------! ! CXXXUP !

| !--------------!

| |

|------------->|<-----------------------|

|

v

/---------\

/ CXXXFIL \ YES

/ > \----------------|

\ CXXXLVL / |

\ ? / |

\---------/ |

| NO v

v !---------------------!

----------- ! STORE KAM CODE (N) !

( EXIT )<-----! ZERO WARM-UP CYCLE !

----------- ! COUNTER (N) !

!---------------------!

29-2

CONTINUOUS SELF TEST, FAULT THRESHOLD/UPCOUNT VALUE SELECTION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FAULT THRESHOLD/UPCOUNT VALUE SELECTION

"WIGGLE" VERSUS NORMAL CONTINUOUS TEST

OVERVIEW

Continuous Self-Test can operate in one of two modes, normal continuous and

Wiggle. In normal continuous, the calibrated values for fault filter

upcounts and thresholds (CxxxUP and CxxxLVL) are used to control the setting

of service codes. During Wiggle mode, a value of 255 is used for all

non-zero upcounts (except as noted) and the value of WIGLVL is used for all

thresholds (except as noted).Also, STO will be activated at any time that a

continuous fault is present. This will cause a STAR tester to output a tone

whenever a failure is caused by a service technician manipulating the EEC

harness and/or connectors. This is done to assist the diagnosis of

intermittent harness problems.

Wiggle mode is entered when Self-Test In (STI) is grounded after initiating

and exiting, or aborting, on demand self test (KOEO or KOER). This can be

done by grounding, ungrounding, then re-grounding STI with the engine off or

running. Or, wiggle will be entered after an on demand Self-Test (KOEO or

KOER) is completed. If the vehicle is in gear when engine running (KOER)

Self-Test is initiated, or the vehicle is placed in gear during engine

running Self-Test; wiggle mode will be entered. See the Self-Test entry/exit

logic for a complete description.

29-3

CONTINUOUS SELF TEST, FAULT THRESHOLD/UPCOUNT VALUE SELECTION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VC\_FAULT\_COM1

WIGFLG = 1 -----------------------------| Wiggle test:

(set in Self-Test entry logic) | Set all non-zero upcounts to

| 255 except as noted in test

| descriptions

| Set all continuous thresholds

| to WIGLVL except as noted in

| test descriptions

|

| --- ELSE ---

|

| Not in Wiggle

| Use calibrated upcounts and

| thresholds

|

WIGFLG = 1 -----------------------| |

(in wiggle test) |AND -| Turn STO on

| |

CxxxFIL > CxxxLVL-----------------| |

(any fault filter greater |

than threshold) |

|

| --- ELSE ---

|

WIGFLG = 1 -----------------------------| Turn STO off

(in wiggle test) |

|

(all fault filters less |

than or equal to the |

threshold) |

CONTINUOUS CODE PARAMETER NAMING CONVENTION

|WARM-UP|VECTOR

FAULT | FILTER |UPCOUNT|THRESHOLD|COUNTER|RAM FLAG

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

FAULT |CXXXFIL |CXXXUP | CXXXLVL |CXXXCNT|CXXX\_KAM\_BIT

DESCRIPTION

29-4

CONTINUOUS SELF TEST, KAM CODE WARM\_UP COUNTER/ERASE LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

KAM CODE WARM\_UP COUNTER/ERASE LOGIC

OVERVIEW

Each KAM code has a counter for "Number of Engine warm-ups" since the fault

was last stored. The warm up counters are incremented once per each power

up, only if a true warm up has occurred as described below.

Each individual code is erased when its counter is >= 80. Codes can also be

manually cleared by ungrounding STI during Engine-Off code output mode.

DEFINITIONS

Calibration Constants:

- VECT3 = coolant temp. limit to trigger warm up counters (150 deg. F).

- VECT5 = starting coolant temp. for warm up counters (120 deg. F).

29-5

CONTINUOUS SELF TEST, KAM CODE WARM\_UP COUNTER/ERASE LOGIC - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VC\_WARMUP\_KAM\_ERASE\_COM1

WARM\_UP COUNTER LOGIC

WARM\_UP = 0 ----------------------|

|

TCSTRT < VECT5 -------------------|

|AND -|SET WARM\_UP = 1

ECT > VECT3 ----------------------| | (the flag WARM\_UP is

| | initialized to 0 on

RUN MODE -------------------------| | power up and is never

(CRKFLG=0, UNSP=0) | cleared once a true

| warmup has occurred

STIFLG = 0 -----------------------|

| |INCREMENT ALL CODE

POWER\_UP = 1 ---------------------|AND -| WARM-UP COUNTERS

(set in RAM INIT.) | |

| |SET POWER\_UP = 0

WARM\_UP = 1 ----------------------| |

KAM CODE ERASE LOGIC

WARM-UP COUNTER(N) >= 80 ---------------|ERASE KAM CODE(N)

|

| --- ELSE ---

|

STO\_WORKING = 1 ------------| |

(engine off code output | |

mode\*) |OR --| |

| | |

STO\_TRIGGER = 1 ------------| | |

|AND -|ERASE ALL KAM CODES

NO\_START = 1 ---------------------| |

(engine off test in process) | |

| |

STIFLG = 0 -----------------------| |

(self test not requested)

\* Note: Includes the output of any codes in Engine Off Self Test;

service codes, separator pulse, and continuous codes.

29-6

COOLING SYSTEM TEST (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

COOLING SYSTEM TEST

OVERVIEW

This module is designed to verify that the cooling system is controlling the

engine temperature by monitoring the ECT input to determine whether the

thermostat has opened. It is based upon the observation of a predicted

temperature drop within a specific control range.

Certain entry conditions must be met to enable the testing process. A

stabilization time is required to initialize the test. There is a

predetermined starting point at which processing will begin. A time limit is

allowed for the system to control engine temperature during which the

determination is made that either: 1) there is a system fault; or 2) the

system is controlling as expected. Once a decision is made the test will be

bypassed for the rest of that power up.

The system faults are indicated by two service codes as listed below.

Condition:

1) code 338; cooling system is not heating (i.e. thermostat stuck open, low

coolant level, very cold ambient temperature, etc.)

2) code 339; cooling system is not cooling (i.e. thermostat stuck closed,

flow restriction within the system, coolant level/ condition or system

operating pressure, etc.)

DEFINITIONS

INPUTS

Registers:

- C338CNT = Continuous code 338 warmup counter.

- C339CNT = Continuous code 339 warm up counter.

- C338FIL = Cont. code 338 register update, counts. Initialized to 0.

- C339FIL = Cont. code 339 register update, counts. Initialized to 0.

- V\_ATMR2 = Time since ECT became greater than V\_ECTCTMIN, seconds.

- V\_ECTCTL = Register used in determining the delta temperature drop

for setting the thermostat open flag, V\_THMOPN, deg F. initialized

to 254 deg. F.

\_ V\_ECT\_CTR = Counter which increments when the ECT is within the

calibrated control range. Initialized to 0.

- V\_ECTHI = Register used to load current ECT input as long as the

value is increasing, deg. F. Initialized to 0.

Continued on Next Page

29-7

COOLING SYSTEM TEST (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Continued from Previous Page

- OUTTMR = Counter used throughout VIP to limit test time, seconds.

Initialized to 0.

Bit Flags:

- C338\_KAM\_BIT = Code 338 KAM bit used in service code output

routine.

- C339\_KAM\_BIT = Code 339 KAM bit used in service code output

routine.

- VATMR2\_FLG = Flag used to count up V\_ATMR2.

- V\_CST\_PASS = Flag used to bypass testing once a decision has been

made that either there is a fault or the system is controlling

within the temperature range, 1 = bypass. Initialized to 0.

- V\_STABLFLG = Flag with is set upon stabilization time V\_STABLTIM.

Initialized to 0.

- V\_THMOPN = Flag which indicates the thermostat has opened, 1 =

opened. Initialized to 0.

- V\_WARM\_FLG = Flag which indicates the engine has warmed up, 1 =

warm. Initialized to 0.

Calibration Constants:

- C338LVL = Continuous code 338 filter level. Base value = 250 cnts.

- C339LVL = Continuous code 339 filter level. Base value = 250 cnts.

- C338UP = Continuous code 338 filter upcount. Base value = 255 cnts.

- C339UP = Continuous code 339 filter upcount. Base value = 255 cnts.

- V\_CSTE\_SW = Cooling System Test enable. 1 = enable, 0 = disable.

- V\_ECT\_DEL = Delta temperature drop required which indicates that

the thermostat has opened. Base value = 10 deg. F.

- V\_ECT\_LIM = Number of valid ECT readings within the control range

before the system is considered warmed up. Base value = 20.

- V\_ECTCTMAX = ECT high limit within the control range. Base value

= 220 deg. F.

- V\_ECTCTMIN = ECT low limit within the control range. Base value

= 170 deg. F.

Continued on Next Page

29-8

COOLING SYSTEM TEST (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Continued from Previous Page

- V\_ECT\_TIME = Time allowed for engine warmup from V\_ECTCTMIN. Base

value = 240 secs.

- V\_STABLTIM = Time allowed for cooling system stabilization after

run mode is entered. Base value = 30 secs.

- V\_TIME\_LIM = Total time allowed for engine warmup from run mode.

Base value = 1200 secs.

OUTPUTS

Registers:

- V\_ECTCTL = See above

- V\_ECT\_CTR = See above

\_ V\_ECTHI = See above

Bit Flags:

- V\_CST\_PASS = See above

- V\_STABLFLG = See above

- V\_THMOPN = See above

- V\_WARM\_FLG = See above

29-9

COOLING SYSTEM TEST (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VC\_COOLING\_SYS\_COM1

TEST ENTRY CONDITIONS:

V\_CSTE\_SW = 0 ----------|

(Test not enabled) |

C118FIL > 0 ------------| | V\_CST\_PASS = 1

(ECT sensor fault) | | (bullet proof to prevent

C117FIL > 0 ------------|OR ----| storing a false code).

(ECT sensor fault) | | EXIT: VC\_COOLING\_SYS\_TEST

V\_CST\_PASS = 1 ---------| |

(Test done this pwrup) | | --- ELSE ---

|

| DO: STABILIZATION CHECK

|

BEGIN: STABILIZATION CHECK

V\_STABLFLG = 1 -----------------| DO: STARTING POINT CHECK

|

| ---ELSE---

|

| OUTTMR = 0

| V\_STABLFLG = 1

ATMR1 >OR= V\_STABLTIM ----------| V\_ECTHI = ECT

(Stabilization time) | EXIT: VC\_COOLING\_SYS\_TEST

|

| --- ELSE ---

|

| EXIT: VC\_COOLING\_SYS\_TEST

END: STABILIZATION CHECK

BEGIN: STARTING POINT CHECK

ECT >OR= V\_ECTCTMIN ------------| DO: ECT MONITORING LOGIC

(ECT above control min.) | DO: COOLING SYSTEM FUNCTION LOGIC

|

| ---ELSE---

|

| DO: COOLING SYSTEM FUNCTION LOGIC

END: STARTING POINT CHECK

29-10

COOLING SYSTEM TEST (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: ECT MONITORING LOGIC

ECT >OR= V\_ECTHI ----------------| V\_ECTHI = ECT

(Coolant Temp. rising) |

| --- ELSE ---

ECT < V\_ECTHI -------------| |

(Coolant temp. falling) | |

ECT < V\_ECTCTL ------------| |

(Sys. controlling temp.) |AND--| V\_ECTCTL = ECT

ECT > V\_ECTCTMIN ----------| | (Note: on power up V\_ECTCTL

(ECT above control min.) | | is initialized to 254 deg. F)

V\_WARM\_FLG = 1 ------------------|

(Engine has warmed up) | |

V\_THMOPN = 0 --------------------|AND---| V\_THMOPN = 1

(Thermostat not open yet) | | (Thermostat has opened)

V\_ECTHI - V\_ECTCTL > V\_ECT\_DEL---| |

(ECT has dropped required delta)|

V\_ECT\_CTR >OR= V\_ECT\_LIM---| |

(Valid ECT readings limit)|AND--| |

V\_ATMR2 >OR= V\_ECT\_TIME----| |OR----| V\_WARM\_FLG = 1

(Time allowed for warmup) | | (Warmup occurred at some

| | previous time)

ECT >OR= V\_ECTCTMAX -------------| |

(ECT above control max.)

ECT > V\_ECTCTMIN ----------------|

(ECT above control min.) | |

|AND---| V\_ECT\_CTR = V\_ECT\_CTR + 1

ECT < V\_ECTCTMAX ----------------| | (ECT within control range;

(ECT below control max.) | increment counter,clip

at 255)

END: ECT MONITORING LOGIC

NOTE: V\_ATMR2 starts running based on the calibration constant

V\_ECTCTMIN.

29-11

COOLING SYSTEM TEST (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: COOLING SYSTEM FUNCTION LOGIC

V\_WARM\_FLG = 0 --------------| | V\_CST\_PASS = 1

(Engine not warm yet) | | Set: ERROR\_DETECTED

|AND--| Cooling system is not heating

| | Do: FAULT FILTERING C338

OUTTMR >OR= V\_TIME\_LIM-------| | (Note: calibrate fault filter

(Total time allowed to warmup) | to store code in one upcount).

|

| ---ELSE ---

V\_WARM\_FLG = 1----------| |

(warmup completed) | | V\_CST\_PASS = 1

| | Cooling system is not cooling

V\_THMOPN = 0------------|AND-------| Set: ERROR\_DETECTED

(Thermostat not open) | | Do: FAULT FILTERING C339

ECT > V\_ECTCTMAX--------| | (Note: calibrate fault filter

(ECT above control limit) | to store code in one upcount).

|

| ---ELSE---

|

V\_WARM\_FLG = 1 ---------| | V\_CST\_PASS = 1

(Warmup completed) |AND-------| (Cooling sys. is controlling)

V\_THMOPN = 1------------| | EXIT: VC\_COOLING\_SYS\_TEST

(Thermostat open) | Do: FAULT FILTERING C338 and C339

|

| ---ELSE---

|

| EXIT: VC\_COOLING\_SYS\_TEST

END: COOLING SYSTEM FUNCTION LOGIC

TIMER CONTROL LOGIC

(Included within this test module)

V\_ATMR2 - TIME SINCE ECT BECAME GREATER THAN V\_ECTCTMIN

ECT > V\_ECTCTMIN -----| | VATMR2\_FLG = 1

|AND --------| V\_ATMR2 = 0

VATMR2\_FLG = 0 -------| |

| ---ELSE---

|

VATMR2\_FLG = 1 --------------------| COUNT UP V\_ATMR2

|

| ---ELSE---

|

| V\_ATMR2 = 0

29-12

CONTINUOUS SELF TEST, ECT OPEN/SHORT TESTS - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ECT OPEN/SHORT TESTS

PROCESS

STRATEGY MODULE: VC\_ECT\_COM1

-----------

( ENTER )

-----------

|

v

/---------\ NO !----------!

/ IECT >= \--------->! FAULT 117!

\ ECTMIN ? / !----------!

\---------/ |

| YES |

|<---------------------|

v

!--------------!

! DO FAULT !

! FILTERING 117!

!--------------!

|

v

/---------\ NO !----------!

/ IECT <= \--------->! FAULT 118!

\ ECTMAX ? / !----------!

\---------/ |

| YES |

|<---------------------|

v

!--------------!

! DO FAULT !

! FILTERING 118!

!--------------!

|

v

-----------

( EXIT )

-----------

29-13

CONTINUOUS SELF TEST, ACT SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ACT SENSOR TEST

PROCESS

STRATEGY MODULE: VC\_ACT\_COM1

-----------

( ENTER )

-----------

|

v

/---------\ NO !----------!

/ IACT >= \--------->! FAULT 112!

\ ACTMIN ? / !----------!

\---------/ |

| YES |

|<---------------------|

v

!--------------!

! DO FAULT !

! FILTERING 112!

!--------------!

|

v

/---------\ NO !----------!

/ IACT <= \--------->! FAULT 113!

\ ACTMAX ? / !----------!

\---------/ |

| YES |

|<---------------------|

v

!--------------!

! DO FAULT !

! FILTERING 113!

!--------------!

|

v

-----------

( EXIT )

-----------

29-14

TRANSMISSION OIL TEMPERATURE SENSOR (CONTINUOUS) - LHBH0

PED-PTEM FoMoCo, PROPRIETARY & CONFIDENTIAL

TOT OPEN/SHORT TESTS

PROCESS

STRATEGY MODULE: VC\_TOT\_COM2

-----------

( ENTER )

-----------

|

v

/---------\ NO !----------!

/ ITOT => \--------->! FAULT 638!

\ TOTMIN ? / !----------!

\---------/ |

| YES |

|<---------------------|

v

!--------------!

! DO FAULT !

! FILTERING !

!--------------!

|

v

/---------\ NO !----------!

/ ITOT <= \--------->! FAULT 637!

\ TOTMAX ? / !----------!

\---------/ |

| YES |

|<---------------------|

v

!--------------!

! DO FAULT !

! FILTERING !

!--------------!

|

v

-----------

( EXIT )

-----------

29-15

CONTINUOUS SELF TEST, MANIFOLD ABSOLUTE PRESSURE SENSOR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MAP SENSOR TEST

PROCESS

STRATEGY MODULE: VC\_MAP\_COM1

-----------

( ENTER )

-----------

|

v

/---------\ NO

/ MAPTMR <= \----------------|

\ VMPMAX ? / |

\---------/ |

| YES |

v v

/---------\ NO !----------!

/ VMDEL5 \--------->! FAULT 126!

/ <= MDELTA<= \ !----------!

\ VMDEL6 ? / |

\ / |

\---------/ |

| YES |

|<---------------------|

v

!--------------!

! DO FAULT !

! FILTERING 126!

!--------------!

|

v

-----------

( EXIT )

-----------

29-16

CONTINUOUS SELF TEST, MAP SENSOR VACUUM CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MAP SENSOR VACUUM CIRCUIT TEST

OVERVIEW

The purpose of this test is to check the vacuum circuit integrity of the map

sensor in speed density systems.

The test philosophy is such that a required difference between BP and MAP

should be observed. This difference is evaluated each background loop and if

present, normal down fault is executed.

Operating modes or situations that prevent this change would be:

1) Cranking/Stall

2) WOT or,

3) MAP vacuum hose disconnect. (MAP = BP)

In order to isolate the disconnect, testing is conducted in Continuous Self

Test and is restricted to closed throttle and run mode where the BP-MAP

change is greatest.

TP and MAP electrical integrity must be assured and checked because they are

essential inputs to the testing conditions. If either input has failed, the

test is immediately exited.

The test is further restricted so that updated BP is greater than about 20"

(V\_BPMIN). This is to prevent executing the test due to low updated BP at

altitude which may cause the MAP difference to be calculated low. In

addition, a time since last PIP limit (V\_PIPMAP\_LMT) parameter is utilized to

abort testing if a stall is imminent. This is to preclude false failure

recognition.

If all testing requirements are met and the BP-MAP change is less than

V\_MAPDIF i.e. 2", then a fault is indicated and up filtering is executed.

When the fault filter exceeds the calibrated threshold, an error code

(128\*/81\*\*) is stored in KAM, and a fault flag (V\_VACFLG) is set and passed

to base strategy to be used for activating MAP MFMFLG.

Continuous checks are made on the fault filter to ascertain whether or not a

fault is present in order to set or clear the failure flag.

The test may be calibrated out if desired by setting V\_MAPFLG = 0.

\* 3-digit codes

\*\* 2-digit codes

29-17

CONTINUOUS SELF TEST, MAP SENSOR VACUUM CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Self Test Registers:

- V\_IMAP = Stored MAP after MAP\_WORD calculation.

- C126\*/22\*\*FIL = Error C126/22 fault filter.

- C128\*/81\*\*CNT = Warm-up counter for Fault 128/81.

- C128\*/81\*\*FIL = Fault filter for error code 128/81.

Self Test Calibration Constants:

- V\_MAPDIF = Required minimum MAP change.

- V\_PIPMAP\_LMT = Max TSLPIP to do MAPVAC test.

- V\_MAPFLG = MAP vacuum circuit test enable flag 1 = enable.

- V\_BPMIN = Minimum BP required to do test.

- C128\*/81\*\*LVL = Threshold level for fault 128/81.

- C128\*/81\*\*UP = Upcount for fault 128/81.

Self Test Flags:

- WIGFLG = Flag to indicate wiggle mode. 1 = enable.

- V\_VACFLG = Error flag passed to base strategy to indicate vacuum circuit

failure. 1 = failure.

- ERROR\_DETECTED = Flag passed to fault filter routine indicating self test

detected a failure.

\* 3-digit codes

\*\* 2-digit codes

29-18

CONTINUOUS SELF TEST, MAP SENSOR VACUUM CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Base Strategy Registers:

- BP = Inferred BP used by control strategy.

- APT = Throttle mode.

Base Strategy Flags:

- UNDSP = Underspeed flag.

- TFMFLG = TP FMEM flag.

Base Strategy Calibration Constants:

- FILHYS = FMEM filter count hysteresis.

NOTE: V\_MAPFLG is set to 0 on Power-up.

29-19

CONTINUOUS SELF TEST, MAP SENSOR VACUUM CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VC\_MAPVAC\_COM1

V\_MAPFLG = 0 ---------------------|

(test cal'd out) |OR --| DO: Fault Filter C128\*/81\*\*

| | DO: Failure Mode Logic

BP-IMAP\_WORD => V\_MAPDIF ---------| |

(MAP difference indicated) |

|

| --- ELSE ---

|

WIGFLG = 0 -----------------------| |

(not in Wiggle Mode) | |

| |

UNDSP = 0 ------------------------| |

(Run mode) | |

| |

TFMFLG = 0 -----------------------| |

(TP ok) | |

| |

C126\*FIL = 0 ---------------------|AND -| SET: ERROR\_DETECTED

22\*\* | | DO: FAULT FILTER C128\*/81\*\*

(MAP elect ok) | | DO: FAILURE MODE LOGIC

| |

TSLPIP <= V\_PIPMAP\_LMT -----------| |

(RPM high enough) | |

| |

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

(closed throttle) | |

| |

BP > V\_BPMIN ---------------------| |

(min BP req'd) | |

| |

BP-IMAP\_WORD < V\_MAPDIF ----------| |

(req'd MAP diff) |

|

| --- ELSE ---

|

V\_VACFLG = 0 ---------------------------| SET: C128\*FIL = 0

(error flag set) | 81\*\*

|

| EXIT: MODULE

|

| --- ELSE ---

|

| EXIT: MODULE

\* 3-Digit code

\*\* 2-digit code

29-20

CONTINUOUS SELF TEST, MAP SENSOR VACUUM CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FAILURE MODE LOGIC:

C128\*FIL > C128\*LVL --------------------| SET: V\_VACFLG = 1

81\*\* 81\*\* |

(failure indicated) |

| --- ELSE ---

|

C128\*FIL <= C128\*LVL - FILHYS ----------| SET: V\_VACFLG = 0

81\*\* 81\*\* |

(failure removed) |

| --- ELSE ---

|

| EXIT

\* 3-digit code

\*\* 2-digit code

29-21

CONTINUOUS SELF TEST, SONIC EGR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SONIC EGR SYSTEM TEST

OVERVIEW

In the documentation, this module is enabled via the lower case parameters

egr\_system and sonic\_egr from VC\_xxxx\_SEL\_COMn. In the software, a similar

parameter may be used or the test may be enabled based on whatever

combinations of PFEHP, PFEHP\_FG, EGRHP\_FG, etc. are available.

When the test is entered, the IEGR input is checked to insure that it is

within the max/min limits. If this test fails, the appropriate fault filter

is upcounted and no further testing is required. If the voltage is within

limits, it is then checked to insure that it is not below the lowest voltage

expected from a closed valve. Note that these checks are bypassed until EGR

is enabled for the first time.

Additional checks are made when the EGR is commanded off to insure that the

valve is returning to the closed position. When the EGR is on (high duty

cycle), a check is made (if the vacuum is high enough) to see if the valve

has moved sufficiently from the closed position.

Lowercase parameters such as sonic\_egr\_test\_ena, sonic\_egr\_off\_test, etc.

are used to control flow through the ladder diagrams. The use of these

parameters in the documentation does not imply that similar parameters are

required in the software.

Note that the flags V\_EGR\_STK\_ON and, V\_EGR\_ON\_CR are used to reset any fault

filters that have partially counted up and control timers when a particular

test mode is first entered.

DEFINITIONS

INPUTS

Registers:

- BP = Barometric pressure. (note: Upper byte of BP\_WORD).

- C332FIL = EGR valve opening not detected (Sonic, PFE) fault filter

- C334FIL = EVP voltage above closed limit (sonic) fault filter.

- EGRDC = EGR duty cycle.

- IEGR = EGR sensor input.

- MAP = Manifold absolute pressure BIN 3.

- V\_EGR\_RDY = Continuous EGR test ready flag (Latched)

- VIP\_TIMER\_EX = VIP state timer.

29-22

CONTINUOUS SELF TEST, SONIC EGR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- V\_EGR\_STK\_ON = Indicates that the EGR off continuous test is in progress.

- WIGFLG = Indicates VIP wiggle test.

Calibration Constants:

- C332LVL = EGR valve opening not detected (sonic/PFE) threshold.

- C334LVL = EVP voltage above closed limit (sonic) threshold.

- EVPMAX = Maximum EVP reading (open) units are counts.

- EVPMIN = Minimum EVP reading (short) units are counts.

- VCRTDC = GR cruise test duty cycle limit, percent.

- VEGVAC = Minimum manifold VAC for cruise test units are inches hg.

- V\_EGR\_CTMR = EGR cruise test timer limit.

- VEITMR = EGR idle test timer limit units are seconds.

- V\_EGR\_ON\_CR = Indicates that the EGR on cruise test (test for flow) was

in progress last background loop.

- VEVPCL = EVP cruise test limit units are counts.

- VEVPHL = EVP high limit (valve closed) units are counts end of essential

ordering of constants.

- VEVPLL = EVP low limit (valve closed) units are counts

29-23

CONTINUOUS SELF TEST, SONIC EGR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VC\_EGR\_SON\_SD\_COM10

Step one (if sonic EGR is present) is to test for an input voltage that is

out of range. If an open or short circuit is detected, the test is complete.

Otherwise, the test continues to check for flow or a stuck open valve.

!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

NOTE:

EFMLO is passed to the fault filter routine every time it is called for code

327 and returns value of 1 if the code is set and returns a value of 0 if the

code is clear. Similarly, EFMHI is passed with code 337. EFMHI and EFMLO

are used to set and clear EFMFLG. This logic is described in the EGR

chapter.

!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

egr\_system <> sonic\_egr ----------------| sonic\_egr\_test\_ena := 0

(parameters egr\_system | (no sonic EGR hardware, no

and sonic\_egr from the | testing)

VC\_xxxx\_SEL\_COMn module) |

| --- ELSE ---

IEGR <= EVPMIN -------------------| |

(voltage below minimum) |AND -| error\_detected := 1

| | Fault Filter Code 327

V\_EGR\_RDY = 1 --------------| | | (upcount fault)

(EGR has been | | | (see note above)

enabled) |OR --| |

| | Fault Filter Code 337

WIGFLG = 1 -----------------| | (see note above)

(Wiggle mode - allow testing) | Fault Filter Code 328

| (downcount faults not present)

|

| V\_EGR\_ON\_CR := 0

| V\_EGR\_STK\_ON := 0

| (clear flags - modes not to be

| active)

|

| sonic\_egr\_test\_ena := 0

| (done testing)

|

| --- ELSE ---

(continued on next page)

29-24

CONTINUOUS SELF TEST, SONIC EGR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

|

IEGR >= EVPMAX -------------------| |

(voltage above maximum) | |

|AND -| error\_detected := 1

V\_EGR\_RDY = 1 --------------| | | Fault Filter Code 337

(EGR has been | | | (upcount fault)

enabled) |OR --| | (see note above)

| |

WIGFLG = 1 -----------------| | Fault Filter Code 327

(Wiggle mode - allow testing) | (see note above)

| Fault Filter Code 328

| (downcount faults not present)

|

| V\_EGR\_ON\_CR := 0

| V\_EGR\_STK\_ON := 0

| (clear flags - modes not to be

| active)

|

| sonic\_egr\_test\_ena := 0

| (done testing)

|

| --- ELSE ---

IEGR < VEVPLL --------------------| |

(voltage below closed | |

valve voltage) |AND -| error\_detected := 1

| | Fault Filter Code 328

WIGFLG = 0 -----------------------| | (upcount fault)

|

| Fault Filter Code 327

| Fault Filter Code 337

| (downcount faults not present)

|

| sonic\_egr\_test\_ena := 1

| (allow further testing)

|

| --- ELSE ---

|

| Fault Filter Code 327

| Fault Filter Code 337

| Fault Filter Code 328

| (no faults, downcount)

|

| sonic\_egr\_test\_ena := 1

| (allow further testing)

29-25

CONTINUOUS SELF TEST, SONIC EGR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

To get here, sonic\_egr\_test\_ena must be set by the previous diagram (sonic

hardware present, no open or short fault). This diagram determines which EGR

mode (on or off) is to be tested. For whichever mode is enabled, the flags

that control action in the other mode are cleared.

sonic\_egr\_test\_ena := 1 ----------|

(testing allowed |

by previous diagram) |AND -| V\_EGR\_ON\_CR := 0

| | sonic\_egr\_on\_test := 0

EGRDC = 0 ------------------------| | (EGR on test not active)

(EGR not on) |

| sonic\_egr\_off\_test := 1

| (perform test for valve stuck

| open)

|

| --- ELSE ---

|

sonic\_egr\_test\_ena := 1 ----------------| V\_EGR\_STK\_ON := 0

(testing allowed | sonic\_egr\_off\_test := 0

by previous diagram; EGR is on) | (EGR off test not active)

|

| sonic\_egr\_on\_test := 1

| (perform test for valve opening)

|

| --- ELSE ---

|

| sonic\_egr\_off\_test := 0

| sonic\_egr\_on\_test := 0

| (no more testing)

Test to see if this is the first pass through the EGR off test. If so, reset

the timer VIP\_TIMER\_EX and clear out the fault filter for code 334. If it is

not the first pass, continue on. Of course, if the EGR off test is not

enabled, no action is required.

V\_EGR\_STK\_ON = 0 -----------------|

(last pass was not in |

EGR off test) |AND -| V\_EGR\_STK\_ON := 1

| | (this is the first background

sonic\_egr\_off\_test = 1 -----------| | loop in this test mode)

(mode enabled) |

| VIP\_TIMER\_EX := 0

| (reset for time delay before

| testing)

|

| Do: EGR Off Fault Filter Reset

| Do: EGR Off Test

|

| --- ELSE ---

|

sonic\_egr\_off\_test = 1 -----------------| Do: EGR Off Test

(mode enabled)

29-26

CONTINUOUS SELF TEST, SONIC EGR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGR Off Test

This diagram, which follows the previous, tests to determine if the input

voltage is too high for a closed valve (valve not closing). If it is, code

334 may be set after the time delay.

IEGR > VEVPHL --------------------|

(voltage above closed value) |

|

VIP\_TIMER\_EX >= VEITMR -----------|AND -| error\_detected := 1

(mode enabled) | | Fault Filter Code 334

| | (upcount fault filter)

WIGFLG = 0 -----------------------| |

(not in wiggle mode) |

| --- ELSE ---

|

IEGR <= VEVPHL -------------------------| Fault Filter Code 334

(voltage OK) | (downcount fault filter)

|

| --- ELSE ---

|

| no action

| (mode not active or fault present

| but not timed out yet)

END: EGR Off Test

29-27

CONTINUOUS SELF TEST, SONIC EGR - LHBH0

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This test (enabled by sonic\_egr\_on\_test = 1) checks to see if the conditions

are right to test the EGR valve for opening. This requires that there is

adequate vacuum and the EGR duty cycle be high to indicate that the EEC is

trying to open the valve. Alternately, if code 332 is already set, the test

will be enabled to allow the system to clear the code (and the MIL light) if

the failure disappears.

sonic\_egr\_on\_test <> 1 -----------------| no action

(do not perform test |

for valve opening) |

| --- ELSE ---

C332FIL > C332LVL ----------------| |

(Code set, bypass | |

entry conditions) |OR --| Do: Test for EGR Flow

| | (perform check to see

BP - MAP > VEGVAC ----------| | | if valve opening can be

(enough muscle vacuum) |AND -| | detected)

| |

EGRDC > VCRTDC -------------| |

(trying to open EGR valve) |

| --- ELSE ---

|

| V\_EGR\_ON\_CR = 0

| (can't run test yet because

| vacuum / duty cycle entry

| conditions have not been met)

29-28

CONTINUOUS SELF TEST, SONIC EGR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: Test for EGR FLow

At this point, the vacuum and EGR duty cycle (or code 332) requirements have

been met to determine if valve opening can be detected. A check is made to

see if this is the first pass through the test - if it is, C332FIL may be

reset. Otherwise, the test continues on.

V\_EGR\_ON\_CR = 0 ------------------------| V\_EGR\_ON\_CR := 1

(not in this mode last | (set up to skip this step next

background pass) | pass)

|

| VIP\_TIMER\_EX := 0

| (start up timer)

|

| Do: EGR On Fault Filter Reset

|

| --- ELSE ---

|

| no action

| (continue to next part of test)

This is the test to determine if the EGR valve has opened. At this point all

of the conditions should be right to insure that the valve should be opened a

significant amount. If an adequate opening is not detected for a period of

time, a fault is assumed.

IEGR <= VEVPCL -------------------|

(open valve not observed) |

|

VIP\_TIMER\_EX >= V\_EGR\_CTMR -------|AND -| error\_detected := 1

(enough time in test) | | Fault Filter Code 332

| | (upcount fault filter)

WIGFLG = 0 -----------------------| |

(not in wiggle mode) |

| --- ELSE ---

|

IEGR > VEVPCL --------------------------| Fault Filter Code 332

(voltage OK.) | (downcount fault filter)

|

| --- ELSE ---

|

| no action

| (mode not active or fault present

| but not timed out yet)

END: Test for EGR FLow

29-29

CONTINUOUS SELF TEST, SONIC EGR - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGR Off Fault Filter Reset

This is called on the first entry into the EGR off test to allow resetting

the fault filter if it has yet set it's code to avoid "pumping up" the filter

and setting a fault if the mode is repeatedly exited and entered.

C334FIL <= C334LVL ---------------------| C334FIL := 0

(code 334 not set) | (Get fresh start on fault filter)

|

| --- ELSE ---

|

| (no action)

END: EGR Off Fault Filter Reset

BEGIN: EGR On Fault Filter Reset

This is called on the first entry into the EGR on test to allow resetting the

fault filter if it has yet set it's code to avoid "pumping up" the filter and

setting a fault if the mode is repeatedly exited and entered.

C332FIL <= C332LVL ---------------------| C332FIL := 0

(code 332 not set) | (Get fresh start on fault filter)

|

| --- ELSE ---

|

| (no action)

END: EGR On Fault Filter Reset

29-30

CONTINUOUS SELF TEST, EGR SYSTEM SELECT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGR SYSTEM SELECTION (SONIC)

OVERVIEW

This module determines if EGR is or is not present based on PFEHP. If there

is no EGR, the FMEM flags and Code 332 are set to zero for bullet proofing.

It also sets the value of egr\_system to enable/disable the Sonic test if

PFEHP is not equal to two.

By putting this logic in a separate module outside the actual EGR tests, the

total number of unique strategy modules required to document the tests for

the various combinations of EGR types along with the variations on PFEHP,

PFEHP\_FG, no PFEHP, etc. are reduced. Note that the use of lower case

parameters (egr\_system, pfe\_egr) does not imply that a parameter be created

in the software - PFEHP can still be used in the assembly code if the same

functionality is maintained.

DEFINITIONS

Registers:

- C332FIL = EGR valve opening not detected (Sonic, PFE) fault filter.

Bit Flags:

- EFMHI = EGRHI FMEM flag.

- EFMLO = EGRLO FMEM flag.

Calibration Constants:

- PFEHP = Switch to select EGR strategy; 2 -> do not use any EGR, 1 -> use

PFE strategy, 0 -> use sonic strategy.

29-31

CONTINUOUS SELF TEST, EGR SYSTEM SELECT - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VC\_SON\_SEL\_COM2

unconditionally ------------------------| sonic\_egr := 0

| no\_egr := 2

| (supply numeric value because

| symbolic names are not part of

| this language. Note that there is

| no real reason to actually look

| at this diagram since the numeric

| values are not actually used

| anywhere)

PFEHP <> 0 -----------------------------| EFMLO := 0

| EFMHI := 0

| C332FIL := 0

| (No EGR system, therefore no EGR

| failure)

|

| egr\_system := no\_egr

| (Done testing EGR system, exit)

|

| --- ELSE ---

|

| egr\_system := sonic\_egr

| (continue to EGR tests; this

| parameter is used to enable

| EGR test)

29-32

IGNITION DIAGNOSTIC MONITOR (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

IGNITION DIAGNOSTIC MONITOR (IDM)

OVERVIEW:

The continuous PIP/IDM routine basically checks if time since last PIP

(TSLPIP) and time since last IDM (TSLIDM) have exceeded a calibrated timeout

period.

Decisions are made in software to assure the engine is running and stabilized

before the test is executed. RPM is compared against VLORPM and if greater,

entry into the PIP/IDM test is permitted.

The PIP/IDM test utilizes free-running timers for processing PIP and IDM 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 for a

calibrated time period VIDMST. This is to insure sufficient time for the TFI

module to calculate a TACH output once PIPS have been restored.

The IDM test is similar to the PIP test in that each transition of IDM also

starts a time-out function. When the time since last IDM is > VIDMTM, an IDM

fault is present.

Both PIP and IDM tests use traditional fault filtering.

29-33

IGNITION DIAGNOSTIC MONITOR (CONTINUOUS) - LHBH0

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EOS\_IDM MODULE

The following logic describes the input processing which occurs when an IDM

transition (IDM\_INT = 1) occurs:

NOTE: IDM\_HIGH reflects the state of the High Speed Input (HSI) pin and not

the IDM voltage. Because of an inversion, when IDM voltage = 0, IDM\_HIGH =

1, and when IDM voltage is greater than 3.5 volts, IDM\_HIGH = 0.

ALWAYS -----------------------| Clear IDM\_INT

IDM\_HIGH = 0 -----------------| Set NEW\_IDM

29-34

IGNITION DIAGNOSTIC MONITOR (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PIP/IDM LOGIC (BACKGROUND)(FOR TACH BUFFER)

PROCESS

STRATEGY MODULE: VC\_PIP\_IDM\_COM2

----------- /---------\ YES !---------!

( ENTER )--->/ IS N < \----->! SET !

----------- \ VLORPM ? / !TSLIDM =0!

\---------/ !---------!

|<----------------|NO |

| v

| ----

| ( EXIT )

| ----

|

| NO

!---------------!

! CLEAR ERROR !-------------------|

!DETECTED FLAGS ! |

!---------------! |

|

!---------------------------! |

!.SET ERROR DETECTED FLAG=1 ! v

!.SET IDM\_BYPASS FLAG=1 ! YES /---------\

!.RESET C212FIL = 0 !<------/ TSLPIP \

!.RESET TSLIDM =0 ! \ > VPIPTM ?/

!---------------------------! \---------/

| | NO

|-------------------------->|

v

!------------!

! CALL FAULT !

! FILTER C211!

!------------!

|

v

!-----------! YES /---------\ NO /-------------\ YES

!.SET ERROR !<----/ TSLIDM \<----/ IS IDM\_BYPASS \----|

! DETECTED ! \ > VIDMTM ?/ \ FLAG =1? / |

! FLAG =1 ! \---------/ \-------------/ |

!-----------! | NO |

| | YES /------------\

|---------------->| |---/ IS TSLIDM > \

| | \ VIDMST ? /

| | \------------/

| v | NO

v !------------------! |

!------------------! !.SET TSLIDM=0 ! |

!.CALL FAULT FILTER! !.CLEAR IDM\_BYPASS ! |

!IDM\_FAULT\_CNT C212! ! FLAG ! |

!------------------! !------------------! |

| | |

----------- v |

( EXIT )<------------------------|

-----------

NOTE: Pip fault filtering uses C211LVL.

IDM fault filtering uses C212LVL.

29-35

CONVERTER CLUTCH VALIDITY TEST (CONTINUOUS) - LHBH0

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CONVERTER CLUTCH VALIDITY TEST

PROCESS

STRATEGY MODULE: VC\_CONVERTER\_CLUTCH\_COM1

------ /--------\YES ----

( ENTER )---->/WIGFLG = 1\--->( EXIT )

------ \ / ----

\--------/

|---------------|NO

v

/--------\ NO

/TSTRAT=4 \----------------------|

\ / |

\--------/ |

| YES |

v |

/--------\ NO !---------! |

/CC\_ERROR \------->!FAULT 628! |

\ = 0 / !---------! |

\--------/ | |

|YES v |

|<---------------------------|

!----------!

!DO FAULT !

!FILTERING !

! 628 !

!----------!

|

|

v

-------

( EXIT )

-------

29-36

ELECTRONIC PRESSURE CONTROL SOLENOID (CONTINUOUS) - LHBH0

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ELECTRONIC PRESSURE CONTROL SOLENOID TEST

PROCESS

STRATEGY MODULE: VC\_EPC\_SOLENOID\_COM2

------

( ENTER )

------

|

v

/----------\NO

/ TSTRAT = 4 \---------------------|

\ ? / |

\----------/ |

|YES |

| |

v |

/----------\YES !----------! |

/ ETV\_ERROR \------>!FAULT 624 ! |

\ = 1 ? / !----------! |

\----------/ | |

|NO v |

|<---------------------------|

|

v

!----------------!

!DO FAULT FILTER-!

! ING 624 !

!----------------!

|

v

------

( EXIT )

------

29-37

CONTINUOUS SELF TEST, THROTTLE POSITION SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

TP SENSOR TEST

PROCESS

STRATEGY MODULE: VC\_TPS\_COM1

-----------

( ENTER )

-----------

|

v

/---------\ NO !----------!

/ ITP >= \--------->! FAULT 122!

\ TAPMIN ? / !----------!

\---------/ |

| YES |

|<---------------------|

v

!--------------!

! DO FAULT !

! FILTERING 122!

!--------------!

|

v

/---------\ NO !----------!

/ ITP <= \--------->! FAULT 123!

\ TAPMAX ? / !----------!

\---------/ |

| YES |

|<---------------------|

v

!--------------!

! DO FAULT !

! FILTERING 123!

!--------------!

|

|

v

-----------

( EXIT )

-----------

29-38

CONTINUOUS SELF TEST, VEHICLE SPEED SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

VEHICLE SPEED SENSOR TEST

OVERVIEW

The Vehicle Speed Sensor (VSS) Test monitors the input for VSBAR = or >

VSSMN1. When there is not sensor input and the parameters that infer the

vehicle is moving are true, [FN689V (speed, load (TP)), and indicators of

transmission in gear with brake not applied], a timer, (VSSTMR), is

incremented. After enough settling time has elapsed, (VSSTMR = or > VSSTIM),

it is assumed the input is not working. The fault flag (VSFMFLG), which is

used by control strategy for shift schedule determination, is set or cleared

based on three independent checks, 1) prior to continuous VIP entry if a

fault code is stored in KAM the flag is set, otherwise it is cleared 2)

during continuous VIP if the fault filter exceeds the level the flag is set,

otherwise 3) any time the input VSBAR is equal to or greater than the

minimum, VSSMN1, the flag is cleared.

DEFINITIONS

Registers:

- C452FIL = Insufficient input from Vehicle Speed Sensor (VSS) fault

filter.

- NEBART = Filtered Engine RPM For Transmission.

- VSBAR = Filtered vehicle speed.

- VSSTMR = Vehicle speed sensor test timer.

Bit Flags:

- BIFLG = Brake on flag.

- NDSFLG = Neutral/drive flag; 1 -> drive.

- TFMFLG = TP FMEM flag.

- VIP\_ENABLE = VIP enable flag.

- VSFMFLG = Vehicle speed sensor FMEM flag.

Calibration Constants:

- BIHP = BRAKE INPUT "Hardware Present" indicator; 0 -> NO, 1 -> YES.

- C452LVL = Insufficient input from Vehicle Speed Sensor(VSS) threshold.

- FN689V = Minimum engine speed at a given TP to test VSS input.

- VSSMN1 = Maximum vehicle speed to enter VSS test, MPH.

- VSSSW = CVIP VSS test enable switch, unitless; 1 -> do VSS test.

29-39

CONTINUOUS SELF TEST, VEHICLE SPEED SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- VSSTIM = Minimum stablized time before performing CVIP VSS test, sec.

- VSTYPE = Integrated vehicle speed/cruise control system present switch; 0

-> no MPH and no VSC, 1 -> MPH and no VSC.

- V\_VSS\_MULT = Multiplier for FN689V when in 4x4 mode.

PROCESS

STRATEGY MODULE: VC\_VSS\_COM6

TFMFLG = 0 -----------------------|

(TP Sensor OK) |

|

NDSFLG = 1 -----------------------|

(In Drive) |

|

I4X4L = 0 ------------| |

(Not in 4x4 mode) |AND -| |

| | |

NEBART => FN689V -----| | |

(min. rpm) |OR --|

| |

NEBART => FN689V \* | |AND -| INCREMENT VSSTMR

V\_VSS\_MULT ------| | |

(min. rpm in 4x4 mode) | |

| |

BIHP = 0 -------------------| | |

|OR --| |

BIHP = 1 -------------| | | |

|AND -| | |

BIFLG = 0 ------------| | |

(Brake off) | |

| |

VSBAR < VSSMN1 -------------------| |

(low VSS reading) |

| --- ELSE ---

|

| VSSTMR = 0

29-40

CONTINUOUS SELF TEST, VEHICLE SPEED SENSOR TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

VSSSW = 1-------------------------|

|

VSTYPE <> 0 ----------------------|AND -| SET ERROR DETECTED

| | Do: FAULT FILTERING

VSSTMR => VSSTIM -----------------| |

| --- ELSE ---

|

| Do: FAULT FILTERING

VIP\_ENABLE = 1 -------------------|

(VIP in progress) |AND -| VSFMFLG = 1

| |

C452FIL > C452LVL ----------------| |

| --- ELSE ---

|

| NO ACTION ON VSFMFLG

VSBAR => VSSMN1 ------------------------| VSFMFLG = 0

|

| --- ELSE ---

|

| NO ACTION ON VSFMFLG

29-41

CONTINUOUS SELF TEST, BRAKE ON/OFF CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BRAKE ON/OFF CIRCUIT TEST

OVERVIEW

If BIFLG (BOO input) does not change state after V\_ZTOSPD\_CNT transitions

from a vehicle speed of zero to a vehicle speed of V\_BOO\_SPD sustained for

V\_BOOSPD\_TM, then the BOO input is assumed to be faulty.

DEFINITIONS

Self Test Registers:

- C452FIL = Fault filter register for VSS test.

- V\_ZTOSPD\_CTR = Number of vehicle speed transitions from a speed of zero

to a speed of V\_BOO\_SPD without a BOO transition.

Self Test Flags:

- V\_SPDTOZ\_FLG = When set this flag indicates a transition from a vehicle

speed of V\_BOO\_SPD to a speed of zero has occurred.

- V\_BOO\_OLD = BIFLG from previous background loop.

- WIGFLG = When 1 indicates wiggle mode.

Self Test Calibration Constants:

- C536UP = Continuous BOO test fault filter increment.

- C536LVL = Continuous BOO test fault filter threshold.

- V\_BOOSPD\_TM = VSBAR threshold to reset V\_BOOSPD\_TMR.

- V\_BOO\_SPD = Vehicle speed required to increment V\_ZTOSPD\_CTR.

- V\_CBOO\_ENA = Continuous BOO test enable flag, 1 = test enabled.

- V\_ZTOSPD\_CNT = Number of zero MPH to vehicle speed = V\_BOO\_SPD

transitions without a brake input considered a BOO failure.

Self Test Timers:

- V\_BOOSPD\_TMR = Non cumulative time VSBAR greater than V\_BOO\_SPD.

29-42

CONTINUOUS SELF TEST, BRAKE ON/OFF CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Base Strategy Registers:

- VSBAR

Base Strategy Flags:

- BIFLG

- CRKFLG

- NO\_START

- RUNNING

Base Strategy Calibration Constants:

- BIHP

Base Strategy Timers:

- PUTMR

29-43

CONTINUOUS SELF TEST, BRAKE ON/OFF CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VC\_BOO\_COM1

Test Entry Conditions:

V\_CBOO\_ENA = 0 -------------------|

(test cal'd out) |

|

BIHP = 0 -------------------------|

(no brake input hardware) |

|

RUNNING = 1 ----------------------|

(KOER) |

|OR --| exit BRAKE ON/OFF CIRCUIT

NO\_START = 1 ---------------------| | TEST

(KOEO) | |

| |

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

(in crank mode) |AND -| |

| | |

WIGFLG = 0 -----------------| | |

| |

PUTMR < 4 ------------------------| |

(less than 4 sec since: |

powerup, exiting KOEO or |

KOER VIP, or a reset) |

|

| --- ELSE ---

|

| DO: BOO\_SPD\_TMR

| DO: BOO\_TEST\_MAIN

| (test is performed)

29-44

CONTINUOUS SELF TEST, BRAKE ON/OFF CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: BOO\_TEST\_MAIN

V\_BOO\_OLD <> BIFLG ---------------------| V\_BOO\_OLD := BIFLG

(boo input changed) | V\_ZTOSPD\_CTR := 0

| call fault filter for code

| 536

|

| --- ELSE ---

|

V\_BOOSPD\_TMR > V\_BOOSPD\_TM -------| |

|AND -| V\_ZTOSPD\_CTR :=

V\_SPDTOZ\_FLG = 1 -----------------| | V\_ZTOSPD\_CTR + 1

| V\_SPDTOZ\_FLG := 0

| DO: BOO\_FAILURE\_PROCESS

| call fault filter for code

| 536

|

| --- ELSE ---

|

VSBAR = 0 ------------------------------| V\_SPDTOZ\_FLG := 1

| call fault filter for code

| 536

|

| --- ELSE ---

|

| call fault filter for code 536

END: BOO\_TEST\_MAIN

BEGIN: BOO\_FAILURE\_PROCESS

C452FIL > 0 ----------------------------| C536FIL := 0

(VSS failure indication) | V\_ZTOSPD\_CTR := 0

| return

|

| --- ELSE ---

|

|

V\_ZTOSPD\_CTR > V\_ZTOSPD\_CNT ------------| ERROR\_DETECTED := 1

(failure) | V\_ZTOSPD\_CTR := 0

| return

|

| --- ELSE ---

|

| return

END: BOO\_FAILURE\_PROCESS

29-45

CONTINUOUS SELF TEST, BRAKE ON/OFF CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: BOO\_SPD\_TMR

VSBAR < V\_BOO\_SPD -----------------------| V\_BOOSPD\_TMR := 0

END: BOO\_SPD\_TMR

29-46

ADAPTIVE TABLE CLIP TEST (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ADAPTIVE TABLE CLIP TEST - SPEED DENSITY

OVERVIEW:

When the fuel system is using a KAMREF that is at its rich or lean limit a service

code is stored in KAM. The test distinguishes between the lean limit and the rich

limit and also whether at idle or not at idle.

DEFINITIONS

Self Test Registers:

- C179FIL = At adaptive fuel limit, system lean fault filter.

- C181FIL = At adaptive fuel limit, system rich fault filter.

- C182FIL = At adaptive fuel limit, system lean at idle fault filter.

- C183FIL = At adaptive fuel limit, system rich at idle fault filter.

Self Test Calibration Constants:

- C179LVL = At adaptive fuel limit, system lean fault filter

threshold.

- C179UP = At adaptive fuel limit, system lean fault filter

increment.

- C181LVL = At adaptive fuel limit, system rich fault filter

threshold.

- C181UP = At adaptive fuel limit, system rich fault filter

increment.

- C182LVL = At adaptive fuel limit, system lean at idle fault

filter threshold.

- C182UP = At adaptive fuel limit, system lean at idle fault

filter increment.

- C183LVL = At adaptive fuel limit, system rich at idle fault

filter threshold.

- C183UP = At adaptive fuel limit, system rich at idle fault

filter increment.

Continued on Next Page

29-47

ADAPTIVE TABLE CLIP TEST (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Continued from Previous Page

- V\_ADAPTV\_ENA = Adaptive fuel clip test enable switch, 1 = enable.

- V\_ADPMP\_MAX = Maximum MAPPA to perform adaptive clip test.

- V\_ADPMP\_MIN = Minimum MAPPA to perform adaptive clip test.

- V\_ADPN\_MAX = Maximum N to perform adaptive clip test.

- V\_ADPN\_MIN = Minimum N to perform adaptive clip test.

- V\_LAMAV\_MAX = LAMAVEn above which a clipped adaptive cell may be

failed.

- V\_LAMAV\_MIN = LAMAVEn below which a clipped adaptive cell may be

failed.

Self Test Flags:

- ERROR\_DETECTED = Flag indicates a failure is indicated, 1 = failure.

Base Strategy Registers:

- KAMREF = Total learned fuel system correction.

- LAMAVE = Average LAMBSE

- MAPPA = MAP/BP.

- N = Engine speed, RPM.

Base Strategy Constants:

- MAXADP = Maximum adaptive correction.

- MINADP = Minimum adaptive correction.

Base Strategy Flags:

- REFFLG = Indication of Idle Air Flow; 1 = Idle Air Flow.

Continued on Next Page

29-48

ADAPTIVE TABLE CLIP TEST (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Continued from Previous Page

PROCESS:

STRATEGY MODULE: VC\_SDADP\_COM1

Fault Filters not currently illuminating the MIL (CxxFIL <=

CxxLVL get a fresh start each time the test conditions

become true.

C179FIL <= C179LVL -------------------------|

(failure no longer indicated) |

MAPPA <= V\_ADPMP\_MIN ----------------| |AND --| C179FIL :=0

MAPPA >= V\_ADPMP\_MAX ----------------| | |

N >= V\_ADPN\_MAX ---------------------|OR ---|

N <= V\_ADPN\_MIN ---------------------|

(outside test condition) |

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

(idle air flow)

C181FIL <= C181LVL -------------------------|

(failure no longer indicated) |

MAPPA <= V\_ADPMP\_MIN-----------------| |AND --| C181FIL :=0

MAPPA >= V\_ADPMP\_MAX ----------------| | |

N >= V\_ADPN\_MAX ---------------------|OR ---|

N <= V\_ADPN\_MIN ---------------------|

(outside test condition) |

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

(idle air flow)

C182FIL <= C182LVL ------------------|

(failure no longer indicated) |AND --| C182FIL := 0

REFFLG = 0 --------------------------|

(not idle air flow)

C183FIL <= C183LVL ------------------|

(failure no longer indicated) |AND --| C183FIL := 0

REFFLG = 0 --------------------------|

(not idle air flow)

Continued on Next Page

29-49

ADAPTIVE TABLE CLIP TEST (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Continued from Previous Page

Test Logic.

REFFLG = 0 -----------------------| | ERROR\_DETECTED := 1

(not idle air flow) | | call fault filter routine

V\_ADPMP\_MAX > MAPPA > V\_ADPMP\_MIN-| | (code 179)

(load window) | | call fault filter routine

V\_ADPN\_MAX > N > V\_ADPN\_MIN ------|AND --| (code 181)

(engine speed window) | | call fault filter routine

KAMREF = MINADP + 0.5-------------| | (code 182)

(failure criteria) | | call fault filter routine

V\_ADAPTV\_ENA = 1 -----------------| | (code 183

(test cal'd in) | |

LAMAVE >= V\_LAMAV\_MAX-------------| |

|

| ---ELSE---

|

REFFLG = 0 -----------------------| | ERROR\_DETECTED := 1

(not idle air flow) | | call fault filter routine

V\_ADPMP\_MAX > MAPPA > V\_ADPMP\_MIN-| | (code 181)

(load window) |AND --| call fault filter routine

V\_ADPN\_MAX > N > V\_ADPN\_MIN ------| | (code 179)

(engine speed window) | | call fault filter routine

KAMREF = MAXADP + 0.5-------------| | (code 182)

(failure criteria) | | call fault filter routine

V\_ADAPTV\_ENA = 1 -----------------| | (code 183)

(test cal'd in) | |

LAMAVE <= V\_LAMAV\_MIN ------------| |

|

| ---ELSE---

|

REFFLG = 1 ----------------------| | ERROR\_DETECTED := 1

(idle air flow) |AND --| call fault filter routine

KAMREF = MINADP + 0.5-------------| | (code 182)

(failure criteria) | | call fault filter routine

V\_ADAPTV\_ENA = 1 -----------------| | (code 179)

(test cal'd in) | | call fault filter routine

LAMAVE >= V\_LAMAV\_MAX ------------| | (code 181)

| call fault filter routine

| (code 183)

|

| ---ELSE---

|

Continued on Next Page

29-50

ADAPTIVE TABLE CLIP TEST (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Continued from Previous Page

REFFLG = 1 -----------------------| | ERROR\_DETECTED := 1

(idle air flow) |AND --| call fault filter routine

KAMREF = MAXADP + 0.5-------------| | (code 183)

(failure criteria) | | call fault filter routine

V\_ADAPTV\_ENA = 1 -----------------| | (code 179)

(test cal'd in) | | call fault filter routine

LAMAVE <= V\_LAMAV\_MIN ------------| | (code 181)

| call fault filter routine

| (code 182)

|

| ---ELSE---

|

V\_ADPMP\_MAX >MAPPA > | |

V\_ADPMP\_MIN --------| |

(load window) |AND----| |

V\_ADPN MAX > N > | |OR --------|

V\_ADPN\_MIN ---------| | | call fault filter routine

(engine speed window) | | (code 179)

REFFLG = 1 ------------------| | call fault filter routine

(idle air flow) | | (code 181)

V\_ADAPTV\_ENA = 0 ------------| | call fault filter routine

(test cal'd out) | (code 182)

| call fault filter routine

| (code 183)

29-51

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

EGO SWITCHING TEST - SD W/SINGLE EGO STRATEGIES

OVERVIEW

This test determines that the EGO sensor is switching properly when

conditions are present that will allow a functional fuel system to cause the

EGO sensor to switch.

DEFINITIONS

Registers:

- AEFUEL = Acceleration enrichment fuel flow, lb/hr.

- ATMR1 = Time since exiting crank mode.

- C171FIL = Lack of EGO switch, adaptive fuel at limit fault filter.

- C172FIL = Lack of EGO switch, EGO indicates lean fault filter.

- C173FIL = Lack of EGO switch, EGO indicates rich fault filter.

- EGOSSS = Number of EGO switches since start.

- EGOTSTCUMTMR = Accumulated time that the EGO test test conditions are

true.

- KAMREF = Total learned fuel system correction.

- MAPPA = MAP/BP.

- PPCTR = PIP counter; updated at PIP rising edge before injector

pulsewidth is calculated and output.

- PRGTMR = Total accumulative purge on time.

- PURGDC = Purge duty cycle.

- PUTMR = Time since powerup.

- TP\_REL = Relative Throttle Position, counts. TP - RATCH.

- V\_EGOTST\_TMR = Time since self test closed loop conditions have been met.

- V\_EGR\_DLYTMR = Test delay timer for EGR transitions.

- V\_LEGOTMR = EGO sensor test time since last EGO state change while

testing is active.

- V\_LESTMR = Self test lack of EGO switchng timer.

- V\_PRG\_DLYTMR = Test delay timer for purge transitions.

- V\_VACPRGTMR = Indicates when non-EEC controlled purge canister is

presumed empty.

29-52

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Bit Flags:

- AFMFLG = Flag indicating that ACT sensor is in/out of range.

- CFMFLG = Flag indicating that ECT sensor is in/out of range.

- CRKFLG = Flag indicating crank mode.

- EGOFL = EGO sensor state flag; 1 -> rich.

- error\_detected = Flag indicates a failure is indicated; 1 -> failure.

- FLG\_OPEN\_LOOP = Open loop fuel flag; 1 -> Open loop fuel

- ISCFLG = ISC mode indicator flag; -1 -> dashpot mode, 0 -> dashpot

preposition mode, 1 -> closed loop RPM control mode, 2 -> closed loop RPM

control lockout.

- LEGONOTPURG = In EGO test, when equal to 1, testing while purging is

appropriate.

- LESFLG = Lack of EGO switching flag; 0 -> switching.

- MFMFLG = MAP failure flag; 1 -> MAP sensor fails.

- MPGFLG = Flag that indicates whether in Fuel Economy mode; 1 -> in Fuel

Economy mode.

- MPGTFG = MPG transition mode flag; 1 -> MPG mode exit into Closed Loop

fuel.

- NO\_START = Engine off VIP enable flag.

- RUNNING = Flag which indicates that idle speed is being controlled by

Engine Running VIP.

- SWTFL = EGO switch flag; 1 -> EGO switched this background loop.

- TFMFLG = Flag indicating TP sensor is in/out of range.

- V\_EGO\_BYPS = Prevents additional EGO service code.

- V\_EGOL\_BYPS = Prevents additional EGO service code.

- V\_LAMJMP = 1 -> base strategy caused a LAMBSE jump since last EGO switch.

- WRMEGO = 1 -> EGO sensor is warm, 0 -> sensor has cooled off.

Calibration Constants:

- C171LVL = Lack of EGO switch, adaptive fuel at limit fault filter

threshold.

- C171UP = Lack of EGO switch, adaptive fuel at limit fault filter

increment.

- C172LVL = Lack of EGO switch, EGO indicates lean fault fault filter

threshold.

29-53

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

- C172UP = Lack of EGO switch, EGO indicates lean fault filter increment.

- C173LVL = Lack of EGO switch, EGO indicates rich fault filter threshold.

- C173UP = Lack of EGO switch, EGO indicates rich fault filter increment.

- ETST\_SWCUMTM = Accumulated time EGO test active before failure is

indicated because of number of switches failure.

- MAXADP = Maximum adaptive correction.

- MINADP = Minimum adaptive correction.

- PIPNUM = Number of PIPs for DFSO exit fuel ramp.

- PRG\_DEC = Purge DC decrement amount when purge overwhelms fuel control.

- V\_EEC\_PRG = 1 -> EEC controlled purge, 0 -> mechanical purge.

- V\_EGOAEMAX = Maximum AEFUEL to perform EGO test.

- V\_EGOIDL\_ENA = Switch to enable EGO sensor test at idle air flows; 1 ->

enable.

- V\_EGOMAP\_MAX = Maximum MAPPA to perform EGO sensor test when not at idle.

- V\_EGOMAP\_MIN = Minimum MAPPA to perform EGO sensor test when not at idle.

- V\_EGORNTM = Time since exiting crank mode (ATMR1) to wait before enabling

ego test.

- V\_EGO\_EGR\_SW = When equal to zero allows EGO test to ignore egr

transitions.

- V\_EGOSWNUM = Value of EGOSSS .LT. indicating an ego

- V\_EGOTP\_MIN = Minimum TP\_REL to perform EGO sensor test when not at idle.

- V\_EGOTST\_TM = Time since closed loop conditions minus EGO input have been

met.

- V\_EGO\_ENA = Continuous EGO test enable switch; 1 -> enable.

- V\_LEGO\_MAX = Maximum time since last EGO switch before failure

indication.

- V\_LEGO\_MAX2 = Maximum time since last EGOn switch before failure

incication.

- V\_LESTM = Time since last EGO switch limit to fail continuous EGO

switching test.

- V\_PRGTOT = Total accumulative purge on time to perform continuous EGO

test.

29-54

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VC\_EGO\_TEST\_COM13

Test Entry Conditions:

V\_EGO\_ENA = 0 ----------|

(test cal'd out) |

|

RUNNING = 1 ------------|OR --| EXIT EGO SWITCHING TEST

(KOER) | |

| |

NO\_START = 1 -----------| |

(KOEO) |

| --- ELSE ---

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

(in crank mode) |OR --| EGOTSTCUMTMR := 0

| | Do: EGO\_TEST\_TMR\_CLEAR

PUTMR < 4 --------------| | (test is bypassed, clear timers

(less than 4 sec since: | until test is executed)

powerup, exiting KOEO | Do: CANISTER\_FILLING\_TIMER\_CONTROL

or KOER VIP, or a reset) | (used when purge not controlled by EEC)

|

| --- ELSE ---

|

| Do: EGR\_TRANSITION\_DELAY\_FLAG\_CONTROL

| Do: EGO\_PURG\_CHK

| Do: CANISTER\_FILLING\_TIMER\_CONTROL

| (used when purge not controlled by EEC)

| Do: PURG\_NOT\_CAUSE\_FOR\_FAILURE

| Do: EGO\_SWITCHING\_FAILURE\_INDICATION\_CONTROL

| Do: ACCUM\_TIMER\_CONTROL

| Do: EGOTST\_TMR\_CONTROL

| Do: EGOTST\_TMR\_CHK

29-55

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGOTST\_TMR\_CONTROL

The following test conditions logic must be true for V\_EGOTST\_TM

seconds before the fuel system can be tested.

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

|

MPGFLG = 0 -----------------------------|

|

MPGTFG = 0 -----------------------------|

|

FLG\_OPEN\_LOOP = 0 ----------------------|

|

PPCTR >= PIPNUM ------------------------|

(past decel fuel shutoff) |

|

AFMFLG = 0 -----------------------------|

(act ok) |

|

CFMFLG = 0 -----------------------------|

(ect ok) |

|

TFMFLG = 0 -----------------------------|

(tp ok) |AND -| (test conditions true)

| | allow V\_EGOTST\_TMR to run

MFMFLG = 0 -----------------------------| |

| | EGOTSTCUMFLG := 1

ATMR1 >= V\_EGORNTM ---------------------| |

| |

V\_PRG\_DLYTMR = 0 -----------------------| |

(purge transition delay past) | |

| |

V\_EGR\_DLYTMR = 0 -----------------------| |

(EGR transition delay past) | |

| |

AEFUEL <= V\_EGOAEMAX -------------------| |

(max AEFUEL to perform test) | |

| |

ISCFLG = 0 -----------------| | |

| | |

TP\_REL >= V\_EGOTP\_MIN ------| | |

|AND -| | |

MAPPA > V\_EGOMAP\_MIN -------| | | |

(load indicator) | | | |

| |OR --| |

MAPPA < V\_EGOMAP\_MAX -------| | |

| |

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

|AND -| |

V\_EGOIDL\_ENA ---------------| |

| --- ELSE ---

|

| Do: EGO\_TEST\_TMR\_CLEAR

| Do: VEGOFIL\_ZERO

| EGOTSTCUMFLG := 0

END: EGOTST\_TMR\_CONTROL

29-56

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGOTST\_TMR\_CHK

Control of how long the test conditions must be present before testing is to

take place is accomplished with the calibration parameter V\_EGOTST\_TM.

V\_EGOTST\_TMR > V\_EGOTST\_TM -------------| Do: EGO\_TESTS

(test conditions present

sufficiently long to test)

END: EGOTST\_TMR\_CHK

BEGIN: ACCUM\_TIMER\_CONTROL

The timer EGOTSTCUMTMR is a cumulative timer that documents total accumulated

time that the EGO test conditions are true while there are no purging

restrictions since the last time crank mode was exitted. If crank mode is

re-entered, this timer is cleared (see "Test Entry Conditions").

EGOTSTCUMFLG = 1 -----------------------| allow EGOTSTCUMTMR to run

(test conditions true) |

|

| --- ELSE ---

|

| freeze EGOTSTCUMTMR

END: ACCUM\_TIMER\_CONTROL

29-57

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGO\_TEST\_TMR\_CLEAR

Conditions other than fuel system failures which may prevent EGO switches are

present. The following timers which are indicators of fuel system failure

are

cleared until conditions for testing become true.

V\_LESTMR := 0

V\_EGOTST\_TMR := 0

V\_LEGOTMR := 0

END: EGO\_TEST\_TMR\_CLEAR

BEGIN: EGO\_PURG\_CHK

PRG\_DEC = 0 --------------|

|OR --|

PURGDC = 0 ---------------| |

(not purging) |AND -|

| |

V\_EEC\_PRG = 1 ------------------| |

(EEC controlled purge) |

|OR --| ego\_purg\_byps := 0

V\_VACPRGTMR >= V\_PRGTOT --| | | (no purging restrictions

(canister sufficiently | | | on ego test)

empty) |OR --| | |

| | | |

APT = -1 -----------------| |AND -| |

(not purging) | |

| |

V\_EEC\_PRG = 0 ------------------| |

(mechanical purge) |

| --- ELSE ---

|

| ego\_purg\_byps := 1

|

| (purging restrictions on

| on ego test in effect)

END: EGO\_PURG\_CHK

29-58

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: PURG\_NOT\_CAUSE\_OF\_FAILURE

If the control system has gone open loop (LESFLG = 1) while the

ego test was being bypassed then testing for a rich failure

may take place if no purging is allowed during open loop

(PURGSW = 0).

LESFLG = 1 -----------------------|

(byples timeout) |AND -| LEGONOTPURG := 1

| | (conditions imply that purge

PURGSW = 0 -----------------------| | was not the cause of EGO

(no purge while open loop) | stuck rich)

|

| --- ELSE ---

|

| LEGONOTPURG := 0

END: PURG\_NOT\_CAUSE\_OF\_FAILURE

29-59

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: VEGOFIL\_ZERO

Fault filters not currently illuminating the MIL (CxxFIL > CxxLVL)

get a fresh start each time the test conditions become true.

1. C171FIL <= C171LVL -----------------| C171FIL := 0

2. C172FIL <= C172LVL -----------------| C172FIL := 0

3. C173FIL <= C173LVL -----------------| C173FIL := 0

END: VEGOFIL\_ZERO

BEGIN: EGO\_TESTS

Base strategy will assign LAMBSE a new value of after TSLEGO > LESTM.

Failure codes 171, 172 or 173 as appropriate will be stored upon failure,

with the MIL being illuminated. But as a result of the Base Strategy action,

the failure condition is overwritten. The fault filter will down count. The

service code will remain stored in KAM, but the MIL will be turned off.

The following logic segment within the below logic will maintain the fault

filter value after failure (CxxxFIL > (CxxxLVL) until the sensor starts

switching, causing the MIL to remain illuminated until the actual failure

condition is not present.

C17xFIL > C17xLVL ------------|

(failure has been indicated) |AND -|

| |

LESFLG = 1 -------------------| |

(ego hasn't switched since |

failure)

29-60

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

C171FIL > C171LVL -----------------------|

(failure has been indicated) |AND -| error\_detected := 1

| | call fault filter routine

LESFLG = 1 ------------------------------| | (code 171)

(ego hasn't switched since | call fault filter routine

failure) | (code 172)

| call fault filter routine

| (code 173)

|

| --- ELSE ---

C172FIL > C172LVL -----------------------| |

(failure has been indicated) |AND -| error\_detected := 1

| | call fault filter routine

LESFLG = 1 ------------------------------| | (code 172)

(ego hasn't switched since | call fault filter routine

failure) | (code 171)

| call fault filter routine

| (code 173)

|

| --- ELSE ---

C173FIL > C173LVL -----------------------| |

(failure has been indicated) |AND -| error\_detected := 1

| | call fault filter routine

LESFLG = 1 ------------------------------| | (code 173)

(ego hasn't switched since | call fault filter routine

failure) | (code 171)

| call fault filter routine

| (code 172)

|

| --- ELSE ---

(continued on next page)

29-61

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

V\_LESTMR > V\_LESTM ----------------| |

(failure indicated) | |

| |

EGOSSS < V\_EGOSWNUM ---------| | |

| | |

ego\_purg\_byps = 0 -----| |AND -| |

|OR --| |OR --| |

EGOFL = 0 -------------| | | | |

| | | |

EGOTSTCUMTMR > ETST\_SWCUMTM -| | | |

(sufficient cumulated test time) | |AND -| error\_detected := 1

| | | (code 171)

V\_LEGOTMR > V\_LEGO\_MAX ------------| | | call fault filter routine

| | (code 172)

KAMREF = 0.5 + MINADP -------------| | | call fault filter routine

(adaptive clip) |OR --| | (code 173)

| | (fuel system failure)

KAMREF = 0.5 + MAXADP -------------| |

|

|

| --- ELSE ---

V\_LESTMR > V\_LESTM ----------------| |

(failure indicated) | |

| |

EGOSSS < V\_EGOSWNUM ---------| | |

| |OR --| |

V\_EGOL\_BYPS = 0 -------------|AND -| | |

| | |AND -| error\_detected := 1

EGOTSTCUMTMR > ETST\_SWCUMTM -| | | | call fault filter routine

(sufficient cumulated test time) | | | (code 172)

| | | call fault filter routine

V\_LEGOTMR > V\_LEGO\_MAX ------------| | | (code 171)

| | call fault filter routine

EGOFL = 0 -------------------------------| | (code 173)

(lean) | V\_EGO\_BYPS := 1

|

| --- ELSE ---

(continued on next page)

29-62

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

(continued from previous page)

LEGONOTPURG = 1 -------------| |

(purge not implicated as | |

cause of failure) |AND -| |

| | |

V\_LEGOTMR > V\_LEGO\_MAX2 -----| | |

| |

V\_LESTMR > V\_LESTM ----------------| |

(lambse at clip) | |

| |

EGOSSS < V\_EGOSWNUM ---------| | |

(fail from start) | |OR --| |

| | | |

ego\_purg\_byps = 0 -----------|AND -| | |

| | | |

V\_EGO\_BYPS = 0 --------------| | | |

| | |AND -| error\_detected := 1

EGOTSTCUMTMR > ETST\_SWCUMTM -| | | | Call fault filter routine

| | | (code 173)

V\_LEGOTMR > V\_LEGO\_MAX ------------| | | Call fault filter routine

(gross lack of ego switch) | | (code 171)

| | call fault filter routine

EGOFL = 1 -------------------------------| | (code 172)

(rich) | V\_EGOL\_BYPS := 1

|

| --- ELSE ---

|

| call fault filter routine

| (code 171)

| call fault filter routine

| (code 172)

| call fault filter routine

| (code 173)

| (no failures present)

29-63

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGR\_TRANSITION\_DELAY\_FLAG\_CONTROL

The EGR transition flag V\_EGR\_DLYFG when set indicates that an EGR transition

has taken place. To allow the EGO test to disregard EGR transitions,

calibrate V\_EGO\_EGR\_SW = 0. Otherwise any EGR transition (on/off, off/on)

will reset the EGO test timer and associated EGO fuel system failure

indicators.

EGRDC = 0 ------------------------------| temp := 1

(egr off) |

| --- ELSE ---

|

| temp := 0

V\_EGR\_OLD <> temp ----------------|

(egr transition) |AND -| V\_EGR\_DLYFG := 1

| | (ego test reset due to

V\_EGO\_EGR\_SW = 1 -----------------| | egr transition)

(egr considered to | V\_EGR\_OLD := temp

affect ego) |

| --- ELSE ---

|

| V\_EGR\_DLYFG := 0

(egr not affecting ego test)

END: EGR\_TRANSITION\_DELAY\_FLAG\_CONTROL

29-64

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: EGO\_SWITCHING\_FAILURE\_INDICATION\_CONTROL

Timer V\_LESTMR indicate the time LAMBSE has been

at its clip.

VIP Lack of EGO Switching Timer:

LAMBSE <= LAMMIN -----------------|

(rich clip, lean system) |

|OR --| (V\_LESTMR runs indicating

LAMBSE >= LAMMAX -----------| | | potential lambse/ego based

(lean clip, rich system) |AND -| | failure)

| |

ego\_purg\_byps = 0 ----------| |

(no purging restrictions) |

| --- ELSE ---

|

| V\_LESTMR := 0

| (no lambse/ego based

| errors indicated)

Time Since Last EGO Switch Logic:

SWTFL = 1 ------------------------------| V\_LEGOTMR := 0

(ego switched this BG) |

| --- ELSE ---

V\_LAMJMP = 1 ---------------------| |

(LAMBSE jump occurred) | |

|OR --| V\_LEGOTMR := 0

ego\_purg\_byps = 1 ----------| | | V\_LAMJMP = 0

(purg is affecting | | | (reinitialize due to LAMBSE

ego performance) | | | jump)

|AND -|

EGOFL = 1 ------------------|

(rich) |

|

LEGONOTPURG = 0 ------------|

(purge implicated as

a cause of failure)

END: EGO\_SWITCHING\_FAILURE\_INDICATION\_CONTROL

29-65

CONTINUOUS SELF TEST, EGO SWITCHING TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: CANISTER\_FILLING\_TIMER\_CONTROL

V\_EEC\_PRG = 0 --------------------------| Do: CANISTER\_CONTENT\_MODEL

(purge is not controlled by EEC)

END: CANISTER\_FILLING\_TIMER\_CONTROL

BEGIN: CANISTER\_CONTENT\_MODEL

TP\_REL <= V\_TPREL\_PRG ------------------| decrement V\_VACPRGTMR

| (canister is filling)

|

| --- ELSE ---

|

V\_VACPRGTMR > V\_PRGTOT -----------------| freeze V\_VACPRGTMR

| (max required purge time

| reached)

|

| --- ELSE ---

|

| increment V\_VACPRGTMR

| (canister emptying)

END: CANISTER\_CONTENT\_MODEL

29-66

CONTINUOUS SELF TEST, FUEL PUMP CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

FUEL PUMP CIRCUIT TEST

OVERVIEW

The state of the Fuel Pump Monitor (FPM) is compared to the expected state

based on the fuel pump on/off command. Also, after a stall, the Output

Circuit Check (OCC) is performed on the fuel pump relay.

When the fuel pump is commanded off, FPM should be low. If it is not (after

waiting V\_FPMTM seconds for the relay to settle) code 542 is set. This

indicates that either the fuel pump relay is stuck "on" or there is an open

circuit between the ECA and the fuel pump ground (circuit ooo in the diagram)

allowing the ECA pull-up circuit to hold FPM high.

If the fuel pump is commanded on, FPM should be high. If it is not (after

waiting V\_FPMTM seconds) code 543 is set. This indicates a break in the line

between the battery and the FPM input to the ECA (circuit xxx in diagram) or

no contact inside the fuel pump relay.

If the engine stalls, the fuel pump is commanded off and then exercised to

perform the output circuit check (OCC). An OCC failure indicates a break in

the line between the battery and the driver inside the ECA (circuit \*\*\* in

the diagram).

FUEL PUMP / FUEL PUMP MONITOR (FPM) CIRCUIT

B+ xxxxxxxxxxxxxxxx oooooooooooo

x ..o.. o g

b+ \*\*\*\*\*\*\*\*\*\*\*\*\* x ..o.. o r

S \* x .. .. ----- o

O .....\*..x.... . PUMP . --- u

L ! > x ! .. .. - n

E ! < \ ! ..o.. d

N ! > x \ ! ..o..

O ! < x ! o

I !....\*..x...! o

D \* xxxxxxxxxxxooooooo

\* x

......\*.............o...............

! \* x !

! \*\*\* OCC o ECA !

! \* x (EEC-IV !

! Driver FPM MODULE) !

!..................................!

29-67

CONTINUOUS SELF TEST, FUEL PUMP CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

DEFINITIONS

Self test Registers:

- IOCC = OCC A/D input level.

- OCCSAV = Saved value of OCC A/D input.

Self Test Calibration Constants:

- OCCDT7 = Fuel pump primary OCC calibration level.

- V\_FPMDLY = Fuel pump monitor test fuel pump on-to-off off-to-on

stabilization delay time.

- V\_FPMFLG = Fuel pump monitor test enable switch, 1 = enable.

- V\_FPMTM = Fuel pump transition delay time.

- VPUMP\_LAST = State of fuel pump during last background loop.

Self Test Flags:

- ERROR\_DETECTED = Flag passed to fault filter routine indicating self test

detected a failure.

- FPM = State of the FPM input. 1 = high (Pump on).

Self Test Timers:

- VIP\_FPMTMR = Fuel pump on-to-off transition delay timer.

Base Strategy Flags:

- PUMP = Controls state of fuel pump control output. 1 = commanded on.

29-68

CONTINUOUS SELF TEST, FUEL PUMP CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS

STRATEGY MODULE: VC\_FUEL\_PUMP\_COM2

Every Background Loop (in continuous or not):

PUMP <> VPUMP\_LAST ---------------------| VIP\_FPMTMR = 0

(Fuel Pump changed on/off state) | (restart timer)

|

| VPUMP\_LAST = PUMP

PUTMR < 4 ------------------------| |

| |

NO\_START = 1 ---------------------|OR --| Exit this test

| | (not in "continuous")

RUNNING = 1 ----------------------| |

| --- ELSE ---

|

V\_FPMFLG = 0 ---------------------------| call fault filter for code 542

(test cal'd out) | call fault filter for code 543

| call fault filter for code 556

| exit this test

|

| --- ELSE ---

|

PUMP = 1 -------------------------------| DO: FP COMMANDED ON PROCESS

|

| --- ELSE ---

|

RMSPRU = 1 -----------------------------| De-energize all OCC outputs

(Run mode since powerup = true | delay 50 msec

and PUMP = 0, engine has stalled) | OCCSAV = IOCC

| PUMP = 1

| (command fuel pump on)

| delay 50 msec

| DO: FP OCC PROCESS

|

| --- ELSE ---

|

VIP\_FPMTMR >= V\_FPMTM ------------| | (FPM high when pump

(Pump has been off for | | commanded off, code 542)

V\_FPMTM seconds) |AND -| ERROR\_DETECTED = 1

| |

FPM = 1 --------------------------| | call fault filter for code 542

(indicates pump on) | call fault filter for code 556

|

| --- ELSE ---

|

| (No errors detected)

| call fault filter for code 542

| call fault filter for code 556

29-69

CONTINUOUS SELF TEST, FUEL PUMP CIRCUIT TEST - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

BEGIN: FP COMMANDED ON PROCESS

UNDSP = 0 ------------------------------| RMSPRU = 1

(Run mode) | (run mode since powerup =

| true)

| (FPM low with pump commanded

| on - fault 543 detected)

FPM = 0 --------------------------| |

(FPM input low) |AND -| ERROR\_DETECTED = 1

| | call fault filter for code 543

VIP\_FPMTMR >= V\_FPMTM ------------| | call fault filter for code 542

(Pump has been on for | call fault filter for code 556

at least v\_FPMTM sec.) |

|

| --- ELSE ---

|

| (No error detected)

| call fault filter for code 543

| call fault filter for code 542

| call fault filter for code 556

END: FP COMMANDED ON PROCESS

BEGIN: FP OCC PROCESS

| (FP relay primary circuit

|OCCSAV-IOCC| < OCCDT7 -----------------| failure; code 556)

(insufficient change in OCC) | PUMP = 0

| RMSPRU = 0

| ERROR\_DETECTED = 1

| call fault filter for code 556

|

| --- ELSE ---

|

| (No failure detected)

| PUMP = 0

| RMSPRU = 0

| call fault filter for code 556

END: FP OCC PROCESS

29-70

MALFUNCTION INDICATOR LIGHT (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MALFUNCTION INDICATOR LIGHT - SPEED DENSITY - SINGLE EGO

OVERVIEW

The purpose of the Malfunction Indicator Light (MIL) is to alert

the driver that the computer has detected a fault with the EEC-IV

system. If the MIL was not present, the driver may not be aware

that a problem exists. The Failure Mode Effects Management

(FMEM) strategy is capable of maintaining good drive

characteristics with a fault present. However, the vehicle will

not be operating at an optimum point with regard to emissions,

economy and performance. When the MIL is on, the driver of the

vehicle should seek service at his earliest convenience. It is

not necessary to immediately shut the vehicle down and have it

towed in for service.

The malfunction indicator light (MIL) warning system was

implemented to comply with California regulations for the 1988

model year. A pilot program was carried out in 1987 on the 2.3L

TC T'Bird/Cougar, 2.3L OHC Mustang and the 3.0L Taurus/Sable. By

the 1989 model year both California and 49 States EEC-IV equipped

passenger car and light and medium duty trucks were equipped with

MIL. The only exception was the 2.3L TC Merkur XR4Ti.

The light, which is labeled "Check Engine" or "Service Engine

Soon" is located on the dashboard such that the driver can see

it. Power is supplied to the light whenever the ignition switch

is in the run or crank position. The ground circuit for the

light is provided through the EEC module self-test output (STO).

Whenever the EEC-IV strategy determines that the light should be

on, the STO output driver is turned on (STO voltage will be low).

Since the light is controlled by STO, the self-test error codes

can be determined by counting the check engine light pulses

during self-test.

The light will be turned on by the EEC module (after a delay of

FMDTM seconds) whenever a fault is detected for any of the

monitored signals. When MILTMR exceeds the calibrateable delay

time (FMDTM), the light will turn on for at least a calibrateable

time of V-MILONTM seconds. If the fault is no longer present,

then the light will turn off as soon as the light has been on for

at least V-MILONTM seconds.

Continued on Next Page

29-71

MALFUNCTION INDICATOR LIGHT (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Continued from Previous Page

If the light is on for a period less than V\_MILONTM seconds, it

indicates that the light was not activated by the check engine

light strategy. This could be caused by an intermittent short to

ground of the STO wire, intermittent operation in HLOS, or fault

detection while in the wiggle self-test mode (STI grounded).

With the exception of the grounded STO wire, operation in HLOS,

or an intermittent fault with VSS in the wiggle test mode, a

continuous error code will always be present, indicating the

reason for the fault.

The check engine light is turned on in the crank mode until a PIP

signal is detected as a bulb check. The bulb check can be

disabled by setting MILLIM to zero. If the light does not turn

off while the engine is cranking, it indicates that the EEC

module is not receiving PIP signals.

The calibration parameter MIL\_SW can take values of 0, 1 or 2.

If MIL\_SW is set to zero, the MIL light is not activated by the

MIL logic. Note that the MIL light will still turn on whenever

STO is grounded (HLOS, self-test). Production calibrations must

have MIL\_SW set to 1 to meet California regulations. When MIL-SW

is set to 2, the MIL light will activate whenever any continuous

fault filter indicates a fault is present for at least FMDTM

seconds.

DEFINITIONS

INPUTS

Registers:

- C332FIL = Fault Filter indicating EGR flow problem.

- CXXXFIL = Fault Filter for any continuous fault.

- MILTMR = Timer used to record the time that a continuous fault

has been present, sec.

Bit Flags:

- ADT1FMFLG = Flag indicating that one or more of the adaptive

table one cells have reached the max or min clip

values (MAXADP OR MINADP).

1 -> TABLE IS AT CLIP.

0 -> TABLE NOT AT CLIP.

Continued on Next Page

29-72

MALFUNCTION INDICATOR LIGHT (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Continued from Previous Page

- EGO1FMFLG = Flag indicating there is an EGO-1 failure.

- AFMFLG = Flag indicating the ACT sensor has failed.

- 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\_NOSTART = Flag set to 1 when KOEO VIP test is entered

Disables bulb check when KoEO test is exited.

- 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.

- MFMFLG = Flag indicating the MAF sensor has failed.

- RUNNING = Flag indicating that engine-running VIP is active.

1 -> IN ENGINE-RUNNING VIP.

0 -> NOT IN ENGINE-RUNNING VIP

- 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.

Continued on Next Page

29-73

MALFUNCTION INDICATOR LIGHT (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

Continued from Previous Page

Calibration Constants:

- C332LVL = Fault threshold for EGR flow problem.

- C332UP = Upcount for fault filter 332.

- CXXXLVL = Fault threshold for any continuous fault.

- CXXXUP = Upcount for any continuous fault.

- FMDTM = Time delay after fault is detected to turn on MIL, sec.

- MILLIM = Software switch to enable/disable bulb check, unitless

( 1 -> enable; 0 -> disable).

- MIL\_SW = MIL enable switch, unitless,

0 = Do not turn on MIL

1 = Do MIL logic to meet California regulation, must be

1 for production

2 = Do MIL logic and turn MIL light on for any

continuous fault, development calibration only.

- V\_MILONTM = Minimum MIL on time, sec.

OUTPUTS

Registers:

- MILTMR = See above.

Calibration Information

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

FMDTM should be set at 4.5 seconds. This will allow the check

engine light to turn on within 5 seconds of the fault occurrence.

The .5 seconds of time is used to allow the fault filter to reach

the fault threshold.

V\_MILONTM should be large enough to easily distinguish between an

intermittent harness short and a strategy controlled activation

of the check engine light. A 10 second on time is suggested. If

set to 8191.875, then the MIL light will remain on once it is on,

until the engine is turned off.

MIL\_SW must be set to 1 for production calibration.

29-74

MALFUNCTION INDICATOR LIGHT (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

PROCESS:

STRATEGY MODULE: VC\_MIL\_SD\_COM1

MILTMR IS A FREE-RUNNING INCREMENTING TIMER

NO\_START = 1 ------------|

(KOEO VIP) |

|OR ------------| EXIT

RUNNING = 1 -------------| |

(ENGINE RUNNING VIP) | ---ELSE ---

|

| ZERO MILTMR

STIFLG = 1 ------------------------------|

(STI GROUNDED, NOW IN WIGGLE MODE) |

|

| ---ELSE ---

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

(IN CRANK) | |

|AND------------| DO BULB CHECK

DISABLE\_NOSTART = 0 -----| | (TURN STO ON)

(KOEO VIP NOT REQUESTED)| | ZERO MILTMR

| |

FIRST\_PIP = 0 -----------| |

(PIP NOT YET RECEIVED) | |

| |

MILLIM = 1 --------------| | ---ELSE ---

(BULB CHECK REQUIRED) |

|

MIL\_SW = 0 --------------| | TURN MIL OFF

| | (STO OFF)

CRKFLG = 1 --------------|OR ------------| ZERO MILTMR

| |

CHECK MIL FAULT NOT | |

PRESENT LOGIC ----------| | ---ELSE ---

(MIL FAULT IS NOT PRESENT) |

|

| TURN MIL OFF

MILTMR <= FMDTM -------------------------| (STO OFF)

|

|

| ---ELSE ---

|

| TURN MIL ON

| (STO ON)

|

29-75

MALFUNCTION INDICATOR LIGHT (CONTINUOUS) - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

MIL FAULT NOT PRESENT LOGIC

AFMFLG = 0 --------------|

(ACT) |

CFMFLG = 0 --------------|

(ECT) | | MIL FAULT IS NOT

EFMFLG = 0---------------| | PRESENT

(EGR) | |

MFMFLG = 0 --------------|AND ----|

(MASS AIR FLOW OR MAP) | | ---ELSE---

TFMFLG = 0 --------------| |

(TP) | | MIL FAULT IS

EGO1FMFLG = 0 -----------| | PRESENT

ADT1FMFLG = 0 -----------|

(ADAPTIVE FUEL) |

C332FIL <= C332LVL ------|

(EGR FLOW) |

|

MIL\_SW <> 2 -----------| |

|OR---------|

CXXXFIL<= CXXXLVL -----| |

(NO OTHER CONTINUOUS FAULTS) |

|

|

MILTMR <= FMDTM--------| |

|OR --------|

MILTMR >= FMDTM + | |

V\_MILONTM ------------| |

(MIL ON MINIMUM TIME)

29-76

CHAPTER 30

ERROR CODE DESCRIPTION

30-1

ERROR CODE DESCRIPTION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

ERROR CODE DESCRIPTION

SELF TEST SECTION

ERROR | |------------------------|

CODE | DESCRIPTION | K.O.E.O | E.R. | CONT. |

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

111 | PASS | X | X | X |

112 | 254 deg. ind. ACT-ckt. grounded. | X | XX | X |

113 | -40 deg. ind. ACT-sensor ckt. open.| X | XX | X |

114 | ACT out of S-T range. | X | X | |

116 | ECT out of S-T range. | X | X | |

117 | 254 deg. ind. ECT-ckt. grounded. | X | XX | X |

118 | -40 deg. ind. ECT-sensor ckt. open.| X | XX | X |

121 | TP out of S-T range. | X | X | |

122 | TPS ckt. below minimum voltage. | X | XX | X |

123 | TPS ckt. above max. voltage. | X | XX | X |

126 | MAP/BP out of S-T range. | X | XX | X |

128 | MAP vacuum circuit failure | | | X |

129 | Insuff. MAP change-dyn resp. test. | | X | |

167 | Insuff. TP change-dyn resp. test. | | X | |

172 | EGO sensor ckt. ind. system lean. | | X | X |

173 | EGO sensor ckt. ind. system rich. | | X | X |

179 | Adaptive Fuel Limit Lean | | | X |

181 | Adaptive Fuel Limit Rich | | | X |

182 | Adaptive Fuel Limit Lean @idle | | | X |

183 | Adaptive Fuel Limit Rich @idle | | | X |

194 | Hego switch rate too fast | | | X |

211 | PIP ckt. fault. | | | X |

212 | Loss of tach input to processor. | | | X |

213 | Spark control fault present | | X | |

225 | Knock not sensed-dyn response test.| | X | |

311 | Themactor air system inop. | | X | |

312 | Thermactor air upstream during S-T.| | X | |

313 | Therm. air not bypassed during S-T.| | X | |

327 | EPT/EVP below min. voltage. | X | X | X |

328 | EVP volt below closed lim (SONIC) | X | X | X |

332 | EGR valve not opening (SONIC). | | X | X |

334 | EVP volt. above closed limit. | X | X | X |

337 | EVP ckt. above max volt. | X | X | X |

338 | Cooling System not Heating | | | X |

339 | Cooling System not Cooling | | | X |

411 | RPM not within S-T lower band limit| | X | |

412 | RPM not within S-T upper band limit| | X | |

452 | Insufficient input from VSS. | | | X |

30-2

ERROR CODE DESCRIPTION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

SELF TEST SECTION

ERROR | |------------------------|

CODE | DESCRIPTION | K.O.E.O.| E.R. | CONT. |

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

511 | ROM test failed | X | | |

512 | KAM Test Failed | | | X |

513 | Failure in EEC ref. voltage. | X | | |

519 | PSPS ckt. open. | X | | |

521 | PSPS did not change states. | | X | |

536 | BOO Sw. Ckt failed open/closed -ECA| | X | |

| input open or brake not actuated | | | |

| during test | | | |

538 | Operator error-dyn response test. | | X | |

539 | A/C Swith error | X | | |

542 | FP Ckt Open -ECA to Motor Ground | X | | X |

543 | FP Ckt Open Bat. to Relay | X | | X |

552 | Air Management 1 (AM1) ckt. failure| X | | |

553 | Air Management 2 (AM2) ckt. failure| X | | |

556 | Fuel pump ckt. failure. | X | | X |

558 | Elect. vac. reg. (EVR) ckt. failure| X | | |

565 | Canister Purge (CANP) ckt. failure.| X | | |

617 | 1-2 Shift Error | | | X \* |

618 | 2-3 Shift Error | | | X \* |

619 | 3-4 Shift Error | | | X \* |

621 | SS1 Sol Ckt Failure | X | | |

622 | SS2 Sol. Ckt. Failure | X | | |

624 | EPC Solenoid Circuit Failure/Shor- | X | | X |

| Output Driver | | | |

626 | CCS Sol Ckt Failure | X | | |

628 | Converter Clutch Failure | | | X |

629 | CCC Sol. Ckt. Failure | X | | |

631 | OCIL Ckt. Failure | X | | |

632 | OCS Not Changing State | | X | |

633 | 4X4 Switch closed | X | | |

634 | MLPS Out of Range | | | X |

636 | TOT Out of S-T range | X | X | |

637 | -40 deg. ind. TOT sensor ckt open | X | | X |

638 | 315 Deg ind. TOT sensor ckt grounded X | | X |

654 | MLPS not in park | X | | |

655 | MLPS not in neutral | X | | |

998 | FMEM failure/Failed (open)EPC | X | XX | |

| Output Driver | | | |

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

XX - Service Code 998 and corresponding code(s) are output which

constitute FMEM mode failure.

\* SEE BASE STRATEGY FOR TEST DOCUMENTATION

30-3

ERROR CODE DESCRIPTION - LHBH0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

30-4

CHAPTER 31

ROM IDENTIFICATION CODE

31-1

ROM IDENTIFICATION CODE - LUT0

PED-PTE, FoMoCo, PROPRIETARY & CONFIDENTIAL

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.

31-2

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

INDEX

A, 8-11 AISFM, 6-61, 6-63

A0COR, 6-8, 6-81, 6-86, 14-7 ALPHA, 6-61

A3C, 20-9, 21-9, 27-19 ALT\_CAL\_DIST, 15-5

A3CTMR, 3-5, 9-19, 21-9 ALT\_CAL\_FLG, 6-13, 6-26, 6-85,

AC\_PPM, 9-12, 9-21 7-13, 7-15, 7-17, 9-17 to

ACCELERATION ENRICHMENT, 6-5 9-18, 9-26, 15-3, 15-5

ACCFLG, 9-19, 9-21, 9-35, 9-39, ALTDLY, 18-33

9-51, 19-10, 20-9 ALWAYS, 7-52

ACCUM, 6-26 to 6-27, 6-36 to 6-38 AM, 6-67, 6-81, 6-85, 11-5, 20-15,

ACD, 9-19 23-8

ACDHP, 9-19 AM1, 12-8 to 12-9, 28-10

ACHPTM, 9-51 AM2, 12-8 to 12-9, 28-10

ACIFLG, 9-19, 9-21, 20-9 AMPEM, 8-12 to 8-13, 20-51

ACMAP, 9-34 to 9-35, 9-37, 9-39 AMPEMT, 20-51

ACSTRT, 6-67, 20-56 to 20-57 AMPMUL, 6-52

ACT, 3-5, 6-28, 6-51, 6-67, 6-85, AMT, 19-10

7-13, 8-11, 20-51, 20-54, APT, 3-5, 5-2 to 5-4, 6-16, 6-30,

20-56 to 20-57, 22-5 to 22-6, 6-36 to 6-37, 6-39, 7-12 to

22-12, 22-14 7-13, 7-17, 7-64, 8-5, 9-9 to

ACTFMM, 22-5 to 22-6 9-10, 9-28, 9-35, 9-38, 12-8,

ACTMAX, 22-5 to 22-6, 27-14, 20-9, 20-44, 21-12, 21-14 to

29-14 21-17, 21-19 to 21-22, 29-20,

ACTMIN, 22-5 to 22-6, 27-14, 29-58

29-14 APTMR, 6-16, 6-28 to 6-29

ADAPTM, 6-51 ARCHG, 19-10, 20-54

ADEFTR, 6-51 ATMR1, 6-9, 6-11, 6-27, 6-61,

ADEGCT, 6-52 6-63, 7-14, 8-5, 9-20, 9-51,

ADPTMR, 6-51, 21-9 12-10, 21-10, 23-2, 23-7 to

ADT1FMFLG, 11-6, 22-10 23-8, 29-56

ADT2FMFLG, 22-11 ATMR1\_LST, 21-10, 21-13

AEDLMP, 20-21 to 20-22 ATMR2, 6-9, 6-11, 8-5, 12-10,

AEFUEL, 6-8, 6-51, 29-56 21-11

AELIM, 6-51 ATMR3, 6-67, 9-9, 9-18, 21-12

AEM, 6-8 AWOTMR, 12-9, 21-12

AEMAP, 3-5, 20-10, 20-21 to 20-22,

20-54 BAP, 23-4

AEMTMR, 20-10, 20-54 BASE\_EM, 6-86, 6-89

AEPP, 6-8 BASEFF, 6-85, 6-88 to 6-89

AEPW, 6-5, 6-8 BASEMD, 20-51

AETAR, 6-8 BETA, 7-48

AETP, 20-7, 20-21, 20-54 BFULSW, 6-89

AETV, 17-30 BG\_TMR, 6-78, 15-5, 20-8, 20-54

AETVTP, 17-30 BGFUEL, 6-81, 6-85 to 6-86, 6-88,

AFACT1, 6-28, 6-51 6-98

AFACT2, 6-28, 6-51 BIAS, 6-16, 6-28, 6-37 to 6-38,

AFECT1, 6-28, 21-9 6-52

AFECT2, 6-28, 21-9 BIFLG, 18-10, 20-8, 28-21, 29-40,

AFMFLG, 6-51, 8-4, 8-13, 12-8, 29-45

22-5 to 22-7, 23-8, 28-9, BIHP, 3-2, 20-8, 28-21, 29-40,

29-56 29-44

AISF, 6-61 to 6-65 Block, 13-5

Index-1

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

BOO\_FAILURE\_PROCESS, 29-45 C118FIL, 22-12, 22-15

BOO\_SPD\_TMR, 29-44, 29-46 C118LVL, 22-12, 22-15

BOO\_TEST\_MAIN, 29-44 to 29-45 C122FIL, 22-20, 22-23

BP, 6-8, 8-11 to 8-13, 9-35, 9-39, C122LVL, 22-20, 22-23

9-44 to 9-45, 18-11, 18-33, C123FIL, 22-20, 22-23

19-15, 20-15, 20-24, 21-17 to C123LVL, 22-20, 22-23

21-18, 23-8, 24-3, 29-20, C128FIL, 29-21

29-28 C128LVL, 29-21

BP\_IMAP\_WORD, 29-20 C171FIL, 29-60 to 29-61, 29-63

BP\_INTR, 3-5, 16-13 to 16-14, C171LVL, 29-60 to 29-61

18-32 C172FIL, 29-60 to 29-61, 29-63

BPCOR, 20-15 C172LVL, 29-60 to 29-61

BPCOR\_SW, 9-44 to 9-45 C173FIL, 29-60 to 29-61, 29-63

BPKAM, 23-2, 23-4, 23-7 to 23-8, C173LVL, 29-60 to 29-61

24-3 C179FIL, 22-10

BPKFLG, 23-2, 23-5, 23-7, 24-3 C179LVL, 22-10

BPKYON, 23-2, 23-4 to 23-5, 23-7, C181FIL, 22-10

24-3 C181LVL, 22-10

BPPTWT, 20-54, 23-2, 23-4, 23-8, C182FIL, 22-10

24-3 C182LVL, 22-10

BPUFLG, 23-2, 23-7 C183FIL, 22-10

BPUNMH, 18-11 C183LVL, 22-10

BPUNMN, 18-11, 18-33 C188FIL, 22-11

BPUNMX, 18-33 C188LVL, 22-11

BRAKE\_INPUT, 20-8 C189FIL, 22-11

BRDRLN\_SPK, 7-21 to 7-22 C189LVL, 22-11

BRK\_NEVER\_OFF, 28-10, 28-21 C191FIL, 22-11

BRK\_NEVER\_ON, 28-10, 28-21 C191LVL, 22-11

BRKDLY, 18-12 C192FIL, 22-11

BYMAP, 21-12 C192LVL, 22-11

BYPMAP, 12-8 to 12-9 C327FIL, 22-16 to 22-17

BYPTMR, 12-8 to 12-9, 21-12 C327LVL, 22-16 to 22-17

BYPWOT, 12-8 C332FIL, 29-28, 29-30, 29-32

BYRPM, 21-15 C332LVL, 29-28, 29-30

BYRPMH, 21-15 C334FIL, 29-30

BYSTM1, 12-10 C334LVL, 29-30

BYSTM2, 12-10 C337FIL, 22-16 to 22-17

BYSTM3, 12-10 C337LVL, 22-16 to 22-17

BYSTM4, 12-8, 21-15 C338LVL, 29-8

BYSTM8, 12-8 to 12-9 C338UP, 29-8

Byte, 13-5 C339UP, 29-8

BYTE\_8, 13-37 C452FIL, 29-41, 29-45

BYTE\_9, 13-37 C452LVL, 29-41

BYTE\_NUM, 13-35 to 13-37 C536FIL, 29-45

BZZRPM, 9-11, 9-17 to 9-18 C617\_KAM\_BIT, 16-43

BZZRPM\_ALT, 9-18 C617CNT, 16-43

BZZTM, 9-18, 9-20 C617FIL, 16-43

BZZTM\_ALT, 9-18 C618\_KAM\_BIT, 16-43

C618CNT, 16-43

C112FIL, 22-5, 22-7 C618FIL, 16-43

C112LVL, 22-5, 22-7 C619\_KAM\_BIT, 16-43

C113FIL, 22-5, 22-7 C619CNT, 16-43

C113LVL, 22-5, 22-7 C619FIL, 16-43

C117FIL, 22-12, 22-15 C628\_KAM\_BIT, 18-41

C117LVL, 22-12, 22-15 C628CNT, 18-41

Index-2

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

C81FIL, 29-21 CRKFLG, 3-5, 4-4 to 4-6, 5-2, 5-4,

C81LVL, 29-21 6-8 to 6-10, 6-57 to 6-58,

CANPHP, 3-2, 11-5 6-63, 6-85, 6-89, 6-98, 6-101,

CART, 13-5, 13-29 8-4, 9-8 to 9-9, 11-5, 11-7,

CART\_MODE, 13-36 12-8, 19-6, 20-9, 20-22,

Cart\_Mode, 13-5 20-32, 20-39 to 20-40, 20-43,

CART\_STATUS, 13-35 to 13-37 21-10, 21-13, 21-22, 22-3 to

CC\_ERR\_SW, 19-6 22-4, 22-12, 22-14, 22-20,

CC\_FM\_FLG, 17-13, 18-41, 19-6, 22-22, 23-2, 23-7 to 23-8,

19-26 29-6, 29-44, 29-55

CC\_FM\_LVL, 18-41 CRKPIP, 4-4, 6-98

CCD\_HP, 7-29, 7-32, 7-35, 7-43 to CRKPIP\_CTR, 6-67, 21-13

7-44, 7-46, 7-48 to 7-50 CRKPIP\_CTR\_BG, 6-85, 21-13

ccd\_hp, 7-34 CRKPIPCNT2, 21-13

CCDHP, 7-48 CRKTIM, 9-9, 9-18

CCE\_TPMN, 18-41 CRKTM1, 21-13

CCV\_STRT\_SFT, 16-40 to 16-41 CRKTMR\_INC, 21-13

CD\_TVENG\_TM, 20-62 CRVDLY, 18-33

CFIEPT, 3-5 CS\_MAX\_TIME, 20-66

CFMFLG, 6-51, 8-4, 8-13, 12-8, CS\_MUL, 20-66

21-17, 22-5 to 22-6, 22-12 to CS\_PDL\_4, 18-45

22-15, 23-2, 23-8, 28-9, CS\_SFT\_MULT, 16-13 to 16-14,

29-56 17-14 to 17-15, 18-11, 20-65

CHANGED PAGES, 1, 5, 9, 1-2 to 20-66

CHGTM, 21-22 CSDYN12, 17-14

CHKAIR, 6-16, 12-8 to 12-9 CSDYN23, 17-14

CHKASW, 12-8 to 12-9 CSDYN34, 17-15

CHKFLG, 24-5 CSHIGH, 7-14

CHKSUM, 6-53, 24-3, 24-5 CSLOW, 7-14

CIBETA, 6-68, 6-70 CSSFLG, 7-14, 7-17, 9-21

CKRFLG, 20-19 CSSPRK, 7-13

CLDCTM, 16-35 CSSTIM, 7-14

CLFLG, 6-26 to 6-29 CTBYS, 12-6

CLOCK\_SEC, 20-8 CTBYSH, 12-6

CMD\_CODE, 13-36 to 13-37 CTDLY, 18-12

CNTVSRATE, 20-27 to 20-28 CTDSFO, 6-80

CODE 112, 27-14 CTEDSO, 6-80

CODE 113, 27-14 CTFLG, 7-64 to 7-65

CODE 114, 27-14, 28-18 CTHIGH, 6-9, 6-11, 8-5, 12-10

CODE 213, 28-32 CTLOW, 6-9, 6-11, 8-5, 12-10

COLTBU, 6-50 CTPTFG, 5-3 to 5-4, 9-51

CONPR, 3-5 CTR\_VSRATE, 20-27 to 20-28

COUNT, 28-8 CTTMR, 6-80, 21-14

COUNTERS CWCTR, 7-60

ECT & PIP, 4-6 CXXX\_KAM\_BIT, 29-4

PIP & ECT, 4-6 CXXXCNT, 29-4

CRANK/UNDERSPEED/RUN MODE SELECT CXXXFIL, 29-4

DEFINITIONS, 4-4 CXXXLVL, 29-4

CRANK/UNDERSPEED/RUN MODE CXXXUP, 29-4

SELECTION CYCCTR, 16-35

LOGIC, 4-5

CRANKING, 26-4 to 26-7 D, 6-80, 6-86

CRKCTR\_RESET, 21-13 D21DLY, 18-13

D32DLY, 18-13

D43DLY, 18-13

Index-3

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

D\_TP\_DT, 6-78 DFSRPH, 6-79

D\_TP\_DT\_F, 6-78 DFSRPM, 6-79

DACTM, 9-19 DFSTM, 6-79

DASCTL, 9-35, 9-38, 21-20 DFSVS, 6-79

DASMHYST, 9-10 DFSVS\_HYS\_FG, 6-79 to 6-80

DASMPH, 9-10 DFSVSH, 6-79

DASPOT, 9-3, 9-30 to 9-33, 9-35, DFTRPH, 7-12

9-38, 9-51, 21-20 DFTRPM, 7-12

DASPTK, 9-28, 9-30 DIAGMODE, 13-11

DASPTO, 9-28, 9-30 DIAGNOSTIC PARAMETER SLOTS, 13-5

DATA COMMUNICATIONS LINK>DCL DIFCTR, 7-40 to 7-42

STATE DIAGRAM, 13-3 DIFF0, 7-40, 7-42

DATA\_TIME, 7-44, 7-51 to 7-52, DIFF1, 7-40, 7-42

20-25, 20-39 DISABLE\_ADAPT, 6-50 to 6-51, 6-86

DCL\_RAM\_START, 13-14 DISABLE\_ISC, 6-71, 6-73, 9-8 to

DCLCT\_START, 13-5 9-9, 28-14, 28-35

DCLST\_DONE, 13-5, 13-24 DISABLE\_NOSTART, 26-4 to 26-5

DCLST\_START, 13-5 DISABLE\_RUNNING, 26-5 to 26-7

DCOFF, 8-15 DISTANCE, 15-5

DD\_UNC\_UNL, 18-10 DLHYST, 6-71 to 6-73

DEBYCP, 9-44 to 9-45, 9-49 DNAC, 9-11, 9-17

DEBYMA, 9-2, 9-44 to 9-45, 9-49 DNDSUP, 6-13, 6-30, 7-15 to 7-17,

DEFAULT\_LVF, 13-5 9-9, 9-18, 9-21, 9-35, 9-38

DELAMB, 6-52 to 9-39, 20-7

DELCOL, 6-51 DNDT\_ISC, 6-71, 6-73, 20-45,

DELHYS, 9-29 20-47, 20-54

DELOPT, 8-7, 8-11 to 8-15, 20-54 DNDT\_SPK, 20-46 to 20-47, 20-54

DELOPT', 8-12, 20-54 DNDTI, 20-45, 20-47, 20-54

DELRAT, 6-71 to 6-73 DNPOWS, 9-11, 9-17

DELROW, 6-51 DNUN\_TM, 16-22, 16-25, 16-27 to

DELTA, 5-2 to 5-3 16-28, 18-19

DELTA\_SPK, 7-17 to 7-18, 7-21 DOL\_COUNT, 14-7

DELTAT, 20-59 to 20-60 DOL\_DUTY, 14-3

DELTIM, 6-61, 6-64 DOLHP, 3-2

DESEM, 8-11 to 8-12 DOUBLE\_EDGE, 7-43 to 7-44

DESMAF, 9-3, 9-44 to 9-45, 9-51, DPLGHP, 8-4

28-45 DPNEU\_MUL, 9-29, 9-31

DESMAF\_PRE, 9-3, 9-50 to 9-51, DPS, 13-4, 13-7, 13-11

28-45 DRBASE, 7-17

DESMAF\_PRE CALCULATION, 9-12 DRBASE\_ALT, 7-17, 9-17

DESNLO, 9-23, 20-54 DRV2NEU\_FLG, 17-8 to 17-10

DFMIN0, 7-40, 7-42 DSDRPM, 6-71, 6-73, 6-79, 7-17,

DFMIN1, 7-40, 7-42 9-8, 9-23, 9-26, 9-31, 9-34

DFNOVH, 6-79 to 9-35, 9-38, 20-54, 28-14,

DFNOVS, 6-79 28-35, 28-46

DFSECT, 6-80 DSFFLG, 6-98

DFSFLG, 6-16, 6-50, 6-61, 6-63, DSFTSW, 12-8

6-80, 6-86, 6-91, 12-8 DSLMBS, 6-40

DFSLAM, 6-26 DSTPBR, 9-8, 9-28, 9-30, 20-54

DFSMAP, 6-79 DT12S, 6-100, 7-32, 7-36, 7-38 to

DFSMPH, 6-79 7-42, 7-48, 20-32

DFSO\_A\_TMR, 6-78, 12-8 dt12s, 7-34 to 7-35

DFSO\_ECT, 6-78 DT12S\_AVG, 18-37 to 18-38

DFSO\_F\_TMR, 6-78, 6-80 DT12SA, 20-32, 20-38

DFSO\_OUT, 6-80 DT23S, 7-36, 7-38, 7-40 to 7-41

Index-4

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

DT\_DNDT, 20-45, 20-47, 20-54 EFFLG1, 6-61 to 6-63

DTPCYC, 7-36 to 7-39 EFMFLG, 8-4, 8-13, 22-16 to 22-17

DTSIG, 7-36 to 7-38 EFMLO, 29-32

DWELD, 7-30 EFTC, 6-61

DWELL, 7-28 to 7-30, 7-32, 7-46, EFTR, 6-51, 6-61 to 6-65, 28-10

7-48 to 7-50 EFTRFF, 6-62 to 6-63, 6-65, 6-81,

dwell, 7-31 6-88 to 6-89

DWELL\_CALCULATION, 7-35, 7-44 EGO, 6-37, 6-52

dwell\_extra, 7-34 to 7-35 EGO1FMFLG, 12-8

DWELLA, 7-28 to 7-29 EGO\_CNT\_IDLE, 6-16, 6-72 to 6-73

DWELLM, 7-28 to 7-29 EGO\_CNT\_OL, 6-28

DWL\_XS\_MIN, 7-28, 7-30 EGO\_IDLE, 6-16

DWLBSE, 7-28 to 7-30 EGO\_TEST\_TMR\_CLEAR, 29-58

DWLCOR, 7-28 to 7-30 EGOBAR, 20-54

DWLELD, 7-28, 7-32, 7-35, 7-43 to EGOCL1, 6-27

7-47, 7-49 to 7-52 EGOCNT, 6-50 to 6-53

dwleld, 7-34 EGOFL, 29-62 to 29-63, 29-65

DWLIDM, 7-28, 7-30, 7-52 EGOSSS, 6-9 to 6-10, 6-27, 29-62

DWLMAX, 7-32 to 29-63

dwlmax, 7-34 EGOSW\_OL\_CTR, 6-28 to 6-29

DWLMIN, 7-28 EGOTSTCUMFLG, 29-56 to 29-57

dwlmin, 7-31 EGOTSTCUMTMR, 29-55, 29-57, 29-62

DWLTSW, 7-32 to 29-63

dwltsw, 7-35 EGRACT, 7-13, 8-2, 8-13, 19-10,

20-54

ECHO\_PIP, 7-43 to 7-45 EGRACT', 8-13, 20-54

ECHO\_TRANS, 7-43 to 7-45 EGRATE, 8-11 to 8-12

ECT, 3-5, 4-3, 6-9, 6-11, 6-13, EGRBAR, 3-5, 20-8 to 20-9, 20-54

6-27 to 6-28, 6-52, 6-67, EGRCNT, 8-17 to 8-19

6-78, 6-80, 6-85 to 6-86, EGRCTF, 8-16 to 8-17, 8-19

7-13, 7-58, 7-64, 8-11, 9-51, EGRDC, 8-11, 8-15, 8-17 to 8-18,

11-5 to 11-6, 12-6, 20-51, 28-10, 29-26, 29-28, 29-64

20-54, 20-56, 21-9, 21-11, EGRDED, 8-4, 8-15

21-17, 22-5, 22-12 to 22-15, EGREN, 8-4 to 8-5, 8-11

22-18 to 22-19, 23-2, 23-8, EGRERR, 8-7, 8-14 to 8-15

29-6 EGRFLG, 8-15

COUNTER LOGIC, 4-6 EGRPER, 8-17 to 8-19

ECT\_HP, 9-51 EGRPRF, 8-16 to 8-17, 8-19

ECTBP, 23-3, 23-8 EGRTB1, 8-5

ECTCNT, 4-4 to 4-5, 9-26, 20-56 EGRTD1, 8-5

to 20-57, 22-12, 22-14, 22-18 EGRTD2, 8-5

to 22-19 EGRTD3, 8-5

ECTFMM, 22-12, 22-15 EGRTD4, 8-5

ECTIP, 7-64 EGRTD5, 8-5

ECTMAX, 20-56 to 20-57, 22-12, EGRTD6, 8-5

22-14, 29-13 EGRTD7, 8-11, 21-14

ECTMIN, 20-56 to 20-57, 22-12, EGRTD8, 8-4

22-14, 29-13 EGRTMR, 8-11, 21-14

ECTNOK, 7-58 EGRTPQ, 8-5

ECTSTABL, 6-9, 6-11 EGTB1H, 8-5

ECTSTHYS, 6-9, 6-11 EISF, 6-61

EEC OVERVIEW EM, 6-86, 8-2, 8-13

DCL HW SWITCHES, 3-4

EEC-IV, 13-9

EEC\_CHKSUM, 13-35 to 13-37

Index-5

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

ENGCYL, 6-81, 6-86, 6-88, 6-96, REFLG

6-104 to 6-105, 7-28 to 7-29, SET/CLEARED, 4-6

7-36, 7-38 to 7-39, 19-10, FLG\_4X4L, 16-13, 16-31, 17-30,

20-38, 20-45, 20-47, 28-10 17-38, 18-41, 19-21, 19-25 to

ENTRY\_T, 7-17 19-26

EOFF, 3-5, 8-4, 8-12 to 8-13, FLG\_CRV\_DS, 18-31 to 18-33

8-15, 20-9, 22-16 to 22-17 FLG\_CRV\_LK, 18-5, 18-33

EPC\_ERR\_SW, 19-6 FLG\_CRV\_LST, 18-31, 18-33

EPC\_OPEN\_FLG, 17-43, 19-6 FLG\_CS\_CM, 18-44 to 18-45

EPC\_OTEMP, 17-13 FLG\_CS\_ENG, 16-25, 16-27

EPC\_TQ\_CONV, 17-29, 17-32 FLG\_CS\_FRST, 18-44

EPC\_TQMAX, 17-32 FLG\_DASMNQ, 9-8, 9-10, 9-28, 9-31

EPTBAR, 3-5 FLG\_DASMNQ LOGIC, 9-10

ERMHI, 29-32 FLG\_DE\_DSGR, 16-8, 16-17

ERR\_BAN\_4X4L, 19-26 FLG\_DEL\_MDN, 16-8, 16-18, 17-12,

ERROR\_4X4L, 19-26 18-45

ERROR\_DETECTED, 29-20, 29-45 FLG\_DFSO\_NOVS, 6-79 to 6-80

ETST\_SWCUMTM, 29-62 to 29-63 FLG\_DN\_LK, 18-16 to 18-17, 18-19,

ETV\_ERROR, 17-43 18-23

ETV\_GAIN\_BAT, 17-42 FLG\_DN\_UNLK, 18-16 to 18-17,

ETV\_OCM\_MIN, 17-43 18-19, 18-23

ETV\_TEST, 17-13, 17-43 FLG\_DRV\_REV, 17-9 to 17-10, 17-25

ETVOCM, 17-43, 19-17 FLG\_DYN\_CD, 17-30, 20-64

EVP, 8-4, 8-7, 8-13 to 8-15, 20-8, FLG\_ECTSTABLO, 6-27

20-54, 22-16 to 22-17 FLG\_ECTSTABLQ, 6-9, 6-11, 6-30

EVPMAX, 22-16 to 22-17, 27-18, FLG\_ENG\_IN, 17-10 to 17-11, 17-22

28-33, 29-25 to 17-23

EVPMIN, 22-16 to 22-17, 27-18, FLG\_ENG\_TV, 17-11 to 17-12, 17-23

28-33, 29-24 FLG\_FMM\_CC, 18-48

EVR, 8-17, 8-19 FLG\_FMM\_LK, 18-5, 18-48

EVTDOT, 11-5 FLG\_FRST\_CM, 16-23, 16-31 to

16-32, 16-36, 16-40, 17-29,

.F, 7-17 17-37, 17-39, 18-11, 18-16,

FAEGCT, 6-52 18-33, 18-44

FFULC, 6-89, 6-98 FLG\_FRST\_DS, 16-8, 16-22, 17-11,

FFULFG, 6-10, 6-89, 6-98 18-16

FFULM, 6-89, 6-98 FLG\_FRST\_NOV, 18-41, 24-3

FIEPT, 3-5, 26-5 FLG\_FRST\_TCS, 19-19

FILHYS, 22-3 to 22-5, 22-7, 22-10, FLG\_FRST\_TV, 17-8, 17-16

22-12, 22-15 to 22-17, 22-20, FLG\_FWD\_REV, 17-10 to 17-11,

22-23, 29-21 17-23

FIRST\_MPH, 20-25 FLG\_GC\_ENG, 16-25

FIRST\_PIP, 4-4, 4-6, 20-46 to FLG\_HS\_LK, 18-17, 18-23, 18-28,

20-47 18-37 to 18-38

FIRST\_RPM, 20-45 to 20-46, 20-48 FLG\_HS\_UNLK, 18-17, 18-24, 18-28,

FK\_TMR, 20-52 18-37 to 18-38

FKBP, 23-3 FLG\_LK\_CM, 16-28, 16-40 to 16-41,

FKEXIT, 7-23 17-29, 17-32, 18-5, 18-11,

FKMKAY, 7-36, 7-39 18-24, 18-35, 18-37 to 18-38,

FKSKAY, 7-36, 7-38 19-25, 20-18

FKTP, 23-8 FLG\_NEU\_DRV, 17-9 to 17-10, 17-25

FL, 29-14 FLG\_NEU\_REV, 17-9 to 17-10

FL ACCEPT, 29-14 FLG\_NEW\_NOV, 18-41, 19-25 to

FL UNDERLINE, 29-14 19-26

FLAGS FLG\_NOT\_ADP, 6-28

Index-6

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

FLG\_NOV\_KAM, 16-40, 19-26, 24-3 FLG\_UP\_NE, 16-13, 18-23 to 18-24

FLG\_OPEN\_LOOP, 6-16, 6-26 to 6-27, FLG\_UP\_NE |, 16-12

29-56 FLG\_UP\_UNLK, 18-16 to 18-17,

FLG\_PWR, 16-27, 16-31 to 16-32, 18-23, 18-26, 18-28

17-12, 18-26, 18-28, 18-45, FLG\_WOT\_LK, 18-5

20-59 to 20-60 FLGWOTLK, 18-36

FLG\_REV\_DRV, 17-9 to 17-10, 17-25 FMAP1, 20-41

FLG\_RLK\_WOT, 18-35 FMAP2, 20-41

FLG\_SCHD\_DLY, 18-33 FMECNT, 22-12, 22-15

FLG\_SF\_AUTO, 16-8, 16-17 to 16-18, FMECTR, 22-12 to 22-15

16-31 to 16-32, 16-40, 18-19, FMEM, 22-3 to 22-4

18-28 FMEM\_FLAG, 22-4

FLG\_SFT\_DN, 16-8, 17-37 to 17-39 FMMDSD, 9-8

FLG\_SFT\_IN, 16-7, 16-12, 16-14, FMMISC, 9-2

16-32, 16-40, 17-12 to 17-13, FMMMLP, 20-70

17-29 to 17-30, 17-32, 17-37, FN031, 6-50

18-32, 19-16 FN046A, 23-3, 23-8

FLG\_SFT\_MDN, 16-31 to 16-32, FN047A, 23-3, 23-8

17-12, 18-45 FN069, 23-8

FLG\_SFT\_UNLK, 18-5, 18-17, 18-19, FN069(AM/BP), 23-8

18-28, 18-37 to 18-38 FN069A, 23-3, 23-8

FLG\_SFT\_UP, 16-8, 17-14, 17-31, FN070L, 6-50

17-37 to 17-39 FN074A, 20-15

FLG\_SFT\_VAL, 16-40 to 16-41 FN090, 22-20

FLG\_SS\_1, 16-36 FN090(MAP), 22-22

FLG\_SS\_2, 16-36 FN093, 20-16, 20-54

FLG\_STALL, 4-5, 21-13 FN093(MAP), 20-16

FLG\_TCS, 19-5, 20-71 FN095(TP\_REL), 20-43

FLG\_TIP\_OUT, 16-17 to 16-18, FN1033, 23-3, 23-8

16-32 FN1120, 7-13

FLG\_TIP\_RATE, 18-23, 18-27 FN1120(N,MAP), 7-13, 7-21 to 7-22

FLG\_TV\_CLK, 17-45 FN1121, 7-13

FLG\_TV\_DATA, 17-45 FN1121(N,MAP), 7-13

FLG\_TVENG\_CD, 17-23, 20-62 FN1122, 7-13

FLG\_TVENG\_MD, 17-11, 17-23, 20-62 FN1122(N,MAP), 7-21 to 7-22

FLG\_TVSTR\_CD, 17-16, 20-62 FN1126, 7-13

FLG\_UN\_ALT, 18-11 to 18-12, 18-14 FN1126(N,MAP), 7-13

FLG\_UN\_BRK, 18-10, 18-12, 18-14, FN1127, 7-13

18-31 FN1128, 7-13

FLG\_UN\_CT, 18-10 to 18-12, 18-14, FN1129, 7-13

18-31 FN1129(N,MAP), 7-13

FLG\_UN\_MDN, 18-11 to 18-12, 18-14 FN1150(ECT,ACT), 7-13, 7-21 to

FLG\_UN\_NE, 18-11 to 18-12, 18-14 7-22

FLG\_UN\_PRN, 18-10, 18-12, 18-14 FN1150\_ALT, 7-13

FLG\_UN\_TEMP, 18-11 to 18-12, FN1220(N,MAP), 8-11

18-14 FN1222(N,MAP), 8-11

FLG\_UN\_TRA, 18-10, 18-12, 18-14 FN12\_DC, 17-37

FLG\_UN\_TRD, 18-10, 18-12, 18-14 FN12A, 16-14

FLG\_UN\_ULSF, 18-11, 18-13 to FN12CA(TSLSFT), 17-38

18-14 FN12S, 16-14

FLG\_UN\_UPSFT, 18-24, 18-27 FN12T, 17-14

FLG\_UNC\_UNLK, 18-5, 18-14, 18-31, FN1303, 6-8

18-33, 18-48 FN1320(NORM\_N070,NORM\_MAPOPE21),

FLG\_UP\_LK, 18-16 to 18-17, 18-23, 20-51

18-26, 18-28 FN1321, 6-63, 6-65

Index-7

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

FN1321(TEISF), 6-61, 6-63 FN2ULK, 18-24

FN1325L, 6-28, 6-54 to 6-55 FN2US, 18-32

FN1325Lrc, 6-53 FN301, 6-30

FN1328, 6-26 FN303, 6-30

FN1343, 6-37 FN305(ACT), 20-51

FN1348, 6-67 FN307(N\_BYTE), 6-61

FN1349, 6-67 FN310, 6-30

FN1350, 6-67, 6-85 FN311, 6-16

FN1354, 6-37 FN312, 6-37

FN1355, 6-16 FN324, 6-8

FN1360, 6-16, 6-27 to 6-28, 21-14 FN325, 6-27

FN1361, 6-27 FN326, 20-51

FN1362, 6-26 to 6-27 FN326(ECT), 20-51

FN1362\_ALT, 6-26 FN32\_DC, 17-37

FN1420, 20-51 FN32A, 16-14

FN143, 7-63, 7-66 FN32S, 16-14

FN144, 7-56 FN32T, 17-14

FN153, 7-13 FN331A, 6-8

FN153(N), 7-13 FN332, 6-8

FN1615A, 19-10 FN348, 6-85

FN1616, 19-10 FN34\_DC, 17-37

FN1617, 19-10 FN34A, 16-13

FN180, 7-21 to 7-22 FN34CA(TSLSFT), 17-38

FN180(IDLTMR), 7-15 FN34PPH, 16-13

FN182(DNDT\_SPK), 7-14 FN34S, 16-13

FN183(VSBAR), 7-14 FN34T, 17-15

FN1CB, 17-18 FN367, 6-5, 6-8, 6-81

FN1CB(VSBART\_RT), 17-17 to 17-18 FN371, 6-13

FN211, 8-11 FN371\_ALT, 6-13

FN212A, 8-11 FN372, 6-37

FN218, 8-12, 8-14 FN378, 6-8

FN218(MAPOPE), 8-13 FN379, 6-8

FN219, 8-14 FN387, 6-85

FN219(EVP-EOFF), 8-13 FN387\_ALT, 6-85

FN21\_DC, 17-37 FN394F, 20-7

FN21A, 16-14 FN3CB, 17-18

FN21S, 16-14 FN3CB(VSBART\_RT), 17-17 to 17-18

FN21T, 17-14 FN3LA, 18-32

FN220, 8-11 FN3LK, 18-23 to 18-24

FN221, 8-12 FN3LS, 18-32

FN222A, 6-78 FN3UA, 18-32

FN222F, 6-78 FN3ULK, 18-23 to 18-24

FN239, 8-14 to 8-15 FN3US, 18-32

FN23\_DC, 17-37 FN405, 20-51

FN23A, 16-13 FN43\_DC, 17-37

FN23CA(TSLSFT), 17-38 FN43A, 16-14

FN23PPH, 16-13 FN43S, 16-14

FN23S, 16-13 FN43T, 17-15

FN23T, 17-14 FN46\_NE, 17-25

FN2CB, 17-18 FN46B\_T, 17-25

FN2CB(VSBART\_RT), 17-17 to 17-18 FN46F\_T, 17-25

FN2LA, 18-32 FN46S\_T, 17-25

FN2LK, 18-24 FN4LA, 18-32

FN2LS, 18-32 FN4LK, 18-23

FN2UA, 18-32 FN4LS, 18-32

Index-8

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

FN4UA, 18-32 FN852, 9-51

FN4ULK, 18-23 FN862, 9-39

FN4US, 18-32 FN862(BP), 9-34 to 9-35, 9-37

FN500, 14-3 FN879, 9-29 to 9-30, 9-32

FN501, 10-3 FN880, 9-11, 9-17

FN54\_NE, 17-25 FN882A(N, 9-29

FN54B\_T, 17-25 FN884, 9-2, 9-8

FN54F\_T, 17-25 FN885, 9-21

FN54S\_T, 17-25 FN887A, 9-21

FN56\_NE, 17-25 FN890(BP), 9-44

FN56B\_T, 17-25 FN891(VSBAR), 9-29

FN56F\_T, 17-25 FN894, 9-31

FN56S\_T, 17-25 FN894(N\_RATCH, 9-29

FN600, 11-5 FN900, 21-17

FN605A, 11-5 FN900(VSBAR), 21-18

FN615, 19-15 FND\_TP\_DT\_A, 6-78

FN615(BP), 19-15 FNTP\_AIR\_OFF(N), 12-6

FN616, 17-16, 17-22 FPWQ2, 6-79 to 6-80

FN616(TP\_REL), 17-16 FPWQ3, 6-79 to 6-80

FN617, 17-29, 19-10 Frame, 13-5

FN618, 19-10 FRCHIC, 6-67

FN619, 19-10 FREQ18, 6-88, 6-98, 7-28

FN620, 17-15 FUEL\_A, 6-81, 6-86, 6-88 to 6-89

FN621, 19-10 FUEL\_FINISHED, 6-99

FN622, 17-15 FUEL\_PIPS, 6-88, 6-98

FN622A, 17-15 FUEL\_SUM\_TKS, 6-8, 6-98, 14-7

FN623, 19-10 FUEL\_SYNC, 6-68, 6-70, 6-96 to

FN624, 16-22 6-97

FN64\_NE, 17-25 FUELPW, 6-50, 6-71, 6-86, 6-98,

FN64B\_T, 17-25 6-100

FN64F\_T, 17-25 FUELPW CALCULATION

FN64S\_T, 17-25 UNDERSPEED MODE, 4-3

FN689D(TP\_REL), 16-14

FN689L, 18-48

FN689U(TP\_REL), 16-14 GEAR\_CUR, 3-5, 16-8, 16-13 to

FN689V, 29-40 16-14, 16-18, 16-23, 16-33,

FN690(INIT\_TOT), 20-66 16-36, 16-40, 16-42, 17-11,

FN703, 22-5, 22-12 17-13 to 17-14, 17-17 to

FN703(IACT), 22-6 17-18, 17-34, 17-38, 18-13,

FN703(IECT), 20-56 to 20-57, 18-16, 18-23 to 18-24, 18-32,

22-14 18-35, 19-25, 21-17

FN703D(ITOT), 20-57, 22-18 to GEAR\_OLD, 3-5, 16-8, 16-40, 17-34,

22-19 18-13, 18-16

FN730, 19-10 GEARCUR, 18-36

FN800, 9-2 GMAPDC, 10-3, 14-3

FN800(DEBYMA), 9-44 GOVHP, 3-3, 10-3, 14-3

FN820, 9-2 GR\_CM, 3-5, 16-22 to 16-23, 16-25,

FN820A(VACUUM), 9-44 16-27 to 16-28, 16-31 to

FN821A, 9-17, 9-20 16-32, 16-35 to 16-36, 17-30

FN825A, 9-17 to 9-18 to 17-31, 18-11, 18-16, 18-44

FN825A\_ALT, 9-18 to 18-45

FN825B, 9-17 GR\_CM\_LST, 3-5, 16-22 to 16-23

FN826A, 9-11, 9-17 GR\_DS, 3-5, 16-7 to 16-8, 16-12

FN839, 7-13 to 16-14, 16-17, 16-22, 16-28,

FN839(DASPOT), 7-14 18-11, 18-16

Index-9

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

GR\_DS\_LST, 3-5, 16-7 to 16-8, IDRPMH, 21-15

16-12, 16-17 IECT, 20-54, 20-56 to 20-57, 22-5,

GR\_DS\_TV, 16-8, 17-11, 17-13 to 22-12, 22-14, 29-13

17-15, 17-30 to 17-31, 17-37, IEGO, 20-54

17-39, 18-45 IEGR, 3-5, 22-16 to 22-17, 26-5,

GR\_NEU, 16-22 29-24 to 29-25, 29-27, 29-29

GR\_OLD, 3-5, 16-23, 16-31 to IETVOCM, 19-17

16-32, 18-44 IGN\_TYPE, 4-4, 4-6, 7-28 to 7-30,

GRMSFT, 16-22 7-35 to 7-36, 7-38, 7-51 to

GRRAT1, 16-35 to 16-36 7-52

GRRAT2, 16-35 to 16-36 IGNITION TIMING

GRRAT3, 16-35 to 16-36 UNDERSPEED MODE, 4-3

GRRAT4, 16-35 to 16-36 IIVPWR, 20-16

IMAP, 23-5

HARDWARE CALIBRATION SWITCHES, IMAP\_WORD, 20-41 to 20-42

3-2 IMS, 3-3, 8-4, 12-9

HCAMFG, 6-50, 6-57 to 6-58, 9-8, INDS, 20-13, 20-69 to 20-70

9-42 INFERRED BAROMETRIC PRESSURE

HCAMSW, 6-50, 6-57 to 6-58 BACKGROUND, 23-4

HFDLTA, 6-102, 6-104 to 6-105, BPPTWT CALCULATION, 23-8

7-32, 7-36 to 7-42, 7-46, BPPTWT LOGIC, 23-8

7-48 to 7-50 KEY ON UPDATE PROCEDURE, 23-5,

hfdlta, 7-35 23-7

HFPCYC, 7-36 to 7-39 LOGIC, 23-7

Hicam, 9-23 SUMMARY, 23-4

HICOMP, 6-67 INFORMATION SLOT, 13-5

HIMAPF, 21-12 ING\_TYPE, 7-29

HLDTIM, 6-16 INIT\_TOT, 4-4 to 4-5, 20-57

HLTMR, 6-16, 21-14 INITTOT, 20-56

HMUMAP, 21-14 INJ1\_PIP, 6-100

HMUMPH, 21-14 INJ2\_PIP, 6-100

HMUTMR, 12-9, 21-14 INJ\_BANK, 6-97, 6-99 to 6-100

HMUTMR\_FLG, 12-9, 21-14 INJ\_PIP\_CNT, 3-5, 6-96 to 6-99

HTPTMR, 12-8, 21-15 INJCNT, 6-96

HWRPM, 9-17 INJECTOR SYNCHRONIZATION, 4-3

HYS\_OTEMP, 17-47 INJOUT, 6-8, 6-81, 6-86, 14-7

HYST2, 5-3 IPDL, 3-5, 20-69 to 20-71

HYSTS, 5-3 IPDL\_LST, 20-69, 20-71

HYSTSPD, 20-59 to 20-60 IPSIBR, 9-3, 9-42, 9-51

HYSTST, 20-59 to 20-60 IPSIDLY, 9-49

ISC\_LATCH, 9-9

I4X4L, 19-21, 29-40 ISCDTY, 9-2, 9-8, 9-45, 9-49

I4X4L\_LST, 19-21 ISCFLG, 6-28, 6-50 to 6-51, 6-61,

IACT, 22-5 to 22-6, 28-18, 29-14 7-14, 7-17, 8-13, 9-8, 9-26,

IBETA, 6-68, 6-96, 6-100 9-28, 9-33, 9-35 to 9-36,

IBGPSI, 9-42 9-38 to 9-39, 9-42, 9-49,

ID SLOT, 13-5 9-51, 21-16, 29-56

IDCMUL, 9-2, 9-44 ISCKAM, 9-3, 9-42, 9-51, 21-16,

IDCOFS, 9-2, 9-44 28-44 to 28-45

IDLE SLOT, 13-5 ISCKAM0, 24-4

IDLFLG, 21-15, 21-17 ISCKAM1, 24-4

IDLRPM, 21-15 ISCKAM2, 24-4

IDLTMR, 6-16, 21-15 ISCKAM3, 24-4

IDM\_HIGH, 7-51 to 7-52 ISCKAM4, 24-4

IDM\_INT, 7-51 to 7-52 ISCKAM5, 24-4

Index-10

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

ISCKAMn, 24-3 KSF, 20-16

ISCLPD, 9-18 KSPARK, 7-16, 7-21 to 7-22, 28-45

ISCLPD\_ALT, 9-18 KSPKDO, 7-16, 7-21 to 7-22

ISCMOD, 3-5, 6-72 to 6-73, 6-86 KSPKDU, 7-16, 7-21 to 7-22

ISCMOD\_MAX, 6-71 to 6-73 KSPKNO, 7-16, 7-21 to 7-22

ISCMOD\_MIN, 6-72 to 6-73 KSPKNU, 7-16, 7-21 to 7-22

ISCMOD\_RPM, 6-72 to 6-73 KTS, 7-56

ISCTM, 9-36 to 9-37, 9-39, 21-16 KULMT, 7-36, 7-39

ISCTMR, 9-35 to 9-36, 9-38 to KVEFF, 20-51

9-39, 9-42, 21-16 KWUCNT, 6-52

ISF, 20-39 to 20-40 KWUCTR, 6-52, 24-3, 24-5

ISF\_UP\_FLG, 20-32, 20-38 to 20-39

ISFLAG, 6-36, 6-39, 6-50, 6-57 to LAM\_OLD, 3-5, 6-17 to 6-18, 6-72

6-58, 9-51 LAMAVE, 3-5, 6-16 to 6-18, 6-28,

ISKSUM, 9-42, 9-51, 24-3 to 24-4 6-72

ISLAST, 6-36, 6-39, 9-51 LAMBSE, 3-5, 6-17 to 6-18, 6-26

ISLBND, 28-35 to 6-27, 6-29 to 6-30, 6-36

ISUBND, 28-14 to 6-40, 6-52, 6-81, 6-85 to

ITCS, 19-19, 28-25 6-86, 11-6, 19-10, 28-10,

ITHBMA, 9-44 to 9-45 29-65

ITOT, 20-57, 22-18 to 22-19 LAMBSE(N), 6-37

ITP, 22-20, 22-22, 27-33, 28-46, LAMBSE(O), 6-37

29-38 LAMBSE1, 19-11

IVCAL, 19-17, 20-16 LAMDLT, 6-16

LAMDLT\_OL, 6-28

JMPFLG, 6-36 LAMMAX, 6-39, 29-65

JMPMUL, 6-36 LAMMIN, 6-39, 29-65

JUMP, 6-38 LAMMUL, 3-5, 6-13, 6-27

LAMRHYS, 6-16, 21-14

KACRAT, 7-63 to 7-64 LAMRICH, 6-16, 6-28, 21-14

KAM, 23-2, 23-4 to 23-5, 23-7 LAMWIN, 6-52

KAM\_ERROR, 9-42, 9-51, 24-3 LAST\_HI\_PIP, 7-46, 7-49 to 7-50,

KAMOK, 23-2, 23-7 20-33, 20-39, 20-45, 20-47

KAMQA, 24-2 to 24-3 LAST\_MAP, 20-33, 20-39, 20-43,

KAMQB, 24-2 to 24-3 23-7

KAMQC, 24-2 to 24-3 LAST\_MAP2, 20-33, 20-39, 20-43,

KAMREF, 6-57 to 6-58, 6-81, 6-85 23-7

to 6-86, 28-10, 29-62 LEGOFG, 11-6

KAMRF, 11-6 LEGONOTPURG, 29-59, 29-63, 29-65

KAYCTR, 7-36 to 7-39 LEQV, 28-28

KDNDT, 6-72 to 6-73 LESFLG, 6-16, 6-27, 11-6, 12-8,

KFT, 6-61, 6-64 21-21, 24-3, 29-59, 29-61

KFTMPG, 6-61, 6-64 LESTM, 21-21

KI, 7-56 LIMIT\_PURGE, 6-52, 11-6 to 11-7

KIHP, 7-58, 7-62, 28-38 to 28-39 LINK MASTER, 13-5

KLLIM, 7-36, 7-39 LINK SWITCH, 13-5

KNK\_HIGH, 7-62 LINK\_SW, 14-7

KNKCYL, 7-65 Link\_sw, 13-5

KNOCK, 7-56 LMAP, 6-16

KNOCK\_DETECTED, 7-60, 7-62 LMBMAP, 21-16

KNOCK\_ENABLED, 7-65, 28-10 LMBTMR, 12-8 to 12-9, 21-16

KNOCK\_INTERRUPT, 7-62 LOACT, 3-5

KNOCK\_OCCURRED, 7-62, 7-65 LOAD, 9-2, 19-10

KPEI, 8-11 LODNOK, 7-58

KS1, 7-13 LOGIC

Index-11

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

CHKAIR, 3-3 MAPBK3, 20-41

CRANK STRATEGY MAPBK4, 20-41

PIP & ECT COUNTER, 4-6 MAPBK5, 20-41

CRANK/UNDERSPEED/RUN MODE MAPCNT, 20-38 to 20-39

SELECT, 4-5 MAPEDG, 20-38

CRANK/UNDERSPEED/RUN SELECT, MAPFMM, 20-43

4-5 MAPLO, 21-17 to 21-18

REFLG, 4-6 MAPLOH, 21-17

LOMAPF, 21-12 MAPOFL, 20-32, 20-39

LOMAPH, 6-16 MAPOPE, 6-50

LONG\_DT12SA, 20-32, 20-38 MAPPA, 6-26 to 6-27, 6-29, 7-58,

LONG\_ISF, 20-38, 20-40 10-3, 21-12, 21-14, 21-17 to

LONG\_ISF\_UP\_FLG, 20-32, 20-38, 21-18, 29-56, 29-63

20-40 MAPTMR, 20-43, 29-16

LONG\_MAP\_AVE, 20-40 MAPUP\_NORM, 20-42 to 20-43

LONG\_MAP\_AVG, 20-32, 20-38, 20-44 MAPWBAR, 20-42, 20-51

LONG\_MAP\_FST, 20-38 MAPWBG, 6-89, 20-51

LONG\_MAP\_RQD, 20-44 MAX\_SCAP\_EDGES, 20-39

LONG\_MAPCNT, 20-38, 20-40 MAXADP, 6-53, 29-62

LOPCT1, 6-51 to 6-53 MAXAET, 20-22

LOPCT2, 6-51 to 6-53 MAXTIM, 21-20

LOWVOL, 21-22 MAXTTM, 20-22

LSTA3C, 21-9 MBTEGR, 19-10

LSTCOL, 6-51 MDELTA, 29-16

LSTROW, 6-51 MEFTRA, 6-61, 6-65

LTMTBL, 6-57 MEFTRD, 6-61, 6-65

LTMTBLrc, 6-53, 6-58, 24-3 MESSAGE

LUDLY, 18-12 SYNC, 13-5

LUTIMR, 21-16 Message, 13-5

MFAMUL, 6-9 to 6-11, 6-26

MAN1HI, 20-70 MFARMP, 6-9, 6-11

MAN1LO, 20-70 MFMFLG, 6-51, 6-79 to 6-80, 6-89,

MAP, 3-5, 6-16, 6-37, 6-79, 6-85, 8-4, 8-13, 9-8, 10-3, 12-8,

7-64, 8-4, 9-34 to 9-35, 9-39, 14-3, 17-13, 19-6, 20-42 to

20-9 to 20-10, 20-16, 20-24, 20-43, 21-17, 23-2, 23-8,

20-42 to 20-43, 20-54, 21-16 28-9, 29-56

to 21-18, 22-4, 22-20, 23-2, MHPFD, 6-102, 6-104 to 6-105

23-4 to 23-5, 23-7 to 23-8, MINACT, 9-19

29-28 MINADP, 6-53, 11-6

MAP\_CYCLE, 20-38 MINDLA, 7-32

MAP\_ERR\_SW, 19-6 mindla, 7-35

MAP\_FREQ, 3-5, 20-38 to 20-39, MINDLB, 7-32

20-41 MINMPH, 7-17, 9-33, 9-36 to 9-38,

MAP\_PIPCNT, 20-32, 20-38 26-5 to 26-6

MAP\_WORD, 3-5, 6-98, 20-42 to MINPW, 6-50, 6-86, 6-98

20-43 MKAY, 3-5, 6-104 to 6-105, 7-36

MAP\_WOT\_EGRC, 8-4 to 7-37, 7-39 to 7-40, 7-42,

MAP\_WOT\_EGRS, 8-4 7-46, 7-48

MAPAEF, 20-10, 20-21 to 20-22, mkay', 7-39

20-54 MLPS\_2, 20-71

MAPAHI, 21-17 to 21-18 MLPS\_2HI, 20-70

MAPBAR, 3-5, 20-9, 20-54, 23-2, MLPS\_2LO, 20-70

23-5, 23-7 to 23-8 MODE SET UP LOGIC, 28-45

MAPBK1, 20-41 MODULE\_ID, 13-36

MAPBK2, 20-41 MPAHIH, 21-17

Index-12

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

MPG\_CL\_SW, 6-16, 6-26 NE23A, 16-13

MPGCL, 21-17 NE23S, 16-13

MPGCTH, 21-17 NE34A, 16-13

MPGDEC, 6-26 NE34S, 16-13

MPGFLG, 6-9, 6-11, 6-16, 6-26, NE\_OTEMP\_MAX, 17-13

6-61, 6-64, 7-13, 8-11, 12-8, NE\_OTEMP\_MIN, 17-13

21-17 to 21-18, 29-56 NE\_STRT\_SFT, 17-29, 17-34

MPGGR, 21-17 NEBART, 16-13 to 16-14, 16-36,

MPGLSW, 20-18 16-40, 16-42, 17-9, 17-13,

MPGNOV, 21-17 to 21-18 17-23, 17-29, 18-11, 18-35 to

MPGRPH, 21-17 18-36, 18-48, 19-15 to 19-16,

MPGRPM, 21-17 to 21-18 19-25, 20-54, 29-40

MPGTFG, 6-16, 6-26, 6-30, 21-18, NELK\_FM, 18-48

29-56 NELKWH, 18-35 to 18-36

MPGTMR, 21-17 to 21-18 NELKWO, 18-35 to 18-36

MPHCNT, 20-25 NELUMN, 18-11

MPHTIM1, 20-25 NETVMN, 17-23

MPHTIM2, 20-25 NETVMX, 17-23

MPMNBP, 21-17 to 21-18 NEU\_RES\_TMR, 17-8 to 17-9

MPNBPH, 21-17 NEUFLG, 6-13

MPNOVH, 21-17 NEUHI, 20-70

MTEISF, 6-61, 6-63, 6-65 NEULO, 20-70

MUINT, 17-32 NEUTIM, 17-8

MULTM, 6-13 NEV\_STRT\_SFT, 16-40, 16-42

MULTMR, 3-5, 6-13, 21-19 new average, 20-52

MUPET\_FLAG, 20-10, 20-43 new value, 20-52

MUSLP, 17-32 NEW\_BETA, 7-46, 7-48

NEW\_DELAY, 6-68 to 6-69, 6-99

N, 4-4 to 4-6, 6-16, 6-26 to 6-27, NEW\_DWLIDM, 7-28 to 7-30, 7-52

6-30, 6-37, 6-50, 6-78 to NEW\_IDM, 7-52

6-79, 6-81, 6-86 to 6-87, NEW\_PIP, 21-21

6-96, 7-58, 7-60, 9-10, 9-26, NEW\_RPM, 20-45 to 20-47

9-28, 9-35, 9-38 to 9-39, NEWSA, 7-12, 7-20

11-5, 12-6, 17-8, 19-10, NEXT\_SPOUT\_ADVANCED, 7-46 to 7-50

19-14, 20-10, 20-18 to 20-19, NEXT\_SPOUT\_BETA, 7-46 to 7-48,

20-45 to 20-48, 20-51, 20-54, 7-50

21-15 to 21-16, 29-63 NGOOSE, 28-35

N\_BYTE, 6-71, 6-73, 7-12, 7-64, Nibble, 13-5

19-10, 20-46 to 20-47, 21-15, NLAST, 9-35 to 9-36, 9-38 to 9-39,

21-17 to 21-18 21-16

N\_PREV, 20-45 to 20-47 NLMT, 6-87, 11-5

N\_RATCH, 9-8, 9-10, 9-28, 9-31 NLMTH, 6-87

N\_RATCH LOGIC, 9-10 255\_NO\_OF\_STARTS, 15-3

NACTMR, 6-79, 8-4, 11-5, 21-19, NO\_OF\_STARTS, 13-37, 15-3, 15-5

21-22 NO\_START, 8-17, 8-19, 26-4, 29-6,

NBAR, 6-8, 20-10, 20-46 to 20-47, 29-44, 29-55

20-54, 28-14, 28-35, 28-46 NO\_START\_CHK, 13-37, 15-3, 15-5

NCNT, 4-4 to 4-5 NO\_SYNC, 6-96 to 6-98

NDDELT, 20-7 NOBART, 16-36, 18-24, 18-26,

NDDTIM, 20-7, 21-19 18-28, 18-37 to 18-38, 19-15

NDIF, 9-36 to 9-37, 9-39, 21-16 NOISE, 7-56

NDSFLG, 6-80, 9-10, 20-7, 20-13, NORM\_MAPOPE21, 20-51

26-5 to 26-6, 29-40 NORM\_N070, 20-51

NE12A, 16-13 NOV\_ACT, 3-5, 18-41, 19-25 to

NE12S, 16-13 19-26

Index-13

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

NOV\_ACT\_LST, 3-5, 19-25 to 19-26 OLITD1, 6-16

NOV\_ERR\_BAND, 18-41 OLITD3, 21-15

NOVCNT, 19-26 OLMCL, 6-27

NOVCTR, 19-26, 24-3 OPCLT1, 6-9

NOVDIF, 19-26 OPCLT2, 6-10 to 6-11

NOVS, 6-79, 20-18, 21-17 to 21-18 OPCLT3, 6-10 to 6-11

NRUN, 4-4 to 4-6, 17-8 OPCTL1, 6-11

NSTALL, 4-4 to 4-5 OPEN\_TMR, 6-16, 6-28

"NTIM", 20-22 to 20-23 OSCDLY, 7-14

NTIP, 7-64 OSCMOD, 7-13 to 7-14

NUBASE, 7-17, 9-11, 9-17, 9-23 OSCTMR, 7-14, 21-19

NUBASE\_ALT, 7-17, 9-17 OTEMP\_ERR\_SW, 19-6

NUMEGO, 22-11 OTEMP\_FM\_FLG, 17-13, 17-47, 19-6

NUMOUT, 6-8, 6-81, 6-86, 6-88, "OTIM", 20-22 to 20-23

6-98, 6-100 to 6-101 OTMP\_EPC\_FLG, 17-13

NVBASE, 18-41, 19-15 to 19-16, OUTINJ, 6-88, 6-92, 6-99, 6-101

19-26 OUTTMR, 27-33, 28-46

O, 6-37

O\_8500\_SW, 21-17 PACLIM, 7-32

OCCCCC, 27-25 paclim, 7-34

OCCCCS, 27-25 PACOFF, 7-28 to 7-29

OCCDT1, 27-25 PACPER, 7-28 to 7-29

OCCDT2, 27-25 PACSLO, 7-32

OCCDT4, 27-25 pacslo, 7-34

OCCDT5, 27-25 PARK\_ERR, 20-70 to 20-71

OCCDT7, 27-25, 29-70 PARKHI, 20-70

OCCSS1, 27-25 PARKLO, 20-70

OCCSS2, 27-25 PDL, 3-5, 16-7 to 16-8, 16-13 to

OCCTCIL, 27-25 16-14, 16-18, 16-22, 16-35,

OCS\_OPEN, 28-10 17-8 to 17-9, 17-11 to 17-13,

OCS\_SHORT, 28-10 17-24, 18-10 to 18-11, 18-35

ODHI, 20-70 to 18-36, 18-44 to 18-45,

ODLO, 20-70 20-13, 20-69, 20-71

OFM\_MUL, 20-66 PDL\_ERR\_SW, 19-6

OFMFLG, 6-16, 6-87, 11-5, 12-8, PDL\_ERROR, 16-40, 17-13, 19-6,

17-43, 18-12, 18-14, 19-6, 19-25, 20-70 to 20-71

20-65 to 20-66 PDL\_LST, 3-5, 16-7 to 16-8, 16-25,

OFSET1, 20-41 16-27, 17-8 to 17-9, 18-44,

OFSET2, 20-41 20-69

OFSET3, 20-41 PDLTIM, 20-71

OFSET4, 20-41 PEXH, 20-15

OFSET5, 20-41 PFEHP, 3-3, 8-2, 8-4, 22-16,

OFSET6, 20-41 29-32

OI\_A4LD, 20-18 PHFDLT, 6-102, 6-104 to 6-105,

old average, 20-52 7-40 to 7-42

OLD\_BETA, 7-43 to 7-44 PIP, 6-68, 7-38, 7-49 to 7-50,

OLD\_TP\_DFSO, 6-78 7-56, 23-2

OLDTP, 20-21 to 20-23 COUNTER LOGIC, 4-6

OLFLG, 3-5, 6-17 to 6-18, 6-26 to PIP\_DOUBLE, 7-43 to 7-46, 7-48 to

6-27, 6-29, 6-36, 11-5, 12-8 7-50

to 12-9, 19-10 to 19-11, PIPACL, 7-32 to 7-33

21-17, 28-44 pipacl, 7-34

OLIDRV, 6-30 PIPCNT, 4-4 to 4-6

OLINEUT, 6-30 PIPNUM, 6-26, 6-91, 29-56

Index-14

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

PIPOUT, 6-69, 6-81, 6-86, 6-88, REFLG, 4-5 to 4-6, 9-9, 20-46 to

6-98, 6-101 20-48

POFFENG, 7-29, 7-32 LOGIC, 4-6

poffeng, 7-34 REQFLG, 27-33

POWER\_UP, 29-6 REQV, 28-28

POWOFF, 28-10, 28-23 REV2NEU\_FLG, 17-8 to 17-10

POWON, 28-10, 28-23 REV\_ENG\_ADD, 17-24

POWSFG, 9-19, 9-21 to 9-23, 28-23 REVHI, 20-70

PPCTR, 3-5, 6-26, 6-91, 29-56 REVLO, 20-70

PPERENG, 7-29, 7-32 RF, 6-37 to 6-38

ppereng, 7-34 RLKCTR, 3-5, 18-35 to 18-36

PREV\_N\_PIP, 20-46 to 20-47 RMSPRU, 29-70

PRG\_DEC, 11-6, 29-58 ROLAV, 20-47, 26-5

PRGTMR, 11-5, 11-7 ROLAV(DNDTI,TCNDT\_ISC), 20-47

PRNDLY, 18-12 ROLAV(DNDTI,TCNDT\_SPK), 20-47

PSGDLT, 7-36 to 7-39 ROLAV(RPMERR, TCFBS), 7-21

PSIBRM, 9-42, 9-51 ROM IDENTIFICATION CODE, 31-2

PSIBRN, 9-42, 9-46, 9-51 PROCEDURES, 31-2

PSPPM, 9-12 ROWTBU, 6-50

PSPSHP, 3-3, 9-19, 9-21 to 9-23, RPMCNL, 7-60

28-23 RPMCTL, 9-34, 9-36 to 9-38

PTPAMP, 6-37, 6-52 RPMDED, 9-42, 21-16

PTPCNT, 23-9 RPMERR, 7-22, 9-26, 20-54

PTPFLG, 23-2, 23-7 RPMERR\_A, 9-26, 9-42, 9-49 to

PTSCR, 5-3 to 5-4, 7-14, 9-20 9-50, 20-54, 21-16

PUL\_PER\_GAL, 14-7 RPMERR\_S, 7-2, 7-16, 7-21 to 7-22,

PUL\_PER\_REV, 18-24, 18-26, 18-28, 9-26, 20-54

18-37 to 18-38 RPMIN, 7-58

PUMP, 3-5, 6-90 RT4X4L, 19-25 to 19-26

PURECT, 11-5 RT\_GR\_CUR, 3-5, 16-23, 16-33,

PURECT1, 11-6 16-35 to 16-36, 17-34, 18-24,

PURG\_ADP\_SF, 11-6 18-26, 18-28, 18-37 to 18-38,

PURGDC, 6-52, 11-5 to 11-7, 28-10, 19-15 to 19-16, 19-25

29-58 RT\_GR\_OLD, 3-5, 16-23, 17-34

PURGING, 11-5, 11-7 RT\_LK\_PWR, 18-23 to 18-24, 18-26,

PURGSW, 11-5, 29-59 18-28

PUTMR, 20-56 to 20-57, 21-19, RT\_NOVS, 3-5, 16-13, 17-17, 19-14,

23-3, 23-7, 23-9, 26-4, 26-6 19-16, 19-26

to 26-7, 29-44, 29-55 RT\_NOVS\_KAM, 6-87, 18-41, 19-26,

PWCF, 6-86, 6-88 to 6-89 24-3

RT\_ULK\_PWR, 18-23 to 18-24, 18-26

R, 6-38 RTLKWH, 18-36

RACHIV, 20-19, 22-22 RTLKWO, 18-36

RAM/CART, 13-5 RTNVMN, 19-26, 24-3

RAM\_INIT, 26-4 RTNVMX, 19-26, 24-3

RAMPSW, 21-14 RTSTAL, 17-12

RANMUL, 6-50 RUN MODE, 29-6

RANNUM, 3-5, 6-50 RUNNING, 6-80, 6-98, 20-19, 26-5

RATCH, 3-5, 5-2 to 5-3, 6-71, 9-8, to 26-6, 29-44, 29-55

9-28, 19-14, 20-17, 20-19, RUNUP\_DIFF, 9-26

20-59, 22-20 to 22-22, 23-3 RUNUP\_DIFF\_A, 9-26

RATIV, 5-2 RUNUP\_FLG, 4-5, 6-71, 6-73, 7-20,

REFFLG, 6-36, 6-50 to 6-51, 6-57 9-8 to 9-9, 9-26

to 6-58, 6-61, 6-71 to 6-73, RUNUPTMR, 4-4, 9-49

6-89

Index-15

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

RVIPRPM, 9-23, 28-10, 28-35, SELF TEST CODES>543, 29-69

28-44 SELF TEST CODES>556, 29-69

SELF TEST CODES>81, 29-20 to

S\_VAL\_NESUB, 16-42 29-21

S\_VAL\_TPADD, 16-41 SELF TEST FLAGS>171, 29-61 to

S\_VAL\_TPSUB, 16-41 29-63

S\_VAL\_VSADD, 16-41 SELF TEST FLAGS>172, 29-61 to

S\_VAL\_VSSUB, 16-41 29-63

SA10FG, 7-12 SELF TEST FLAGS>173, 29-61 to

SAF, 3-6, 7-12, 7-18, 7-20, 7-23 29-63

to 7-24, 28-10 SELF TEST FLAGS>174, 29-63

SAFTOT, 7-24, 19-10 SELF TEST FLAGS>194, 29-63

SARCHG, 19-10 SETLNG\_TM, 9-36, 9-38

SBDS, 13-4, 13-7 SETTMR, 9-35, 9-38 to 9-39, 21-20

SBDS\_CHKSUM, 13-36 SFT\_ERR\_SW, 19-6

SCINT1, 17-31 SFT\_ERROR, 16-43, 19-25

SCINT2, 17-31 SFT\_FM\_FLG, 16-43, 17-13, 19-6

SCINT3, 17-31 SFT\_FM\_LVL, 16-43

SCINT4, 17-31 SFT\_STEADY, 16-41

SCSLP1, 17-31 SFT\_TOTAL, 16-40

SCSLP1SD, 17-31 SHFDLT, 21-19

SCSLP2, 17-31 SHFTMR, 21-20

SCSLP2SD, 17-31 SIGDLT, 7-36 to 7-39

SCSLP2SU, 17-31 SIGKAL, 6-104 to 6-105, 7-36 to

SCSLP3, 17-31 7-39

SCSLP3SD, 17-31 sigkal', 7-38

SCSLP3SU, 17-31 SIGKLL, 7-36, 7-38

SCSLP4, 17-31 SIGKLU, 7-36, 7-38

SCSLP4SU, 17-31 SIGPIP, 6-104 to 6-105, 7-37 to

Self Test CODE>334, 29-27 7-39

SELF TEST CODES SKSSLC, 7-38

128, 28-9 SLOPE1, 20-41

411, 28-35 SLOPE2, 20-41

412, 28-14 SLOPE3, 20-41

521, 28-23 SLOPE4, 20-41

536, 28-21 SLOPE5, 20-41

998, 28-9 SLOPE6, 20-41

SELF TEST CODES>112, 29-14 Slot, 13-5

SELF TEST CODES>113, 29-14 SLOTS

SELF TEST CODES>117, 29-13 DIAGNOSTIC PARAMETERS, 13-5

SELF TEST CODES>118, 29-13 ID, 13-5

SELF TEST CODES>122, 29-38 IDLE, 13-5

SELF TEST CODES>123, 29-38 INFORMATION, 13-5

SELF TEST CODES>126, 29-16 SMTPDL, 20-21

SELF TEST CODES>128, 29-20 to SPD\_PM, 20-59 to 20-60

29-21 SPD\_RATIO, 17-12, 17-29, 18-32,

SELF TEST CODES>327, 29-24 to 18-48, 19-10, 20-59 to 20-60

29-25 SPD\_RT\_STRT, 16-36, 18-23 to

SELF TEST CODES>328, 29-24 to 18-24

29-25 SPDRATIO, 18-36

SELF TEST CODES>332, 29-29 SPK\_DELTA, 19-10

SELF TEST CODES>337, 29-24 to SPK\_ENTRY, 7-20 to 7-21

29-25 SPK\_EXIT, 7-20, 7-23

SELF TEST CODES>536, 29-45 SPK\_FBS, 7-20, 7-22, 28-45

SELF TEST CODES>542, 29-69

Index-16

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

SPK\_IDLE, 7-15, 7-17, 7-21 to CCC\_VALID\_COM2, 18-41

7-22, 20-54, 28-45 DCL\_UART\_COM1, 13-35

SPK\_LAMBSE, 19-10 to 19-11 DOL\_PULSE\_CALC\_COM3, 14-7

SPK\_NORM, 7-13 to 7-14, 7-18, EGR\_ENABLE\_LH, 8-4

7-20, 7-23 EGR\_SONIC\_COM2, 8-11

SPK\_RAMP, 7-17, 7-20 to 7-21, EPC\_ENGMT\_STALL\_COM1, 17-22

20-54 EPC\_GUIDE\_COM1, 17-8

SPK\_RUNUP, 7-20 EPC\_NORM\_COM7, 17-29

SPK\_STATE, 7-20 EPC\_OFM\_COM2, 17-42

SPKAD(n), 7-24 EPC\_OTEMP\_TEST\_COM2, 17-47

SPKCTL, 7-17 EPC\_TQ\_IALPHA\_COM4, 17-34

SPKCTL\_ALT, 7-17 EQCOLDTV\_LH, 20-64

SPKIDR, 7-15, 7-21 to 7-22 EQUAL\_LH, 20-7

SPKIDR\_ALT, 7-15 FUEL\_ADAPT\_COM4, 6-50

SPKINU, 7-15, 7-21 to 7-22 FUEL\_AE\_COM5, 6-8

SPKINU\_ALT, 7-15 FUEL\_BG\_PW\_DET\_COM5, 6-85

SPKLIM, 7-33, 7-47 to 7-48 FUEL\_CL\_LAMBSE\_COM3, 6-36

spklim, 7-34 FUEL\_DFSO\_COM2, 6-78

SPKTMR, 7-15, 7-20 to 7-21 FUEL\_INJ\_OUT\_COM6, 6-96

SPLCLP, 7-24 FUEL\_LAMMUL\_COM3, 6-13

SPOUT, 4-6, 7-40 to 7-41 FUEL\_OL\_LAMBSE\_COM3, 6-26

SPOUT\_CALCULATION, 7-44 to 7-45 INTRN\_MLPS\_CONV\_COM1, 20-69

SPOUT\_HIGH\_EDGE, 7-44, 7-46 to INTRN\_RT\_NOVS\_KAM\_CALC\_COM1,

7-47, 7-49 to 7-50 19-25

SPOUT\_ICCD\_DELTA, 7-46 to 7-49 INTRN\_TCIL\_REPEAT\_COM1, 19-7

SPOUT\_LOW\_DELTA, 7-33, 7-46, 7-49 INTRN\_TCIL\_STATE\_COM1, 19-5

to 7-50 INTRN\_TCS\_COM1, 19-19

spout\_low\_delta, 7-35 ISC\_DSDRPM\_COM1, 9-17

SPOUT\_LOW\_EDGE, 7-46 to 7-47, ISC\_IPSIBR\_COM1, 9-49

7-49 to 7-52 ISC\_RPMERR\_COM3, 9-26

SPUCLP, 7-24 SC\_CM\_GR\_DETR\_COM1, 16-22

SR\_PP\_LIM, 18-24, 18-26, 18-28, SPARK\_BASE\_COM2, 7-12

18-37 to 18-38 SPKKNOCK\_LL, 7-56

SRLK, 18-23 to 18-24 THERM\_LH, 12-6

SRLK2, 18-24, 18-32 TIMER\_LH, 21-9

SRLK3, 18-23 to 18-24, 18-32 VO\_4X4L\_SWITCH\_COM2, 27-22

SRLK4, 18-23, 18-32 VO\_ACCS\_COM2, 27-19

SRLK\_FM, 18-48 VO\_ACT\_COM1, 27-14

SSFCTR, 7-36, 7-39 VO\_BLOCKDIAG\_COM1, 25-3

SSMAP, 23-3, 23-8 VO\_ECT\_COM1, 27-9

STALLN, 4-4, 4-6, 6-96, 20-45, VO\_EGR\_COM5, 27-18

20-48 VO\_EOTS\_COM1, 27-2

STALLTV\_SW, 17-22 VO\_EPC\_SOLENOID\_COM1, 27-31

STI\_RESET, 26-5, 28-8, 28-44 VO\_I\_EXEC\_COM2, 26-4

STIFLG, 19-5 to 19-6, 26-4 to VO\_IVPWR\_COM1, 27-24

26-7, 28-44 to 28-45, 29-6 VO\_KAMRAM\_COM1, 27-5

STO, 28-46 VO\_MAP\_COM2, 27-12

STO\_TRIGGER, 26-4, 29-6 VO\_MLPS\_INPUT\_COM1, 27-21

STO\_WORKING, 26-4, 29-6 VO\_OCC\_COM12, 27-25

STRATEGY MODULES VO\_OCCTS\_COM4, 27-26

ALTR\_CAL\_CLR\_COM1, 15-5 VO\_OTM\_LH\_COM1, 27-33

ALTR\_CAL\_INIT\_COM1, 15-3 VO\_PSPS\_COM1, 27-23

CCC\_COM1, 18-5 VO\_ROM\_COM1, 27-7

CCC\_FMEM\_COM2, 18-48 VO\_TOT\_COM2, 27-17

CCC\_SCHLD\_LCK\_UNLCK\_COM1, 18-31 VO\_TP\_COM1, 27-13

Index-17

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

VR\_ACT\_COM1, 28-18 SW\_MLK, 18-5, 18-14

VR\_BOO\_COM1, 28-21 SW\_MPD, 12-8

VR\_DELAYLOGIC\_COM1, 28-5 SW\_MSF, 16-22

VR\_ECT\_COM1, 28-15 SW\_RLK, 18-31

VR\_EGO\_COM1, 28-28 SWITCHES

VR\_EGOBAR\_COM1, 28-4 LINK, 13-5

VR\_EGR\_COM6, 28-33 SWTFL, 6-9 to 6-10, 6-29, 6-50,

VR\_ERTS\_LH\_COM1, 28-2 29-65

VR\_GENISC\_COM1, 28-11 SYNC MESSAGE, 13-5

VR\_GOOSE\_SD\_COM1, 28-38 SYNCH\_VALUE, 6-96 to 6-97

VR\_HICAM\_ISC\_COM2, 28-14 SYNCTR, 3-6, 6-96 to 6-97, 6-104

VR\_LOW\_ISC\_COM4, 28-35 to 6-105

VR\_MAP\_COM1, 28-16 SYNFLG, 6-68, 6-96 to 6-97, 6-104

VR\_PSPS\_COM2, 28-23 to 6-105, 7-37 to 7-39

VR\_RUN\_INIT\_COM8, 28-8

VR\_SPARK\_COM1, 28-32 T70LSW, 6-16, 12-9

VR\_TCS\_COM4, 28-25 T75LSW, 12-8

VR\_THERMAIR\_COM2, 28-29 TABVAL, 20-58

VR\_TOT\_COM1, 28-19 TAPBAR, 20-16, 20-54

VR\_TPADJ\_MODE\_COM1, 28-44 TAPMAX, 22-20, 22-22, 27-13,

VR\_TPS\_COM1, 28-17 29-38

STRATEGY MODULES> TAPMIN, 22-20, 22-22, 27-13,

VC\_WARMUP\_KAM\_ERASE\_COM1, 29-38

29-6 TAQ1, 12-6, 12-8

STRATEGY MODULES>VC\_ACT\_COM1, TAR, 6-8, 7-23, 20-23, 20-54

29-14 TAR', 20-23, 20-54

STRATEGY MODULES>VC\_BOO\_COM1, TARFLG, 20-21 to 20-22

29-44 TARMAX, 7-23

STRATEGY MODULES>VC\_ECT\_COM1, TARTMR, 20-22, 21-20

29-13 TBART, 3-6, 20-54

STRATEGY TCAEMP, 20-10, 20-54

MODULES>VC\_EGO\_TEST\_COM13, TCAETP, 20-7, 20-54

29-55 TCBP, 20-54

STRATEGY TCBPA, 9-26, 20-54

MODULES>VC\_EGR\_SON\_SD\_COM10, TCDASD, 9-29 to 9-30, 20-54

29-24 TCDASU, 9-29 to 9-30, 20-54

STRATEGY MODULES>VC\_FAULT\_COM1, TCDESN, 20-54

29-4 TCDHMF, 16-32

STRATEGY MODULES>VC\_FILTER\_COM2, TCDLMF, 16-32

29-2 TCDLOP, 8-12, 20-54

STRATEGY TCDNAF, 16-31

MODULES>VC\_FUEL\_PUMP\_COM2, TCDNON, 16-31 to 16-32

29-69 TCEACT, 8-13, 20-54

STRATEGY MODULES>VC\_MAP\_COM1, TCECT, 20-54, 22-13 to 22-14

29-16 TCEGR, 20-8, 20-54

STRATEGY MODULES>VC\_MAPVAC\_COM1, TCF, 7-64

29-20 TCFBS, 7-2, 7-22, 9-26, 20-54

STRATEGY MODULES>VC\_SON\_SEL\_COM2, TCIL\_FLASH\_TMR, 19-5

29-32 TCIL\_STATE, 19-5, 19-7

STRATEGY MODULES>VC\_TPS\_COM1, TCIL\_TM\_DLY, 19-5

29-38 TCILTM1, 19-5

STRATEGY MODULES>VC\_VSS\_COM6, TCILTMR, 19-5 to 19-6

29-40 TCMAPW, 20-42

STTIM, 7-15, 7-21 TCMBAR, 20-9, 20-54

SW\_DYN, 17-37 TCN, 20-10, 20-54

Index-18

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

TCNDT\_ISC, 20-45, 20-54 TIPRET, 7-24, 7-65

TCNDT\_SPK, 20-45, 20-47, 20-54 TKYON1, 23-3, 23-5, 23-9

TCNE, 19-14, 20-54 TKYON2, 20-56 to 20-57, 23-3,

TCRAMP, 7-21, 20-54 23-5, 23-7

TCS\_OPEN, 28-25 TKYON3, 23-3, 23-5, 23-7

TCS\_SHORT, 28-25 TKYON4, 23-3, 23-7 to 23-8

TCSTRT, 4-5, 6-10 to 6-11, 6-52, TL0, 7-40

7-14, 8-5, 9-2, 9-8, 12-10, TL0FLG, 7-40 to 7-41

20-56 to 20-57, 29-6 TLOFLG, 7-42

TCTAR, 20-23, 20-54 TLS24D, 6-88

TCTOT, 22-18 to 22-19 TLS24X, 6-88

TCTP, 20-16, 20-54 TLS34D, 6-88

TCTPDL, 20-17, 20-54 TLS34S, 6-88

TCTPT, 20-54 TLS\_24\_FLG, 6-87 to 6-88, 6-100,

TCTPTC, 19-15, 20-54 19-10

TCTPTE, 19-15, 20-54 TLS\_34\_FLG, 6-87 to 6-88, 6-100,

TCTPTV, 19-15, 20-54 19-10

TCTTA, 19-10, 20-54 TLS\_NV\_FLG, 6-16, 6-87 to 6-88,

TCUPOF, 16-31 19-10

TCUPON, 16-31 TLS\_SHFTR, 6-100

TCUPON4L, 16-31 TLSCTR, 3-6, 6-100

TCVBAT, 20-16, 20-54 TLSNV, 6-88

TCVS, 20-26, 20-54 TLSPAT, 6-8, 6-88, 6-100

TCVSRPH, 20-27 to 20-28 TM12MN, 16-27

TCVST, 19-14, 20-54 TM46BLP, 17-9

TDSEC, 6-38 TM54BLP, 17-9

TE\_LK\_PWR, 18-23 to 18-24, 18-28 TM56BLP, 17-9

TE\_LK\_UP, 18-23 to 18-24, 18-28 TM64BLP, 17-9

TE\_ULK\_PWR, 18-23 to 18-24, 18-28 TM\_4X4L\_RES, 19-21

TE\_ULK\_UP, 18-23 to 18-24, 18-28 TM\_BLP\_TV, 17-9, 17-25

TEISF, 6-63 TM\_CRV\_UNLK, 18-33

TEMP\_VALUE, 7-48 TM\_CS\_DLY, 18-44 to 18-45

TEMPFB, 21-11 TM\_CS\_ENG, 18-44 to 18-45

TFCBITS, 6-61, 6-65 TM\_DEL\_DOWN, 16-17

TFCDED, 6-62, 6-65 TM\_DEL\_SFT, 16-8, 16-17 to 16-18,

TFCISW, 6-62 to 6-63 16-32, 17-12

TFCTM, 6-62 to 6-63 TM\_DEL\_TO\_UP, 16-18

TFMFLG, 6-51, 6-78, 6-80, 6-85, TM\_DEL\_UP, 16-18

8-4, 8-13, 9-8, 10-3, 12-8, TM\_ENG\_TV, 17-9 to 17-10, 17-25

14-3, 16-40, 17-13, 18-12, TM\_LK\_CONV, 19-25

18-14, 18-48, 19-6, 20-43, TM\_LK\_DLY, 18-12 to 18-14

20-59 to 20-60, 22-20 to TM\_NOV\_CALC, 19-25

22-23, 23-3, 23-8, 28-9, TM\_PDL\_RES, 20-71

29-20, 29-40, 29-56 TM\_SFT\_12MN, 16-27

TFRFSW, 6-62 TM\_SFT\_CCO, 16-28, 18-16 to 18-17,

THBP2, 5-3 18-19, 18-23, 18-28

THRMHP, 3-3 TM\_SFT\_IN, 16-7, 16-31 to 16-32,

TICKS\_DOUBLE, 7-47, 7-50 19-25

TICKS\_SINGLE, 7-47, 7-49 TM\_SS1\_GR2, 16-35 to 16-36

TIME\_OL, 6-16 TM\_TCS\_RES, 19-19

TIPFLG, 7-64 to 7-65 TM\_TV\_SS, 17-42 to 17-43

TIPHYS, 7-64 TM\_UN\_CT, 18-11, 18-14

TIPINC, 7-65 TM\_UNLK\_CONV, 16-25, 16-27, 19-25

TIPMAP, 7-64 TM\_VSRATE, 20-27 to 20-28

TIPMAX, 7-65 TMCSE2, 18-44

Index-19

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

TMCSE3, 18-44 TP, 5-3, 6-8, 6-78, 9-28, 17-30,

TMCSOD, 18-44 18-33, 19-14 to 19-15, 20-7,

TMCTDY, 18-14 20-16 to 20-17, 20-21 to

TMDNLK, 18-19 20-23, 20-54, 20-59, 22-3,

TMDRVREV, 17-9, 17-25 22-20 to 22-22, 23-3 to 23-4

TMLFN2, 18-24 TP\_AIR\_OFF\_F, 12-6, 12-8

TMLFN3, 18-23 TP\_AIR\_OFF\_H, 12-6

TMLFN4, 18-23 TP\_DECHOKE, 6-85

TMLFW2, 18-24 TP\_ERR\_SW, 19-6

TMLFW3, 18-24 TP\_HYS\_OL, 6-16

TMLFW4, 18-23 TP\_RATE, 16-18, 18-10, 18-27

TMLON2, 18-24 TP\_REL, 5-2, 6-16, 6-71, 6-73,

TMLON3, 18-23 6-85, 7-14, 8-5, 12-6, 14-3,

TMLOW2, 18-24 16-13 to 16-14, 16-22, 16-40

TMLOW3, 18-24 to 16-41, 17-16, 17-23, 17-29,

TMLOW4, 18-23 18-10, 18-23 to 18-24, 18-35,

TMNEUDRV, 17-9, 17-25 18-41, 18-48, 20-17, 20-59 to

TMNEUREV, 17-9 20-60, 23-3, 23-8, 29-56,

TMNVCAL, 19-25 29-66

TMNVLK, 19-25 TP\_REL\_H, 17-22, 17-37, 20-17

TMREVDRV, 17-9, 17-25 TP\_REL\_LST, 20-17

TMS1G2, 16-35 to 16-36 TP\_SH\_VALID, 16-40

TMTVRMP\_12, 17-39 TP\_STRT\_SFT, 17-37

TMTVRMP\_23, 17-39 TPBAR, 3-6, 20-16, 20-19, 20-54

TMTVRMP\_34, 17-39 TPBART, 3-6, 19-15, 20-54

TMUFN2, 18-24 TPBARTC, 3-6, 18-33, 19-15, 20-54

TMUFN3, 18-23 TPBARTV, 3-6, 17-30, 19-15, 20-54

TMUFN4, 18-23 TPDLBR, 7-14, 20-17, 20-54, 21-19

TMUFW2, 18-24 TPDLMX, 7-14

TMUFW3, 18-24 TPDLTA, 20-21 to 20-22

TMUFW4, 18-23 TPLKWH, 18-35 to 18-36

TMUON2, 18-24 TPLKWO, 18-35 to 18-36

TMUON3, 18-23 TPOBP2, 7-14

TMUON4, 18-23 TPOH2, 7-14

TMUOW2, 18-24 TPPLW, 7-40 to 7-41

TMUOW3, 18-24 TPREL, 18-36

TMUOW4, 18-23 TPTVMN, 17-23

TO\_TP\_RATE, 16-18 TPTVMX, 17-23

TOT, 17-14 to 17-15, 17-32, 17-38, TPUNBRK, 18-10

17-47, 20-62, 20-64, 20-66, TPUNCH, 18-10

22-18 to 22-19 TPUNCT, 18-10

TOT\_OTEMP, 17-47 TPUNSC, 18-33

TOTAL\_DELAY, 6-68 to 6-70, 6-96 TPUNTR, 18-10

TOTMAX, 20-56 to 20-57, 22-18 to TPV\_STRT\_SFT, 16-40 to 16-41

22-19, 27-17, 29-15 TQ\_IALPHA, 17-29, 17-34

TOTMIN, 20-56 to 20-57, 22-18 to TQ\_NET, 17-29, 19-10

22-19, 27-17, 29-15 TQ\_OFM, 6-87, 19-10

TOTTV1, 20-62 TQ\_STAT\_CAP, 17-29, 17-31 to

TOTTV2, 20-62 17-32

TOTTV3, 20-62 TQCONVINT, 17-32

TOTTV4, 20-64 TQCONVSLP, 17-32

TOTTV5, 17-38 TQIA12, 17-34

TQIA21, 17-34

TQIA23, 17-34

TQIA32, 17-34

Index-20

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

TQIA34, 17-34 TVPMIN, 17-15

TQIA43, 17-34 TVPMN1, 17-13

TQMAX1, 6-87 TVPMN2, 17-13

TQMAX2, 6-87 TVPMN3, 17-13

TQMAXH, 6-87 TVPMX1, 17-13

TR\_STRT\_SFT, 17-29 TVPMX2, 17-13

TRADLY, 18-12 TVPMX3, 17-13

TRANS\_T, 7-15, 7-17, 7-20 to 7-21 TVRPM\_12, 17-39

TRDDLY, 18-12 TVRPM\_23, 17-39

TRLOAD, 3-3, 6-13, 6-30, 6-80, TVRPM\_34, 17-39

9-10, 9-18 to 9-19, 9-21, TVRPMTM, 17-39

9-36, 9-38 to 9-39, 20-7,

20-13, 26-5 to 26-6 U12DLY, 18-13

TRSRPH, 7-40, 7-42 U23DLY, 18-13

TRSRPM, 7-40, 7-42 U34DLY, 18-13

TRUHAC, 18-10 UART, 13-4 to 13-5

TRUHDC, 18-10 UART\_State, 13-6

TRULAC, 18-10 UNDSP, 3-6, 4-5, 6-63, 6-86, 6-98,

TRULDC, 18-10 6-100, 6-104 to 6-105, 7-12,

TS0FLG, 7-40 7-28, 7-30, 17-42, 20-44,

TSFETMR, 17-8, 20-62, 20-66 21-12, 23-7 to 23-8, 26-6 to

TSLADV, 7-66 26-7, 29-20, 29-70

TSLAMU, 6-37 UNRPM, 4-4 to 4-5

TSLEGO, 6-36, 6-38, 21-21 UNRPMH, 4-4 to 4-5

TSLMPH, 3-6, 20-25 to 20-26 UNSP, 29-6

TSLPIP, 4-4, 4-6, 6-90, 9-8, UP\_TIP\_RATE, 18-27

20-45, 20-47, 21-21, 29-20 UPDATM, 9-42

TSLSFT, 17-37 UPDISC, 9-42

TSPKUP, 7-40 to 7-41 UPRATE, 6-53 to 6-54, 6-56

TSSTIL\_TMR, 26-6 to 26-7 UPSMAP, 12-9

TSTRAT, 3-3, 20-18, 20-69, 28-25 UPSTM1, 12-10

TV1CNTS\_TEST, 27-31 UPSTM2, 12-10

TV2CNTS\_TEST, 27-32 UPSTM3, 12-10

TV\_4L\_12, 17-38 UPSTM4, 12-10

TV\_4L\_21, 17-38 UPSTM5, 12-10

TV\_4L\_23, 17-38 UPSTM6, 12-10

TV\_4L\_32, 17-38 UPSWOT, 12-9

TV\_4L\_34, 17-38 UROLAV, 19-10, 19-14 to 19-15

TV\_4L\_43, 17-38 UROLAV(N,TCNE), 19-14

TV\_COUNT\_LST, 17-15 UROLAV(TP,TCTPTC), 19-15

TV\_COUNTS, 17-15, 17-42, 17-45 UROLAV(TP,TCTPTE), 19-15

TV\_DYN, 17-30, 17-37 to 17-38 UROLAV(TP,TCTPTV), 19-15

TV\_PRES, 17-12 to 17-15, 17-17 to UROLAV(VS,TCVST), 19-14

17-18, 17-30

TV\_RAMP, 17-39 V820A, 9-44 to 9-45

TV\_RAMP\_TMR, 17-39 V\_879\_MULT, 9-29, 9-32

TV\_SLT\_TM, 17-42 V\_BOO\_OLD, 29-45

TV\_ST\_SFT, 17-30 to 17-31 V\_BOO\_SPD, 29-46

TV\_STAT, 17-29 to 17-31 V\_BOOSPD\_TM, 29-45

TVASOF, 17-12 V\_BOOSPD\_TMR, 29-45 to 29-46

TVCDLT, 17-42 V\_BPMIN, 29-20

TVCHRG, 17-16 V\_CBOO\_ENA, 29-44

TVEMAX, 17-23 V\_CSTE\_SW, 29-8

TVEMOD, 17-23 V\_ECT\_DEL, 29-8, 29-11

TVFMMN, 17-13 V\_ECT\_LIM, 29-8, 29-11 to 29-12

Index-21

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

V\_ECT\_TIME, 29-8, 29-11 V\_LESTMR1, 29-58

V\_ECTCTMAX, 29-8, 29-11 to 29-12 V\_LESTMR2, 29-58

V\_ECTCTMIN, 29-8, 29-11 V\_MAPDIF, 29-20

V\_EEC\_PRG, 29-58, 29-66 V\_MAPFLG, 29-20

V\_EGO\_BYPS, 29-63 V\_MODE\_END, 28-46

V\_EGO\_EGR\_SW, 29-64 V\_MODE\_SETUP, 7-15 to 7-16, 9-51,

V\_EGO\_ENA, 29-55 20-19, 24-4, 28-8, 28-44

V\_EGOAEMAX, 29-56 V\_NACTMR\_CUM, 21-21

V\_EGOBUZ\_ERR, 29-63 V\_NHIGH, 28-46

V\_EGOBUZ\_MAP, 29-63 V\_NLOW, 28-46

V\_EGOBUZ\_N, 29-63 V\_PIPMAP\_LMT, 29-20

V\_EGOHP, 28-28 V\_PRG\_DLYTMR, 29-56

V\_EGOMAP\_MIN, 29-56 V\_PRGTOT, 29-58, 29-66

V\_EGORNTM, 29-56 V\_RPM\_SET, 28-44

V\_EGOSWNUM, 29-62 to 29-63 V\_RUNUP\_DIFF, 9-26

V\_EGOTP\_MIN, 29-56 V\_SETLNG\_TM, 9-36, 9-39

V\_EGOTST\_TM, 29-57 V\_SPDTOZ\_FLG, 29-45

V\_EGOTST\_TMR, 29-57 to 29-58 V\_SPK\_ENABL, 28-32

V\_EGR\_CTMR, 29-29 V\_SPK\_FINAL, 28-32

V\_EGR\_DLY, 29-64 V\_SPK\_INIT, 28-32

V\_EGR\_DLYFG, 29-64 V\_SPK\_RATE, 28-32

V\_EGR\_DLYTMR, 29-56 V\_STABLTIM, 29-8

V\_EGR\_OLD, 29-64 V\_SW\_PRK, 27-21

V\_EGR\_ON\_CR, 29-24 to 29-26, V\_TDSECAV\_AV, 29-63

29-28 to 29-29 V\_TIME\_LIM, 29-8

V\_EGR\_RDY, 29-24 V\_TPREL\_PRG, 29-66

V\_EGR\_STK\_ON, 29-24 to 29-26 V\_TSLEGO\_AV, 29-63

V\_ETV\_TEST, 27-31 V\_VACFLG, 20-42, 28-9, 29-21

V\_FPMDLY, 29-70 V\_VACPRGTMR, 29-58, 29-66

V\_FPMFLG, 29-70 V\_VSS\_MULT, 29-40

V\_FPMTM, 29-69 to 29-70 V\_ZTOSPD\_CNT, 29-45

V\_GOOS\_DELAY, 28-39 V\_ZTOSPD\_CTR, 29-45

V\_GOOSEC, 28-39 VACUUM, 9-44, 20-24

V\_GOOSMP, 28-39 VAIRFL, 28-29

V\_GOOSN, 28-39 VATMR2, 28-29

V\_GOOSPK, 28-38 VBAT, 3-6, 7-28 to 7-30, 17-42,

V\_GOOSTP, 28-39 20-16, 20-54, 21-22

V\_GOOSW, 28-38 VBAT', 20-16, 20-54

V\_HICKOKTM, 27-4 VBAT\_DWELL, 7-28, 7-30

V\_ISCMOD\_MAX, 6-72 to 6-73 VBAT\_DWL\_HYS, 7-28, 7-30

V\_ISCMOD\_MIN, 6-72 to 6-73 VBISW, 28-21

V\_ISDL2, 28-38 VCAL, 20-16

V\_KDNDT, 6-72 to 6-73 VCRTDC, 29-28

V\_KTS, 28-38 VDCMAX, 28-34

V\_LAMAV\_MAX, 29-51 VDCMIN, 28-34

V\_LAMAV\_MIN, 29-51 VDLY2, 28-30

V\_LAMJMP, 6-36, 29-65 VDLY8, 28-30, 28-32

V\_LANSDTM, 27-4 VECT3, 6-52, 29-6

V\_LEGO\_MAX, 29-62 to 29-63 VECT5, 6-52, 29-6

V\_LEGO\_MAX2, 29-63 VEGOFK, 28-4

V\_LEGOTMR, 29-62 to 29-63, 29-65 VEGRAT, 28-34

V\_LEGOTMR1, 29-58 VEGVAC, 29-28

V\_LEGOTMR2, 29-58 VEITMR, 29-27

V\_LESTM, 29-62 to 29-63 VETVDT, 27-32

V\_LESTMR, 29-62 to 29-63, 29-65 VEVPCL, 29-29

Index-22

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

VEVPDL, 28-34 VR\_LOW\_ISC, 28-35

VEVPHL, 27-18, 28-33, 29-27 VR\_OUT\_ENGCYL, 28-10

VEVPLL, 27-18, 28-33, 29-25 VR\_RUN\_INIT, 28-8

VFPMDLY, 27-29 VR\_SENSOR\_CHK, 28-14

VFPMFLG, 27-29 VREF, 20-69

VFS\_OUT\_FLG, 17-15, 26-4 VRLAM, 28-10, 28-30, 28-39

VIACT1, 27-14 VRLAM2, 28-38

VIACT2, 27-14 VRUN\_ISCFLG, 6-71, 6-73, 9-23,

VIACT3, 28-18 9-26, 9-28, 9-35, 9-39, 9-44

VIACT4, 28-18 to 9-45, 9-51, 28-10

VIDMST, 29-35 VS, 16-13 to 16-14, 19-14, 20-25

VIDMTM, 29-35 to 20-26, 20-54

VIP\_CNT\_EX, 28-10, 28-14, 28-35, VS21PI, 16-25

28-44 to 28-46 VS\_ERR\_SW, 19-6

VIP\_ENABLE, 26-4 to 26-7, 29-41 VS\_NEU, 16-22

VIP\_FP\_OVERRIDE, 26-4 VS\_RATEPH, 16-13, 20-27 to 20-28

VIP\_KAM, 24-3, 27-4 VS\_SH\_VAL2, 16-40

VIP\_KNOCK, 7-62 VS\_SH\_VAL3, 16-40

VIP\_REINIT, 28-44 VS\_SH\_VAL4, 16-40

VIP\_TIMER\_EX, 28-10, 28-14, 28-35, VSBAR, 6-79, 6-87, 7-14, 7-17,

28-44, 28-46, 29-26 to 29-27, 9-10, 9-28, 9-35, 9-38, 15-5,

29-29 20-18, 20-26, 20-54, 21-17 to

VIPLR1, 28-28 21-18, 26-5 to 26-6, 29-40 to

VIPRR1, 28-28 to 28-29 29-41, 29-45 to 29-46

VIPSPK, 28-10, 28-32, 28-39 VSBART, 17-18, 19-14, 19-25,

VIPTM2, 28-29 20-54

VIPTM3, 28-28 VSBART\_FM, 6-87, 19-16

VIPTM4, 28-28 VSBART\_RT, 16-13 to 16-14, 16-22,

VISCN, 28-10 16-25, 16-32, 16-40 to 16-41,

VISDL1, 28-14 17-12, 17-17, 17-23, 18-14,

VISDL3, 28-35 18-32, 18-48, 19-14 to 19-15

VITOT1, 27-17 VSBARTL, 20-27 to 20-28

VITOT2, 27-17 VSBARTL\_PREV, 20-27 to 20-28

VITOT3, 28-19 VSCNT, 20-26

VITOT4, 28-19 VSCTDY, 18-14

VKYPWR, 27-24 VSCTR, 16-12, 16-40, 17-13, 19-25,

VLORPM, 29-35 20-26

VMDEL3, 28-16 VSDELT, 20-26

VMDEL4, 28-16 VSDNMF, 16-32

VMDEL5, 29-16 VSFMFLG, 6-80, 6-87, 16-12, 16-22,

VMDEL6, 29-16 16-25, 16-40, 17-13, 18-45,

VMPMAX, 20-43, 28-16, 29-16 18-48, 19-6, 19-25, 29-41

VND1, 27-21 VSLIM, 6-87

VND2, 27-21 VSLIMH, 6-87

VND3, 27-21 VSLK\_FM, 18-48

VND4, 27-21 VSMPG, 21-17 to 21-18

VNMIN, 28-28 VSMPGH, 21-17

VOLHYS, 21-22 VSOMAX, 7-14

VOLTCLP, 21-22 VSOMXH, 7-14

VOLTMR, 21-22 VSPOUT\_INIT, 28-30

VPIPTM, 29-35 VSPTDL, 28-32

VPSSW, 28-23 VSSMN1, 29-40 to 29-41

VPUMP\_LAST, 29-70 VSSSW, 29-41

VR\_GOOSE, 28-35 VSSTAL, 17-12

VR\_HICAM\_ISC, 28-10 VSSTIM, 29-41

Index-23

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

VSSTMR, 29-40 to 29-41 WINCLD, 7-60

VSTVMN, 17-23 WINDOW\_BETA, 3-6

VSTVMX, 17-23 WINLEN, 7-56

VSTYPE, 3-3, 20-25, 21-17, 26-5 WOPEN, 7-56

to 26-6, 29-41 Word, 13-6

VSV\_STRT\_SFT, 16-40 to 16-41 WOT, 12-8

VTABFL, 28-30 WOT\_EGR\_FLG, 8-4 to 8-5

VTAP1, 27-13 WOTRPH, 6-30

VTAP2, 27-13 WOTRPT, 6-30

VTAP3, 28-17, 28-46 WOTTMR, 6-30, 8-11, 12-8, 21-22

VTAP4, 28-17, 28-46 WRMEGO, 6-10 to 6-11, 6-27, 6-30,

VTAP5, 27-33 11-5 to 11-6, 21-12, 22-5 to

VTAP6, 27-33 22-6, 29-56

VTCEGO, 20-54, 28-4

VTCEPT, 26-5 X, 8-11

XAPT, 6-16, 6-28

WAC, 28-10 XDCL\_BAUD, 13-36

WARM\_UP, 6-52, 29-6 XDCL\_ERRO, 13-36

WIGFLG, 26-4 to 26-5, 26-7, 29-4, XFRAME, 13-36

29-20, 29-24 to 29-25, 29-27, XMAPPA, 6-29

29-29, 29-44

WIGLVL, 29-4 Y, 7-13

INDEX - LHBH1

\_

PED-PTE, FoMoCo, PROPRIETARY CONFIDENTIAL

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INDEX - LHBH1

\_

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