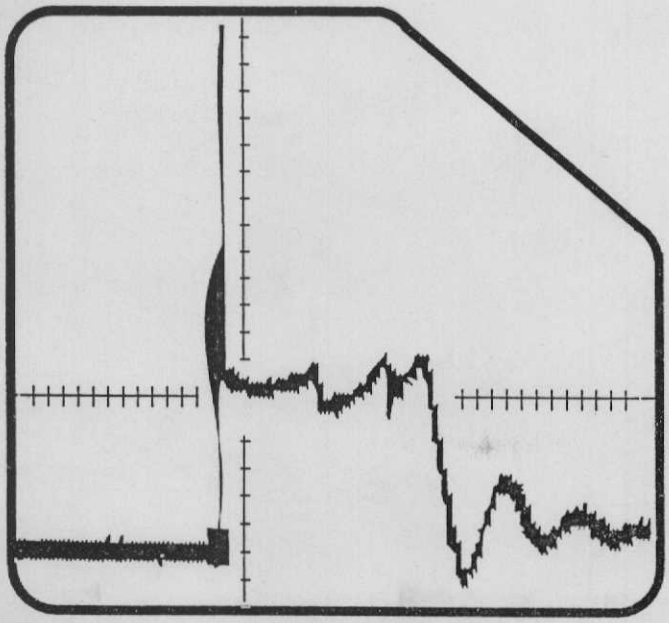
GENERAL MOTORS

ENGINE PERFORMANCE TESTING

And

ON BOARD DIAGNOSTICS



Includes

OBD III

Bill Fulton Of:

OHIO AUTOMOTIVE TECHNOLOGY

GENERAL MOTORS OBDI/OBDII SYSTEMS WITH IGNITON SYSTEMS TESTING

I would like to express my thanks to Joel Burrows of Precision Tune Car Care Corporate Training Center, whose wonderful ideas and technical expertise are seen throughout this manual.. Joel in my opinion has been the industrys leader in the art of lab scope diagnostics. No one in my 15 years of automotive training has been more commited than Joel Burrows. I am very fortunate to have him as a friend.

William A. Fulton

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Complete the enclosed test and
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GM OBD II POST TEST

1. The Diagnostic Executive is software inside the PCM designed to:

A. Record diagnostic test results and controls the MIL light.
B. Perform Diagnostics tests.
C. Conducts the Active, Passive and Intrusive tests.
D. All of the above.

2. GM OBDII systems use class 2 serial data for bi-directional control and serial data. This is a :

A. 5/0 volt pulse width modulated signal at pin 2 of the ALDL.
B. 5/0 volt pulse width modulated toggle at pin 1 of the ALDL.
C. 7/0 volt pulse width modulated signal at pin 2 of the ALDL with 7 volts at rest and 0 volts active.
D. 7/0 volt pulse width modulated signal at pin 2 of the ALDL with 0 volts at rest and 7 volts active.

3. A type A DTC will set on the:

A. The second consecutive failure.
B. The first failure.
C. Any failure.
D. When a system fails a diagnostic test.

4. Active, Passive and Intrusive tests are specific type tests the Diagnostic Manager may run if a failure occurs before it will illuminate the MIL.

A. True
B. False

5. A type B DTC will set of the second consecutive failure.

A. True
B. False

6. A warm up cycle is defined as an engine start up where the engine temperature must rise at least ___*F from start up and achieves a minimum temperature of ___*F.

A. 40* F and 160* F
B. 60* F and 140* F
C. 80* F and 120* F
D. 50* F and 150* F

7. Warm up cycles are also used to clear DTCs. It normally takes ___ warm up cycles without a failure to erase a DTC out of memory. On misfire and fuel system rich/lean codes it will take___ warm up cycles.

A. 50 and 60.
B. 40 and 80.
C. 60 and 120.
D. 20 and 20.

8. Type C and D DTCs are not emission related and will not illuminate the MIL light.

A. True
B. False

9. Freeze Frame is information about:

A. Operating conditions of the engine at the time the DTC was set.
B. Will record on any DTC.
C. Both A and B.
D. Neither A or B.

10. Fail record is operating condition information that is used on:

A. Non emission DTCs only.
B. Any DTC with a limit of 5.
C. Used only for emission related DTCs.
D. None of the above.

11. The DTC status information will show the tech:

A. When a test is being run.
B. Pass or fail information for a specific DTC.
C. How many times a specific test has failed.
D. A code description.

12. Pre and post HO2S are used to monitor the:

A. Catalytic converter during idle conditions on 1998 and up GM systems.
B. Catalytic converter during steady state cruise conditions on GM OBDII systems from 1994 thru 1997 model years.
C. Both A and B.
D. Neither A or B.

13. A CASE relearn procedure must be done on certain GM systems whenever the following parts are replaced except:

A. PCM.
B. CKP sensor.
C. CMP sensor.
D. Vibration dampener.

14. OBDII Misfire relief begins in model year___ and is designed to:

A. 1998, prevent common false misfire codes.
B. 1997, prevent common false misfire codes.
C. 1998. help detect cylinders that are misfiring.
D. 1997, help detect cylinders that are misfiring.

15. The Continuous Monitors are:

A. Fuel System Rich/Lean Monitor, the Catalyst Monitor, the EGR Monitor and the EVAP Monitor.
B. The Misfire Monitor, the Fuel System Rich Lean Monitor, and the Comprehensive Component.
C. The EVAP Monitor, the Catalyst Monitor and the Secondary Air Monitor.

16. The Once per Trip monitors include the:

A. EGR. EVAP, Secondary Air, the HO2S, the Catalyst Monitor, the HO2S Heater Monitors and the R-12 monitor.
B. The HO2S, EVAP, EGR and Fuel System Monitor.
C. The secondary Air, EVAP and EGR monitors.
D. None of the above.

17. On 1997 and up GM vehicles whenever a DTC is cleared using a scan tool, all system status flags are also cleared.

A. True.
B. False.

18. Technician A says on PO series codes you are limited to one Freeze Frame with Misfire and Fuel System Rich Lean codes taking priority.
Technician B says, GM vehicles have an enhancement to Freeze Frame called Fail Record with a limit of 5. In addition, Tech b says Fair Record will trigger off any DTC. Who is right?

A. Tech A only.
B. Tech B only.
C. Both A and B.
D. Neither A or B.

19. Early GM OBDII systems thru 1997 uses a steady state cruise condition to monitor the pre and post HO2S for Catalyst efficiency. 1998 and later GM systems use an idle Catalyst Monitor to check for Catalyst efficiency at idle.

A. True.
B. False.

20. Fuel Trim values that vary outside of a ____% window will normally alert the technician to a air fuel ratio problem.

A. 15%
B. 5%
C. 10%
D. 2%

21. On V6 and V8 engines the fuel trim values should not vary more than _____ points between banks.

A. 10
B. 20
C. 5
D. 2

OBD II ANSWER SHEET

1.	A	B	C	D
2.	A	B	C	D
3.	A	B	C	D
4.	A	B	C	D
5.	A	B	C	D
6.	A	B	C	D
7.	A	B	C	D
8.	A	B	C	D
9.	A	B	C	D
10.	A	B	C	D
11.	A	B	C	D
12.	A	B	C	D
13.	A	B	C	D
14.	A	B	C	D
15.	A	B	C	D
16.	A	B	C	D
17.	A	B	C	D
18.	A	B	C	D
19.	A	B	C	D
20.	A	B	C	D
21.	A	B	C	D

TECHNICIAN NAME _____

ADDRESS _____

CITY,STATE _____ ZIP _____

PHONE _____ FAX _____

GM OBD I/OBD II SYSTEMS

On-Board Diagnostics
Lab Scope Diagnostics

Section 2 Table of Contents

Section 2 Table of Contents (Continued)

A WORD ABOUT DIAGNOSTICS

SCAN TOOL DIAGNOSTICS VERSUS OTHER TEST EQUIPMENT DIAGNOSTICS

As good as the OBD II systems are, they in most cases, will not pin point the exact problem. Scan tool usage has always had severe limitations, and has not changed with OBD II. The OBD II strategies will increase the likleness of setting a fault code but all too often the technician will have to pin point the problem using other diagnostic equipment.

The first diagnostic decision the technician must make after the symptom is verified is which piece of test equipment is best suited to identify the cause. An example would be any thing that could create a misfire can and will if bad enough set a misfire code. A lean density misfire, a secondary ignition problem, a primary ignition problem or excessive EGR could set a misfire code. Ignition problems are best identified using ignition scopes and or lab scopes. Scan tools are best at identifying a symptom and perhaps narrowing it down to a specific system but to actually pin point the faulty component will necessitate the use of different diagnostic equipment. An intermittent loss of the D/REF signal for example has never been detected well on a scan tool and more often than not will not set a code especially on the GM systems, OBD II included. No code driveability is often the most challenging area for the automotive technician. With

the increasing speed of the scan tool/serial data transmisions the OBD II systems with their diagnostic strategies will greatly enhance the technicians effort but will never be the only tool needed to diagnose the computer controlled, coil fired, internal combustion engine on todays cars.

Fundamentally sound technicians know that conventional components and conventional problems all too often create driveability problems with or without the aid of a diagnostic code. The technicians best approach is to perform engine diagnostics 1st to verify the performance of the systems that are not directly controlled by the PCM, such as, vacuum, fuel pressure and primary and secondary ignition systems. 80% of all engine performance problems are not affected by the PCM, the PCM inputs or the PCM output devices! Scan tools can help you verify and indentify these areas but to actually locate and pin point the problem will often require the use of a lab scope, multimeter, vacuum gauge or fuel pressure/volume gauge. The diagnostic strategies of the OBD II systems mostly involve the monitoring the components and systems that are directly related to emissions. Ironically, the OBD II systems **DO NOT** monitor the vehicles emissions but rather the components that control the vehicles emissions.

Bill Fulton
Ohio Automotive Technology

Engine Performance Diagnostics

1. **Visual / Maintenance Items / Fluid Levels**
2. **System Voltage: OCV / Cranking / Hot Run**
3. **Engine Vacuum: Cranking / Idle / WOT Snap / Cruise**
4. **Ignition: Cranking KV / Idle KV / Snap KV / Cruise KV / Spark KV PTS / Spark Line Length and Angle (Idle and Loaded)**
5. **Fuel System: Fuel Pressure and Volume / Fuel Pump Current**
6. **O2 Sensor Waveform Diagnostics**
7. **Fault Code Retrieval: Hard or Soft Code ?**

Computer Performance Diagnostics

- **Serial Data or Break-Out-Box Data**
- **PCM Power / Ground Checks**
- **TSB Search**

Differences Between OBD I and OBD II

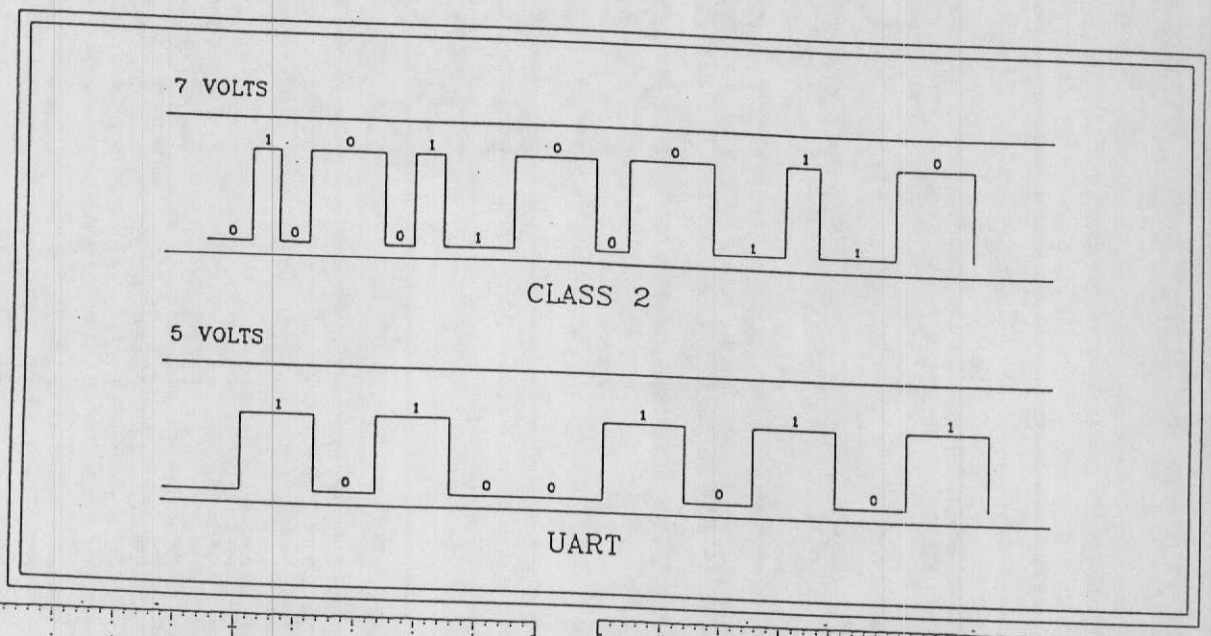
OBD I

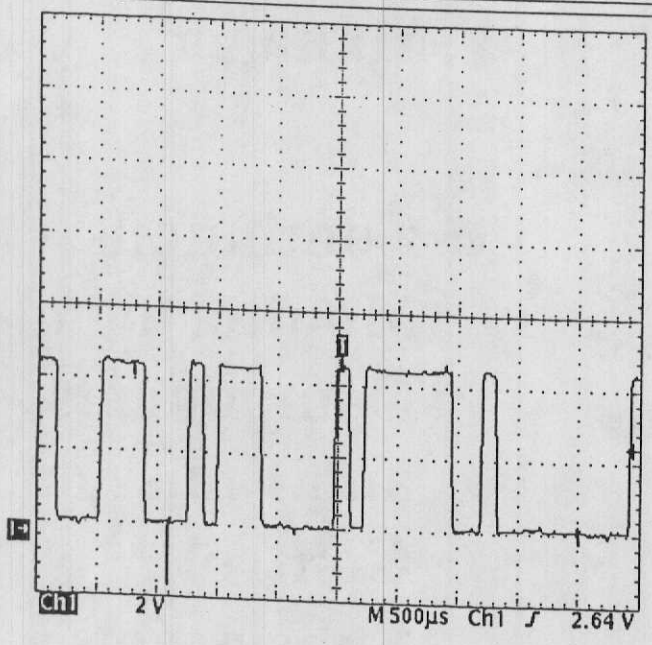
- Limited Diagnostics on Outputs
- 30 % or Less Success Rate

OBD II

- Diagnostic Manager
- Continuous Monitoring of Components and Emission Control Subsystems
- ?

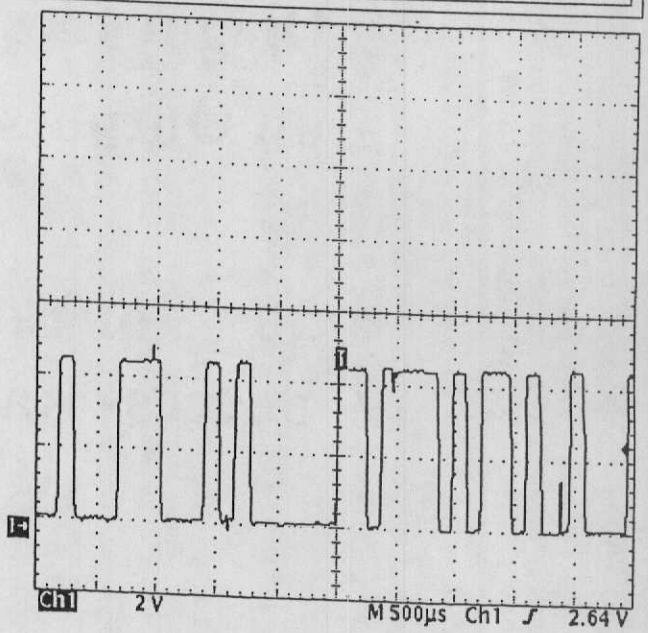
SCAN TOOL COMMUNICATION INTERFACE (FROM PCM)



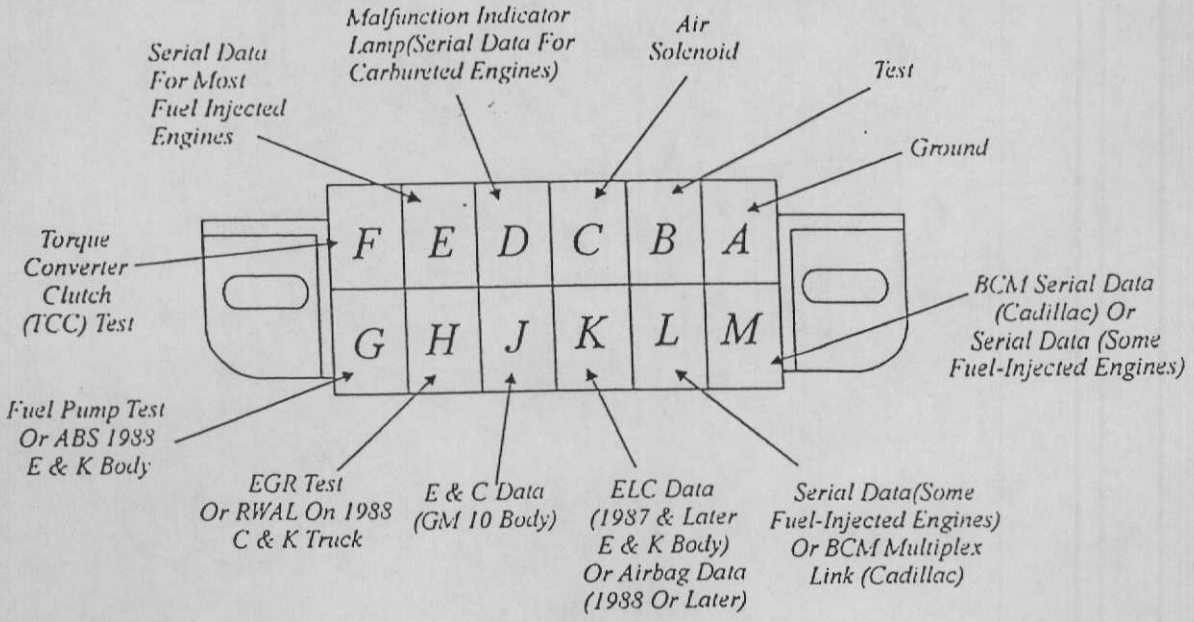


8192 BAUD RATE (OBD 1)

Normal serial data transiton speed at 5 times per second.

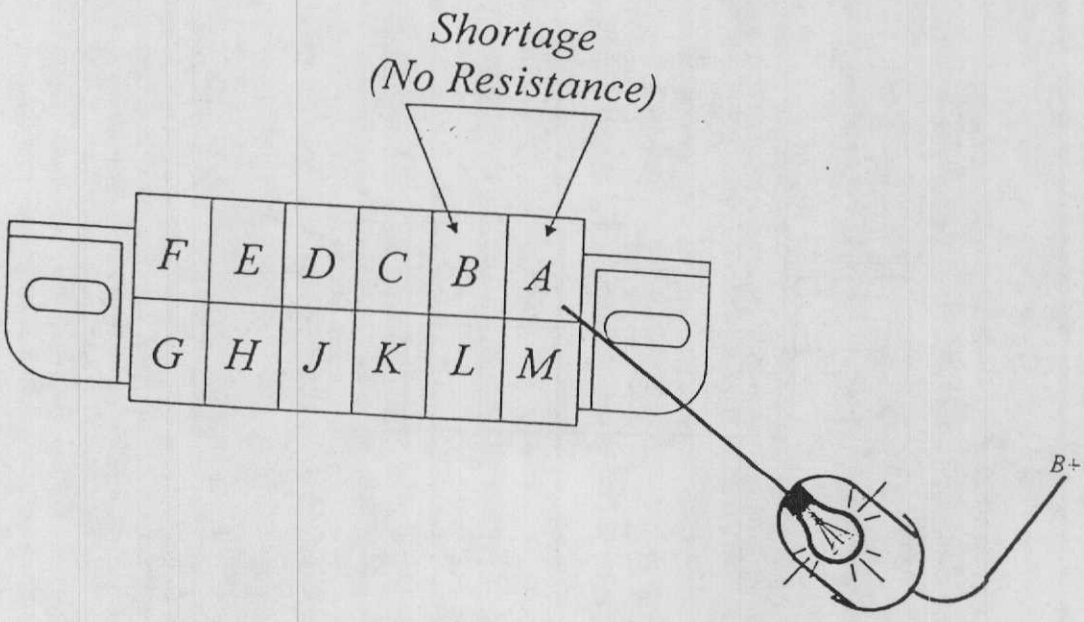


High speed serial data transition at 8 times per second.



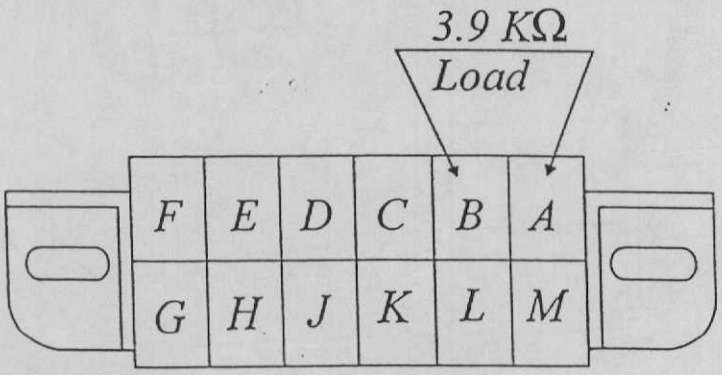
ALDL PIN CHART

NOTES



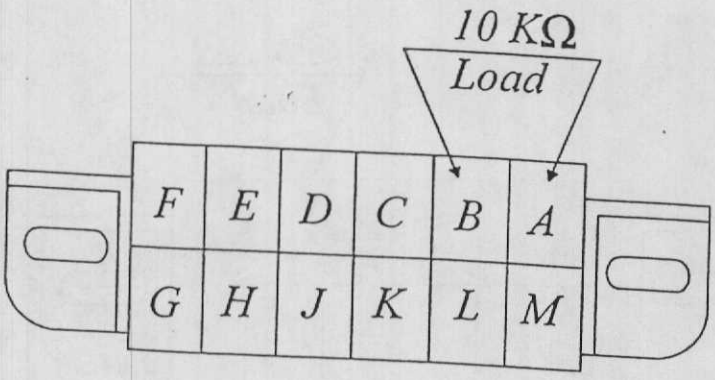
FIELD SERVICE MODE

NOTES



BACK UP MODE OR 3.9K MODE

NOTES



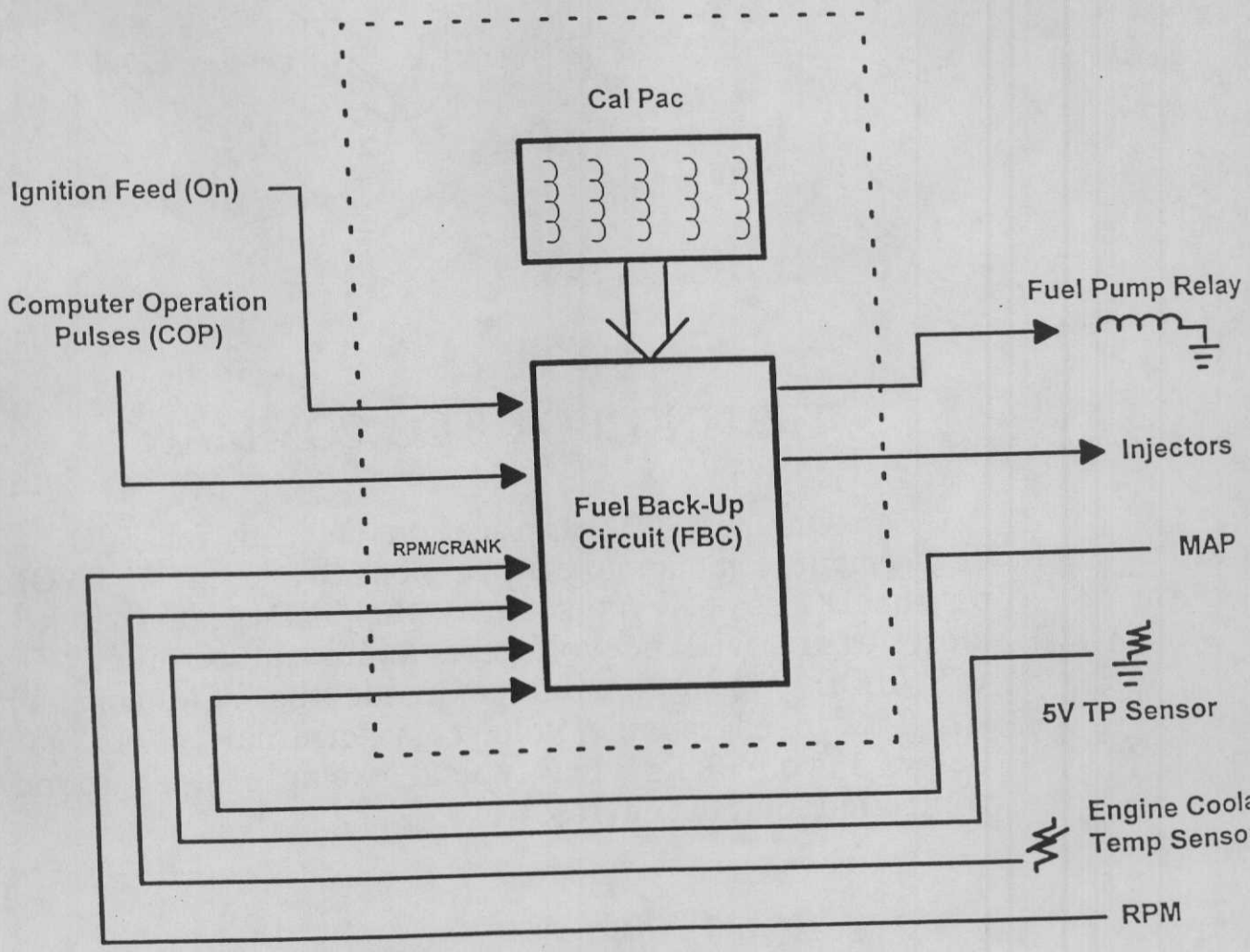
DIAGNOSTIC MODE OR 10K MODE

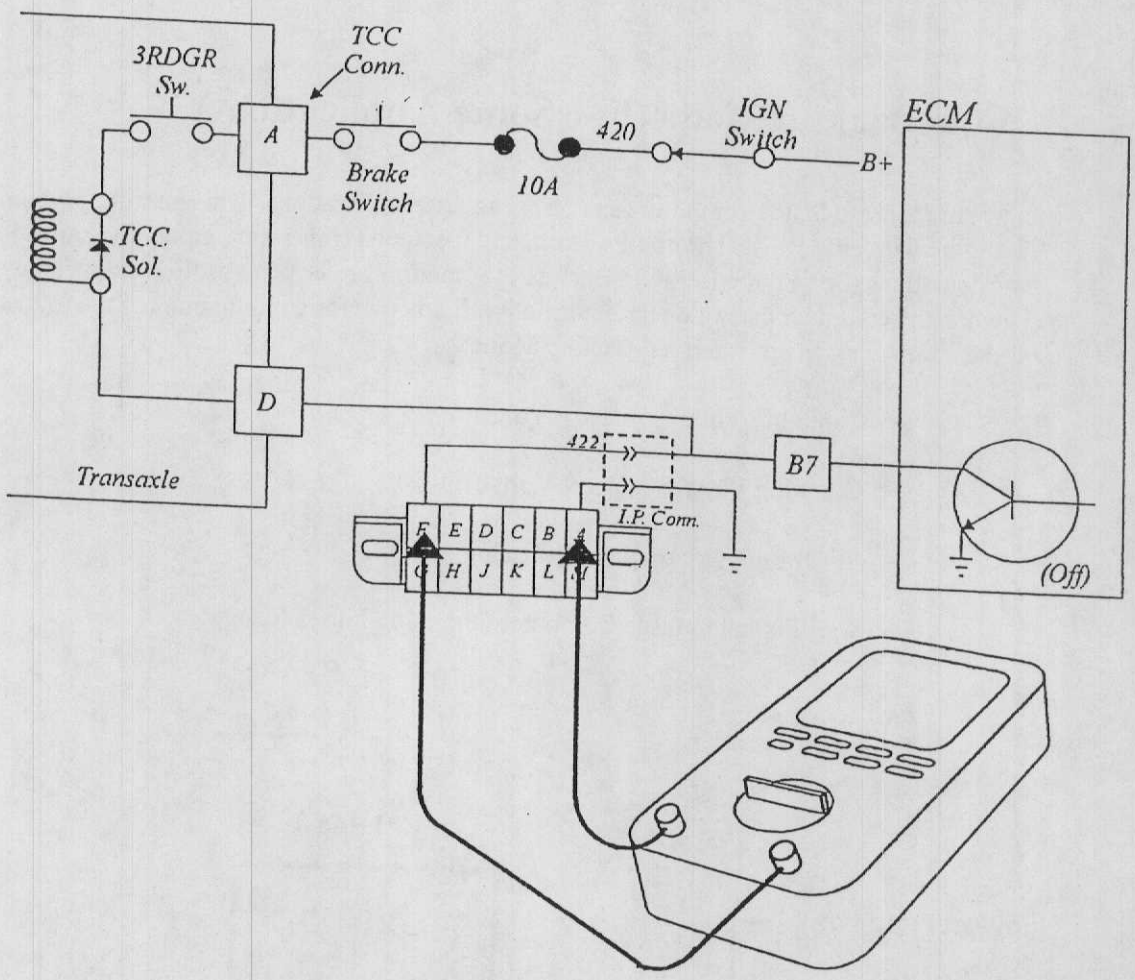
NOTES

Fuel Backup Mode (For Some Applications)

Within this mode, the computer runs on the internal calibrations. This permits the computer to run the engine with only RPM, Throttle Position, and Coolant Temperature inputs to change fuel and timing calculations (See Figure Below). Backup is sometimes referred to as limp-home mode and is only used when the computer cannot operate normally. If any one (or combination) of the following conditions occur, the computer will activate Fuel Backup Mode:

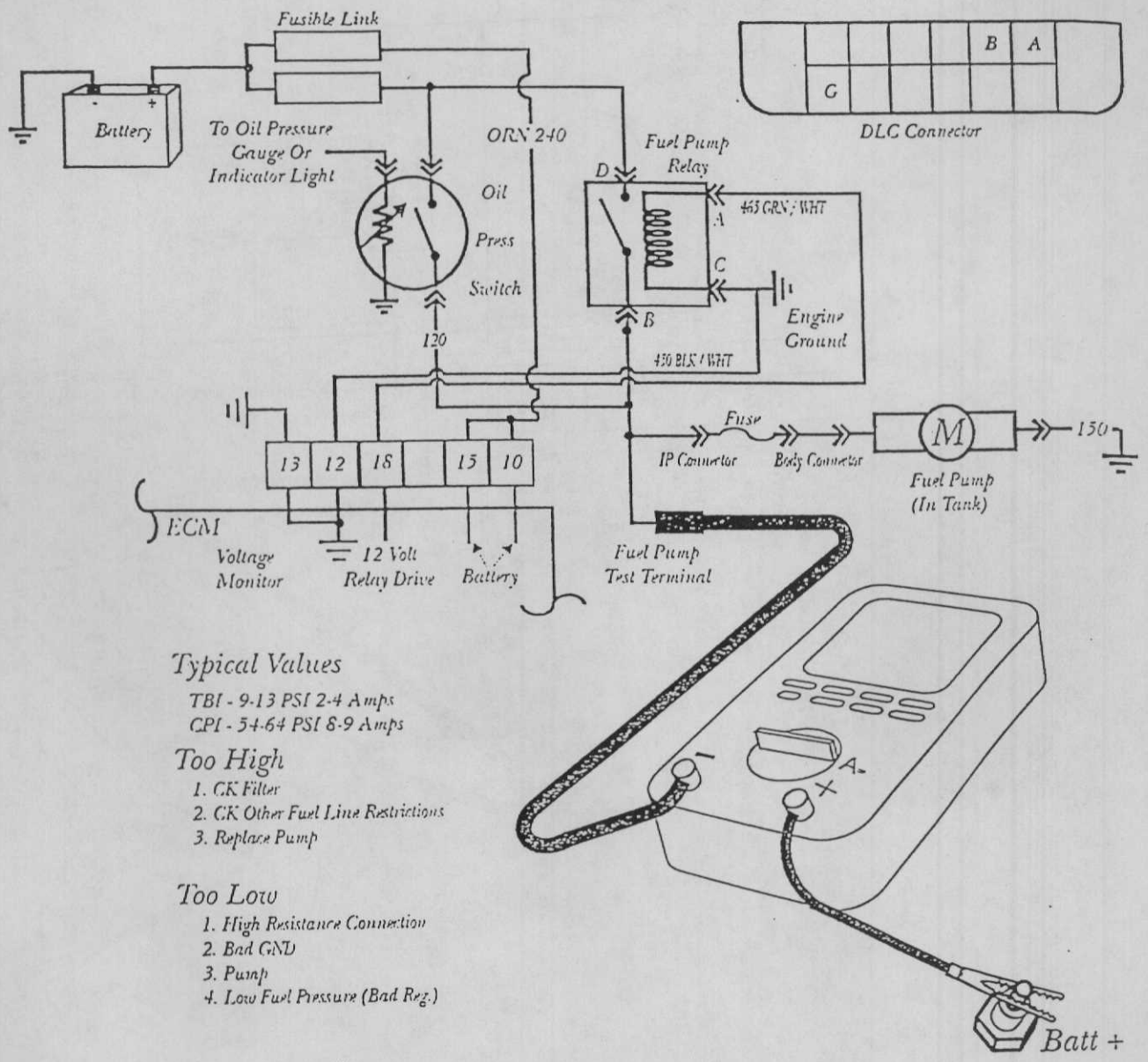
* Computer Voltage under 9 Volts
* Cranking Voltage under 9 Volts
* PROM not functioning or missing
* Circuits fail to issue Computer Operation Pulses (COP)





TESTING FOR TCC COMMAND

On most GM applications testing for TCC engagement commands can be done by using a DVOM on the DC scale. As soon as the 3RD gear switch closes there will be voltage available at terminal F of the ALDL. When the driver inside the PCM commands the TCC to engage the voltage at terminal F will go below 1 volt. This is a typical example of a ground controlled output device.



Typical Values

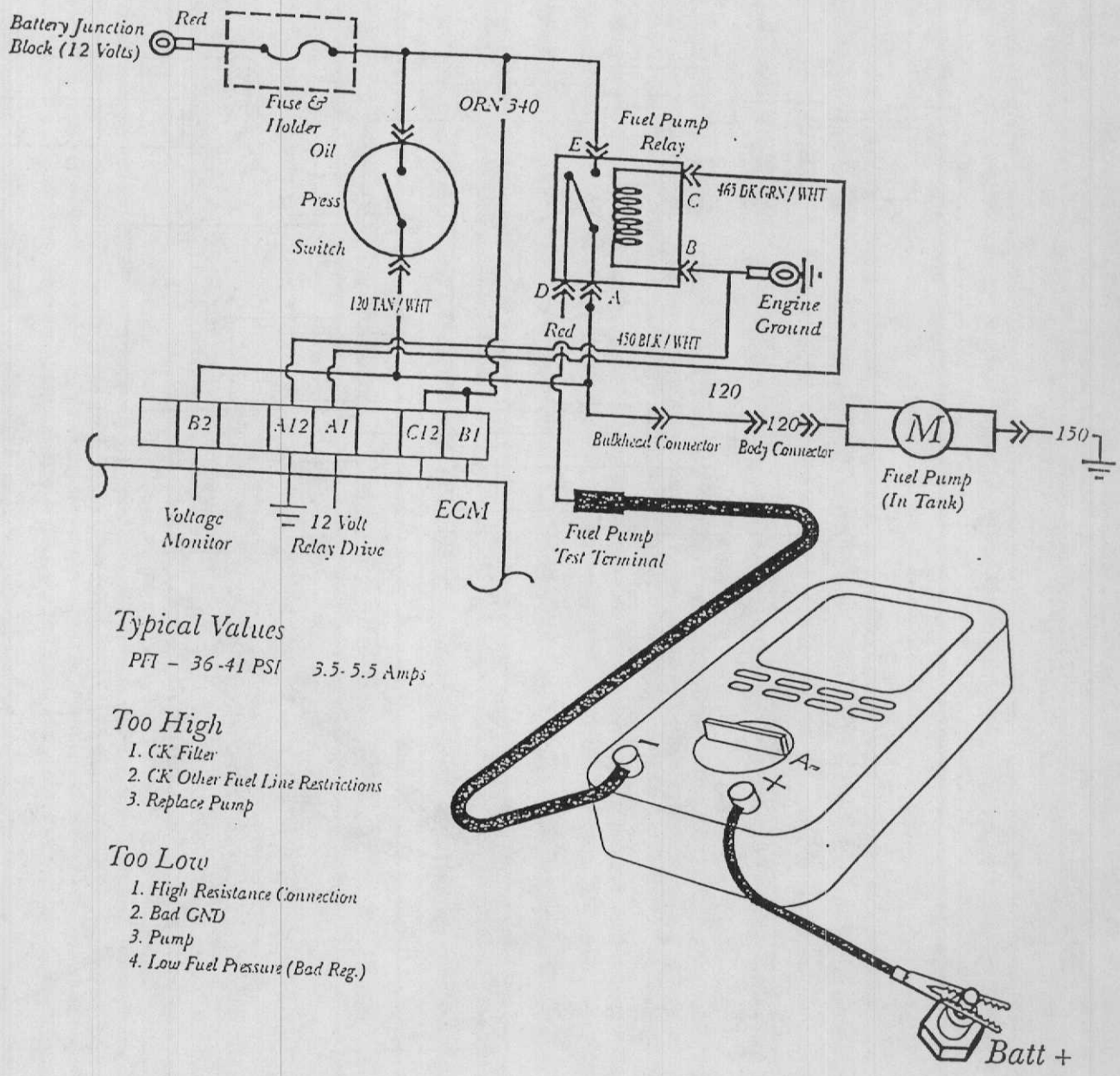
TBI - 9-13 PSI 2-4 Amps
CPI - 54-64 PSI 8-9 Amps

Too High

1. CK Filter
2. CK Other Fuel Line Restrictions
3. Replace Pump

Too Low

1. High Resistance Connection
2. Bad GND
3. Pump
4. Low Fuel Pressure (Bad Reg.)



Typical Values

PFI – 36-41 PSI 3.5-5.5 Amps

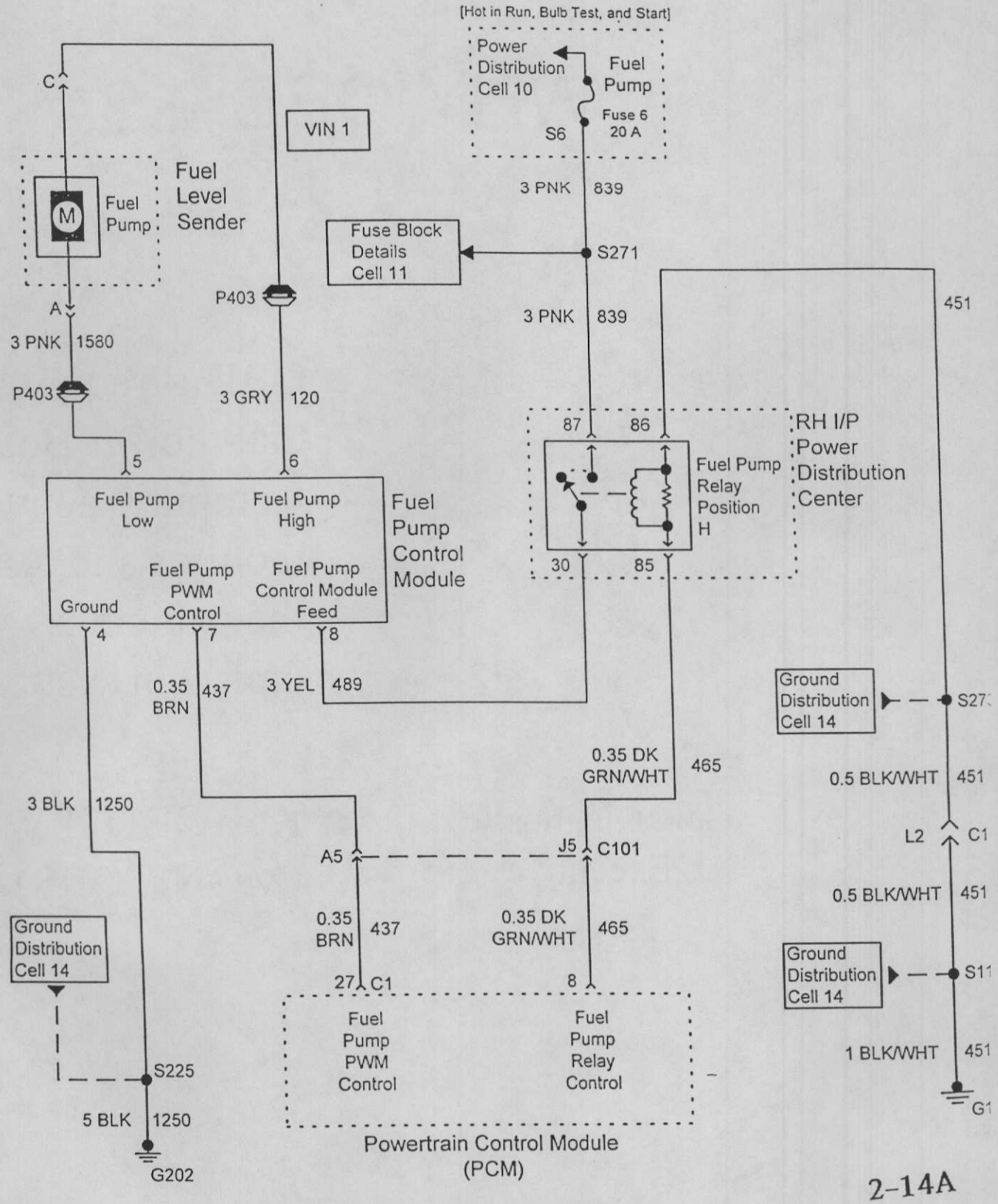
Too High

1. CK Filter
2. CK Other Fuel Line Restrictions
3. Replace Pump

Too Low

1. High Resistance Connection
2. Bad GND
3. Pump
4. Low Fuel Pressure (Bad Reg.)

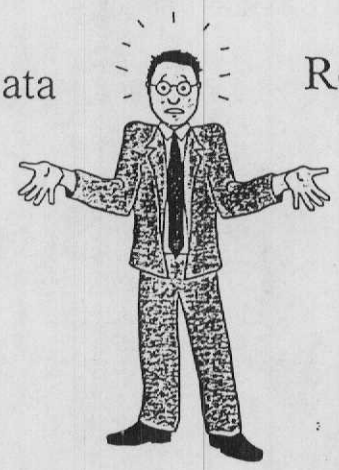
Fuel Pump Module Circuit



2-14A

WHY OBD II ?

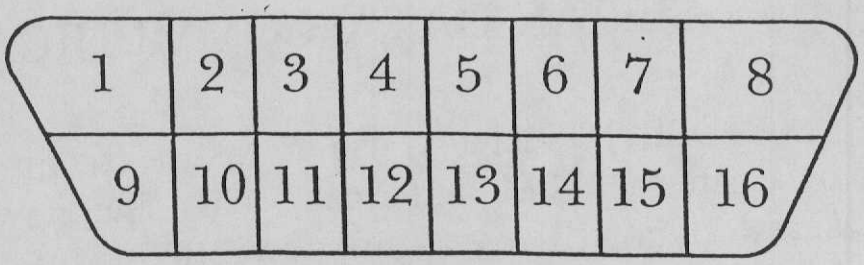
Scan Data



Records

The Diagnostic Executive

- OBD II requires that the On-Board Computer actively monitor and test the vehicle's emission systems
- Key OBD II Word (MONITORS)



PIN 1 - *Secondary UART 8192 Baud Serial Data (CKT 800), Secondary Class B (CKT 710) or 160 Baud Serial Data(1995 Only) (CKT 461)*

PIN 2 - *J1850 Bus + L Line on 2-Wire Systems, or Single Wire (Class 2) (CKT 1807)*

PIN 3 - *Ride Control Diagnostic Enable (CKT 1826)*

PIN 4 - *Chassis Ground Pin (CKT 150)*

PIN 5 - *Signal Ground Pin (CKT 451)*

PIN 6 - *PCM / VCM Diagnostic Enable (CKT 448)*

PIN 7 - *K Line for International Standards Organization (ISO) Application*

PIN 8 - *Keyless Entry Enable (CKT 1455) or MRD Theft Diagnostic Enable (CKT 477)*

PIN 9 - *Primary UART (CKT 1061)*

PIN 10 - *J1850 Bus-Line for J1850-2 Wire Applications*

PIN 11 - *Electronic Variable Orifice (EVO) Steering (CKT 1294) or Magnetic Steering Variable Assist (MSVA)*

PIN 12 - *ABS Diagnostic (CKT 799) or CCM Diagnostic Enable (CKT 555)*

PIN 13 - *SIR Diagnostic Enable (CKT 326)*

PIN 14 - *E & C Bus (CKT 835)*

PIN 15 - *L Line for International Standards Organization (ISO) Application*

PIN 16 - *Battery Power from Vehicle Unswitched (4 AMP MAX.)*

SERIAL DATA COMMUNICATION

OBD II systems use a faster communication link between the PCM and Scan Tool. The new class 2 serial data utilizes a pulse width modulated 7/0 volt toggle. The pulses can be either long or short. The two pulse widths and the 10.4 kilobits per second transfer rate allow the scan tool and the PCM to communicate at a much faster rate.

The previous serial data was known as UART or Universal Asynchronous Transmit and Receive. The UART is a 5/0 volt toggle that has a fixed pulse width. Some manufacturers are still using the slower UART on their OBD systems. It is important to note that GM separates engine data into groups so as to allow the scan tool display to keep up with the newer serial data tranmit speed.

Diagnostic Manager

- **Diagnostic Executive**
- **Sequence of Testing**
- **Controls MIL**
- **Controls:**

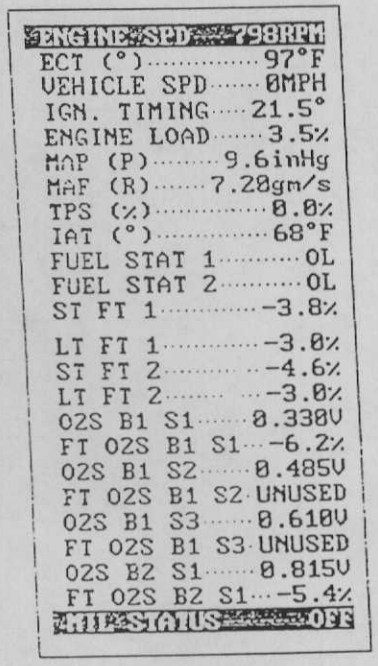
    1. **Monitors**
    2. **100 Millisecond Loop Time**

OBD II Scan Tool Usage

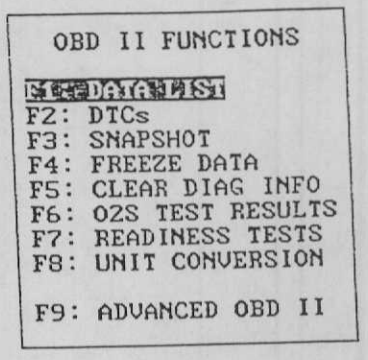
- **Generic**
- **Enhanced**

MASTER TECH GENERIC OBD II DATA

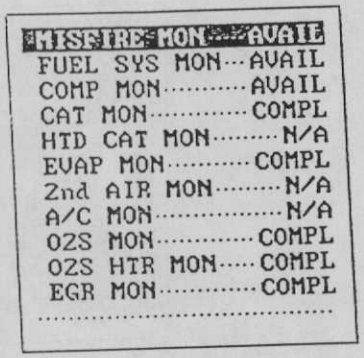
ENGINE DATA



GENERIC MENU



READINESS TESTS

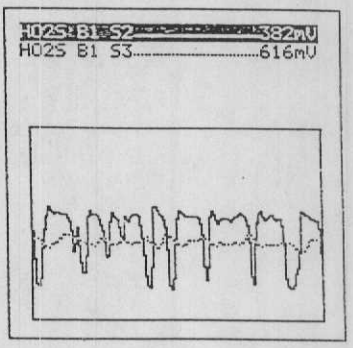


MASTER TECH ENHANCED OBD II

ENGINE DATA 1

ENGINE SPEED	589RPM
SPARK ADVANCE	21÷
IAC	62
TPS (V)	0.52V
TPS (%)	0.0%
ECT (÷)	189÷F
IAT (÷)	72÷F
MAP (P)	10.32inHg
BARO (P)	28.64inHg
IGNITION (V)	14.0V
DESIRED IAC	62
DESIRED IDLE	600RPM
LONG TERM FT B1	118
LONG TERM FT B2	120
SHORT TERM FT B1	127
SHORT TERM FT B2	130
AIR FUEL RATIO	14.7
KNOCK RETARD	0÷
KS ACTIVE CNTR	161
ENG RUN TIME	357s
STARTUP ECT	70÷F

PRE & POST HO2S



ENGINE DATA 2

ENGINE SPEED	603RPM
IAC	62
VEHICLE SPEED	0mph
ECT (°)	190°F
IAT (°)	104°F
IGNITION (V)	13.8V
DESIRED IAC	62
DESIRED IDLE	600RPM
AIR FUEL RATIO	14.7
EGR DUTY CYC.	0.0%
EGR ACT. POS.	0.0%
EGR DES. POS.	0.0%
EVAP PURGE DC	0.0%
ENG RUN TIME	37s
STARTUP ECT	196°F
TCC DUTY CYC.	0.0%
TCC SLIP SPD	601RPM
BRAKE SWITCH	CLOSED
TCC ENABLE	NO
1-2 SHFT SOL.	ON
2-3 SHFT SOL.	ON

ENGINE DATA 3

ENGINE SPEED	595RPM
IAC	60
TPS (V)	0.52V
TPS (%)	0.0%
ENGINE LOAD	19.2%
MAP (P)	10.04inHg
MAF (R)	4.5g/s
BARO (P)	28.64inHg
DESIRED IAC	60
DESIRED IDLE	600RPM
EGR DUTY CYC.	0.0%
EGR ACT. POS.	0.0%
EGR DES. POS.	0.0%
EVAP PURGE DC	0.0%
A/C REQUEST	NO
A/C RELAY	OFF

MASTER TECH ENHANCED OBD II

MISFIRE MONITOR

```
ENGINE SPEED..... 601RPM
IAC..... 62
VEHICLE SPEED..... 0mph
DESIRED IAC..... 62
DESIRED IDLE..... 600RPM
RICH-LN STAT1..... LEAN
RICH-LN STAT2..... RICH
MISFIRE CURR #1..... 0
MISFIRE CURR #2..... 0
MISFIRE CURR #3..... 0
MISFIRE CURR #4..... 0
MISFIRE CURR #5..... 0
MISFIRE CURR #6..... 0
BRAKE SWITCH..... CLOSED
TCC ENABLE..... NO
```

```
VEHICLE SPEED·····0mph
DESIRED IAC·····88
DESIRED IDLE···550RPM
RICH-LN STAT1·····RICH
RICH-LN STAT2·····RICH
MISFIRE CURR #1·····1
MISFIRE CURR #2·····1
MISFIRE CURR #3·····0
MISFIRE CURR #4·····0
MISFIRE CURR #5·····2
MISFIRE CURR #6·····2
BRAKE SWITCH···CLOSED
```

READINESS TESTS

```
Sep 30, 98    7:22:14 am
Test Complete ↑↓
Catalyst        Y
EVAP System     Y
HO2S            Y
HO2S Heater     Y
EGR System      Y
0.00 V
[*EXIT] TO EXIT
```

O2 SENSOR INFO

```
ENGINE SPEED···606RPM
IAC·····60
ECT (°)·····199°F
LOOP STATUS·····CLOSED
MAF (R)·····4.5g/s
IGNITION (V)·····13.7V
DESIRED IAC·····60
DESIRED IDLE···600RPM
HO2S B1 S1·····165mV
HO2S B1 S2·····586mV
HO2S B1 S3·····742mV
HO2S B2 S1·····859mV
HO2S X CNT B1·····62
HO2S X CNT B2·····121
RICH-LN STAT1·····LEAN
RICH-LN STAT2·····RICH
LONG TERM FT B1···120
LONG TERM FT B2···124
SHORT TERM FT B1·128
SHORT TERM FT B2·130
AIR FUEL RATIO···14.7
ENG RUN TIME·····424s
STARTUP ECT·····196°F
```

SNAP-ON GENERIC OBD II INFO
(K-2 KEY)

OBD II GENERIC

OBDII GENERIC

** DATA (NO CODES). OK TO DRIVE. **
(NO CODES AVAILABLE IN THIS MODE)

OBD II DATA

ENGINE RPM_____626	THROTTLE(%)_____0.0
FUEL SYS1_____CL	FUEL SYS2_____CL
INTAKE AIR(F)___75	COOLANT(F)_____140
AIRFLOW(g/s)___5.22	MAP("Hg)_____10.1
IGN TIMING( )__20.0	ST TRIM B1(%)__-3.1
LT TRIM B1(%)__-4.7	ST TRIM B2(%)__-1.6
LT TRIM B2(%)__-3.1	NOT USED
O2 B1-S1(mV)__0.575	TRIM B1-S1(%)__-3.9
O2 B1-S2(mV)__0.825	TRIM B1-S2(%)___N/A
O2 B1-S3(mV)__0.465	TRIM B1-S3(%)___N/A
O2 B2-S1(mV)__0.820	TRIM B2-S1(%)__-3.1
VEH SPEED(MPH)____0	LOAD(%)_____2.3

MONITORS READINESS TEST

*** OBDII READINESS	MONITORS FOLLOW***
MISFIRE_____READY	FUEL SYS_____READY
COMPONENTS____READY	CATALYST_____READY
HEATED CAT_____N/A	EVAP SYS_____READY
AIR_____N/A	A/C REFRIG_____N/A
O2 SENSOR_____READY	O2 HEATER_____READY
EGR SYS_____READY	

SNAP-ON ENHANCED OBD II INFO

(K-9 KEY)

ENGINE DATA 1

```
1997 CHEVROLET                    A/C
4.3L V6 CHEVY CSFI                A/T
 **  CODES & DATA.  OK TO DRIVE.  **
(NO CODES AVAILABLE IN THIS MODE)
     RPM__614 TPS(V)__0.53 TPS(%)_____0

O2 B1-S1(mV)____408  O2 CROSSCNTS-1___98

O2 B2-S1(mV)____278  O2 CROSSCNTS-2__124

O2 B1-S3(mV)____525  O2 B2-S2(mV)____560

ST TRIM-1_______128  LT TRIM-1_______124

ST TRIM-2_______128  LT TRIM-2_______124

INJ PW B1(mS)___4.0  INJ PW B2(mS)___4.0

A/F RATIO______14.7  OPEN/CLSD LOOP_OPEN

MAF(gm/Sec)_____6.7  BARO("Hg)______29.2

MAP(V)_________1.41  MAP("Hg)_______10.9

COOLANT( F)_____145  COOLANT(V)_____3.13

INTAKE AIR( F)__107  INTAKE AIR(V)__3.96

IAC POSITION_____50  DESIRED IAC______50

DESIRED IDLE____622  IGNITION(V)____13.8

FT CELL B1_______17  FT CELL B2_______17

ENGINE LOAD(%)___22  FUEL LEVEL(%)____85

TORQUE FT-LBS____24  START CLNT( F)__146
```

MISFIRE MONITOR INFO

```
1997 CHEVROLET                    A/C
4.3L V6 CHEVY CSFI                A/T
 **  CODES & DATA.  OK TO DRIVE.  **
(NO CODES AVAILABLE IN THIS MODE)
              MISFIRE DATA
MISFIRE CYCLES___58  MISFIRES/CYCLE____0

MISFIRE CYL 1_____0  MISS HISTORY 1____0

MISFIRE CYL 2_____0  MISS HISTORY 2____0

MISFIRE CYL 3_____0  MISS HISTORY 3____0

MISFIRE CYL 4_____0  MISS HISTORY 4____0

MISFIRE CYL 5_____0  MISS HISTORY 5____0

MISFIRE CYL 6_____0  MISS HISTORY 6____0

KNOCK____________NO  KNOCK(V)_______4.65

SPARK ADV( )_____20  KNOCK RETARD( )___0

CAM RETARD( )_____0  TIME___________1:57
```

SNAP-ON ENHANCED OBD II INFO

(K-9 KEY)

ENGINE DATA 3

1997 CHEVROLET A/C
4.3L V6 CHEVY CSFI A/T
** CODES & DATA. OK TO DRIVE. **
(NO CODES AVAILABLE IN THIS MODE)

ENGINE LIST 4

O2 B1-S1 STAT__RICH	O2 B2-S1 STAT__LEAN
O2 S2 READY_____YES	O2 S1 READY_____YES
RESTART CLSD LP_YES	POWER ENRICH_____NO
EGR DUTY(%)_____0	EGR POS(%)_____0
DES EGR(%)_____0	EGR POS(V)_____0.78
SPARK CTRL RET___NO	SPARK CTRL ADV__YES
EVAP DUTY(%)_____0	EVAP CANISTER___OFF
EVAP VENT SOL___OFF	FT PRES("H2O)__0.61
FUEL LEVEL(%)____85	FUEL LEVEL(V)__2.19
EXCESS VAC PASS__NO	WEAK VAC PASS____NO
SMALL LEAK PASS__NO	PURGE LEAK PASS__NO
IGNITION(V)____13.8	INTAKE AIR(F)___94
COOLANT(F)_____194	START CLNT(F)__146
A/F RATIO_____14.7	LT TRIM ENABLED_YES
DECEL FUEL MODE__NO	IGNITION 1 SW____ON
BRAKE SW_____OPEN	CC ENABLED_____NO
VEH SPEED(MPH)____0	HOT MODE_____NO
4WD ACTIVE_____NO	4WD LOW SW_____OFF
A/C REQUEST_____NO	A/C CLUTCH_____OFF

Once Per Trip Monitors

- **EGR**
- **EVAP**
- **HO2S**
- **Catalyst Monitor**
- **HO2S Heaters**
- **Secondary Air**
- **R-12**

Continuous Monitors

- **Misfire Monitor**
- **Fuel System Rich/Lean Monitor**
- **Comprehensive Component Monitor**

Need To Know OBD II Terms

- **Enable Criteria**

- **DTC**

Need To Know OBD II Terms (Continued)

- **MIL**

- **Type A Code vs. Type B Code**

DTC Types

Every DTC is directly linked or related to a diagnostic test. DTCs are set by the Diagnostic Management System when a test failure occurs during a trip or multiple trips. Some tests require a failure on two consecutive trips prior to setting the DTC.

The following illustrates the five types of DTCs and their corresponding characteristics:

➢ Type A

- ✓ Requests activation of the MIL on the first trip failure
- ✓ Stores/Records a History DTC on the first trip failure
- ✓ Stores/Records a Freeze Frame (if empty) on the first trip failure
- ✓ Stores/Records a Fail Record
- ✓ Updates the Fail Record upon the first failure within each ignition cycle
- ✓ Emissions related

➢ Type B

- ✓ Requests activation of the MIL on the second consecutive trip failure
- ✓ Stores/Records a History DTC on the second consecutive trip failure
- ✓ Stores/Records a Freeze Frame (if empty) on the second consecutive trip failure
- ✓ Stores/Records a Fail Record (on the first trip failure)
- ✓ Updates the Fail Record upon the first failure within each ignition cycle
- ✓ "Armed" after first trip failure, "Disarmed" after one successful trip
- ✓ Emissions related

➢ Type C (or C1) *

- ✓ Requests activation of the Service Lamp or DIC Service Message on the first trip failure
- ✓ Stores/Records a History DTC on the first trip failure
- ✓ Does not store/record a Freeze Frame
- ✓ Stores/Records a Fail Record
- ✓ Updates the Fail Record upon the first failure within each ignition cycle
- ✓ Non-Emissions related **

DTC Types (Continued)

➢ Type D (or C0) *

- ✓ Does not request the activation of any lamps
- ✓ Stores/Records a History DTC on the first trip failure
- ✓ Does not store/record a Freeze Frame
- ✓ Stores/Records a Fail Record
- ✓ Updates the Fail Record upon the first failure within each ignition cycle
- ✓ Non-Emissions related **

➢ Type X

- ✓ Disabled software coded diagnostics that are intended mostly for export vehicles that do not require DTC storing or MIL illuminations.
- ✓ DTC Codes are not stored (However, the DTC chart can still be utilized as a resource when diagnosing "Type X" DTC associated system problems)
- ✓ Some domestic vehicles use Type X DTCs

* Mid 1997, Type C and Type D codes were changed to Type C1 and Type C0 codes respectively. They may or may not appear in certain service manuals, but they are shown here to illustrate the recent changes in the Type C and D diagnostics.

** Emissions are no greater than 1 ½ times the FTP standards when failure occurs.

Note: The Diagnostic Executive stores/records a limited amount of Fail Records (usually five or less). Each Fail Record is associated with a different DTC. Fail Records for every DTC may not appear when multiple DTCs are set.

Need To Know OBD II Terms (Continued)

- **Freeze Frame vs. Fail Record**

Need To Know OBD II Terms (Continued)

- **Trip**

- **Warm-up Cycle**

- **Global Good Trip**

UNDERSTANDING GM OBD 2 SYSTEMS

NEED TO KNOW OBD 2 TERMS

Active Testing An action, taken by the PCM to actively test and monitor a specific component or sub system.

Class 2 Data Stream A type of digital data stream communication between the PCM and the scan tool that consists of a 7/0 toggle and is also pulse width modulated resulting in a faster communication line between the PCM and the scan tool. Some manufacturers do not use this updated quicker scan tool communication speed on their OBD 2 systems.

Diagnostic Various on board tests done by the PCM in order to check for malfunctions in sensors and output devices or sub systems to meet Federal Test Procedure Emmission Standards.

Diagnostic Executive Software programming inside the PCM that is responsible for conducting diagnostics, recording the results, arming or turning on the MIL and performing the test fail actions.

DTC The new term for a fault code, now known as a Diagnostic Trouble Code.

Enable Criteria These are the exact conditions the PCM needs to see before it can run diagnostics.

Fail Record An actual addition to the freeze frame function whereas the PCM will record various parameters that were occurring before and after a DTC was seen by the Diagnostic Executive. GMs PCM has the ability to store multiple fail records and update.

Freeze Frame The exact operating conditions of the vehicle are stored in memory by the PCM at the instant a DTC was set and the MIL was illuminated. The PCM will only store one freeze frame at a time, however GMs PCM will back the freeze frame up with fail records in the event of multible DTCs or DTCs that are not emission related.

Fuel Trim The PCMs adjustment of the air fuel ratio during closed loop to obtain a 14.7 to 1 air fuel ratio.

Intrusive Diagnostic Test An on board test that is sometimes conducted by the Diagnostic Executive to test a specific component or sub system. GM warns that this strategy can effect vehicle performance and can be felt by the driver.

MIL The new acronym for the Sevice Engine Soon Light indicating a failure and a DTC. To the technician MIL refers to "Money in Light".

Passive Testing A normal operation whereas the PCM monitors the component or system.

Statistical Filtering During the normal passive monitoring the PCM will chart the results to create a baseline. In so doing, the PCM is able to filter out information that could set a false DTC.

System Status A display of the cetain critical emission related systems, indicating whether or not the diagnostics have run, usually answered with a yes or no.

Trip A complete key on, engine run and key off power down cycle, where the enable criteria was met for a particular diagnostics and the diagnostic tests

were run.

UART Universal Asynchronous Receive and Transmit. The type of data stream used on non OBD 2 systems at a speed of 8.2 kilobits per second. Newer OBD 2 class 2 data is now at a speed of 10.4 kilobits per second.

Warm up Cycle A warm up cycle is defined as when the engine temperature rises at least 40°F from time of start up and reaches a minimum of 160°F. The PCM uses warm up cycles to erase DTCs. If the PCM does not see a repeated failure from a stored DTC after 40 key cycles the DTC will be erased automatically.

COMPREHENSIVE INPUT MONITORING

OBD I VS OBD II

The diagnostic strategy for monitoring inputs to the PCM have been greatly enhanced with OBD II systems. The OBD I systems did a good job of detecting a sensor from a hard failure, such as a circuit problem, but had its limitations on detecting a sensor that was simply out of range. The newer OBD II systems uses a rationality testing strategy to monitor the performance of the input devices. For example, the PCM monitors the performance of the ECT sensor at approxiamately 100 millisecond intervals for a fixed interval of time. The look up tables inside the PCM expect a certain value given on the time since engine start up. Should a fault occur from a deteriorating sensor the PCM counts the number ECT readings that are outside the sensors expected range. If there are enough fail readings beyond a certain calibrated value the PCM will set a DTC for the sensor. The PCM can detect either high or low voltage values that are out of the calibrated range over a given interval with any of a possible 5 different PO series codes and a possible 2 different PI series codes that not only look at an out of range voltage value but also look at an out of range temperature value.

The diagnostic for closed loop enable monitors the engine run time required for the ECT to reach the

closed loop enable threshold. This particular diagnostic strategy in intended to identify an ECT sensor reading that is delaying or preventing closed loop, yet has not failed out of range. Low coolant levels or missing or stuck thermostats may create a ECT related fault code.

Comprehensive Input Monitoring

- **Rationality Testing**
- **Circuit Continuity**
- **Learned Values**
- **Statistical Filtering**

Comprehensive Output Monitoring

- **Dynamic Voltage Values**

- **Voltage Drop across driver during actuation**

Types of DTCs

- **Type A - Emission related. Turns on MIL on first failure.**

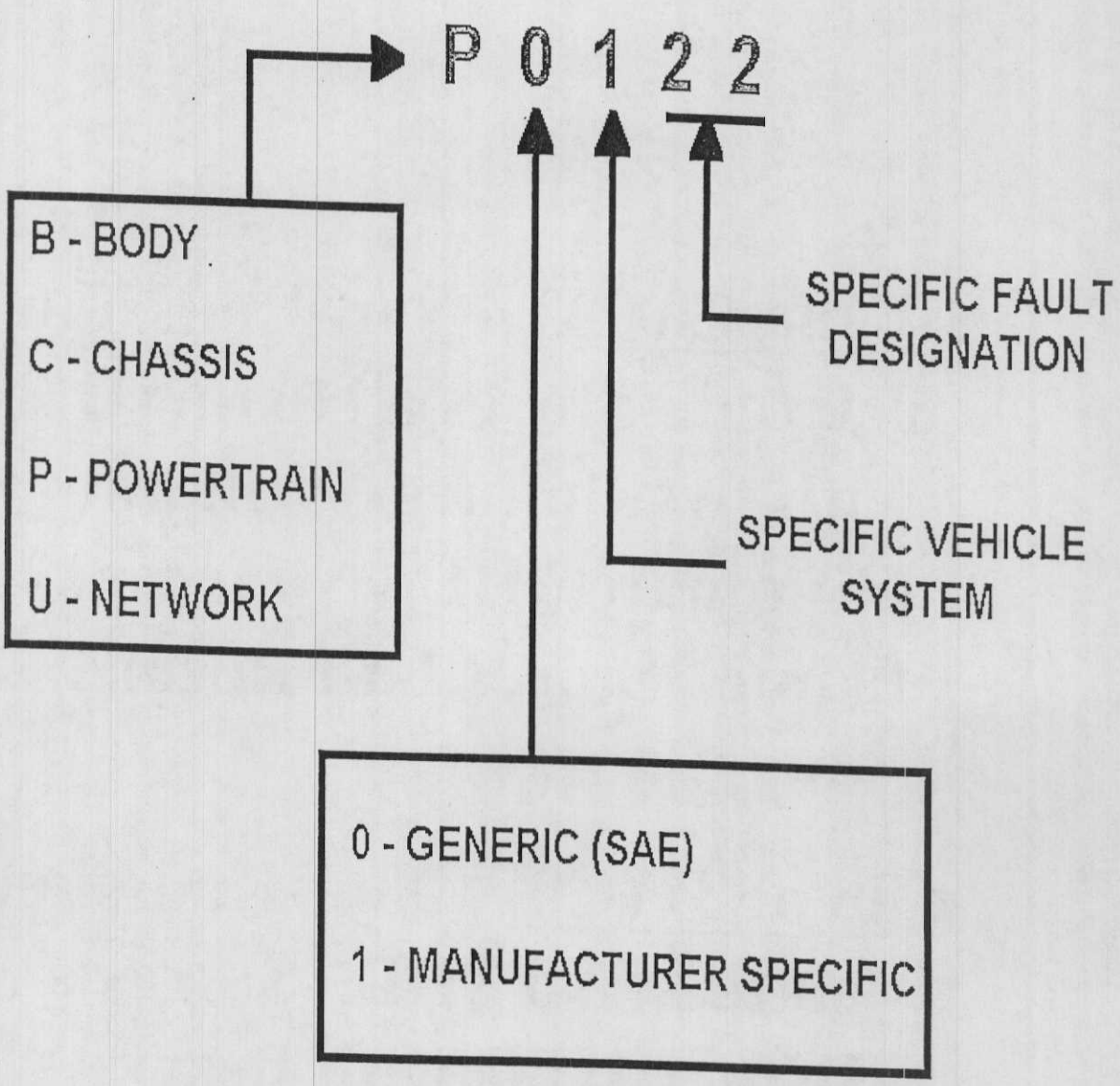
- **Type B - Emission related. Arms MIL on first failure. Disarms after 1 trip with pass. Turns on MIL on 2nd consecutive failure.**

Types of DTCs

- **Type C (C1) - Non-Emission related. Stores a History DTC with first failure. Will not illuminate MIL. No freeze frame. Stores Fail Record.**

- **Type D (C0) - Non-Emission related. No MIL. Stores a History DTC with first failure. No freeze frame. Stores Fail Record.**

OBD II Code Format



Enable Criteria for a DTC varies by Body and Engine Specific

DIAGNOSTIC TROUBLE CODE SYSTEM IDENTIFICATION (DTC)

1- FUEL AND AIR METERING

2- FUEL AND AIR METERING (INJECTOR CIRCUIT MALFUNCTIONS ONLY)

3- IGNITION SYSTEM OR MISFIRE

4- AUXILIARY EMISSION CONTROLS

5- VEHICLE SPEED CONTROL OR IDLE CONTROL SYSTEM

6- COMPUTER OUTPUT CIRCUIT

7- TRANSMISSION

8- TRANSMISSION

THE LAST TWO DIGITS INDICATE THE COMPONENT OR SECTION OF THE SYSTEM THAT HAS THE FAULT.

OBD II Code Types

	Number Of Consecutive Failed Trips	Serve Engine Soon Lamp	History	Other Service Lamp (ABS,Etc.)	Freeze Frame	Failure Record
A	1	X	X		X	X
B	1					X
	2	X	X		X	X
C	1		X	X		X
D	1		X			X
X	1					

OBD II Diagnostic Trouble Codes

Code	System	Fault	Code Type
P0106	MAP Sensor	Out of Range	B
P0107	MAP Sensor	Voltage Low	A
P0108	MAP Sensor	Voltage High	A
P0112	IAT Sensor	Temp High	A
P0113	IAT Sensor	Temp Low	A
P0117	ECT Sensor	Temp High	A
P0118	ECT Sensor	Temp Low	A
P0121	TPS	Out of Range	B
P0122	TPS	Voltage Low	A
P0123	TPS	Voltage High	A
P0125	Cooling System	Temp Low	B
P0131	O2 Sensor	Low Voltage	B
P0132	O2 Sensor	High Voltage	B
P0133	O2 Sensor	Slow Response	B
P0134	O2 Sensor	No Response	B
P0137	Rear O2	Low Voltage	B
P0138	Rear O2	High Voltage	B
P0140	Rear O2	No Response	B
P0141	Rear O2	Heater Circuit Fault	B
P0171	Fuel Trim	System Lean	A
P0172	Fuel Trim	System Rich	A
P0201	Cylinder 1	Injector Fault	D
P0202	Cylinder 2	Injector Fault	D
P0203	Cylinder 3	Injector Fault	D
P0204	Cylinder 4	Injector Fault	D
P0205	Cylinder 5	Injector Fault	D
P0206	Cylinder 6	Injector Fault	D
P0207	Cylinder 7	Injector Fault	D
P0208	Cylinder 8	Injector Fault	D
P0217	Temp Light	Engine Hot Temp	D
P0218	Temp Light	Transaxle Hot	D
P0300	Any Cylinder	Random Misfire	A or B
P0301	Cylinder 1	Misfire	A or B
P0302	Cylinder 2	Misfire	A or B

Code	System	Fault	Code Type
P0303	Cylinder 3	Misfire	A or B
P0304	Cylinder 4	Misfire	A or B
P0305	Cylinder 5	Misfire	A or B
P0306	Cylinder 6	Misfire	A or B
P0307	Cylinder 7	Misfire	A or B
P0308	Cylinder 8	Misfire	A or B
P0326	Knock Sensor	Constant Knock	D
P0327	Knock Sensor	Circuit Fault	B
P0336	Crank Sensor	Erratic Signal	A
P0340	Cam Sensor	No Signal	B
P0341	Cam Sensor	Signal Error	B
P0351	Ignition	Faulty	D
P0352	Ignition	Faulty	D
P0401	EGR	Insufficient Flow	A
P0420	Converter	Low Efficiency	A
P0440	EVAP Purge	System Fault	A
P0443	EVAP Purge	Circuit Fault	D
P0500	VSS Sensor	No Signal	A
P0506	Idle RPM	Too Low	B
P0507	Idle RPM	Too High	B
P0560	Battery Voltage	Out Of Range	D
P0561	Battery Voltage	Unstable	D
P0562	Battery Voltage	Low	D
P0563	Battery Voltage	High	D
P0565	Cruise Control	Circuit Fault	D
P0571	Brake Switch	Circuit Fault	D
P0572	Brake Switch	Low Voltage	D
P0573	Brake Switch	High Voltage	D
P0600	PCM	No Serial Data	A
P0601	EPROM	Fault	A
P0602	PCM Program	Fault	A
P0603	PCM DTC Memory	Fault	A
P0604	PCM RAM Memory	Fault	A
P0605	EEPROM	Fault	D
P0606	PCM Processor	Fault	A
P0721	VSS Sensor	Signal Noisy	A
P0722	VSS Sensor	No Signal	A
P0727	Engine RPM	Signal Fault	A

CLEARING DTCs

METHOD 1

Tech 1, Tech 1A or the Master Tech scan tool can be used to clear DTC information. However, this will also clear the Freeze Frame and the Fail Record data. Also the system status flags and statistical filtering will also be cleared if the DTCs involved those systems.

METHOD 2

A loss of battery power to the PCM will erase all DTCs, Freeze Frame, Fail Records, System Status and Statistical Filtering. (not a good idea)

METHOD 3

Once the fault has been corrected, the Diagnostic Executive will begin to count the warm up cycles. Once it has seen 40 consecutive warm up cycles the DTC will be cleared from the PCM memory. Dont confuse this procedure with the actual turning off of the MIL. If the PCM does not see a repeated failure it will usually turn of the MIL within 3 drive cycles.

DTC STATUS

DTC INFORMATION

HISTORY Lists DTCs that are stored in memory.

MIL REQUESTED Shows the DTCs that are requesting the illumination of the MIL.

LAST TEST FAIL This lists the DTCs that have failed the last test that was run.

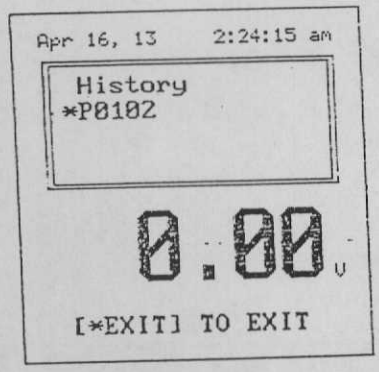
TEST FAIL SINCE CODE CLEARED (SCC) This lists the DTCs that have failed since the last time the DTCs were cleared.

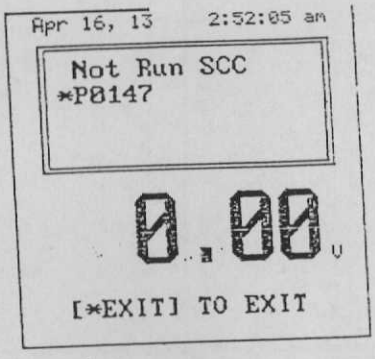
NOT RUN SINCE CODE CLEARED (SCC) This lists the DTCs that have not had their diagnostics ran since the last time the codes were cleared, therefore, their status would be unknown.

FAIL THIS IGNITION Shows you the DTCs that have failed the current key cycle.

DTC STATUS This is the easy way. The DTC status will display a YES when the diagnostics have ran and a NO when not. If the DTC fails again the DTC will be listed. If the DTC diagnostics have run and the Diagnostic Executive does not show a failure the DTC will not be listed. INT would mean a possible

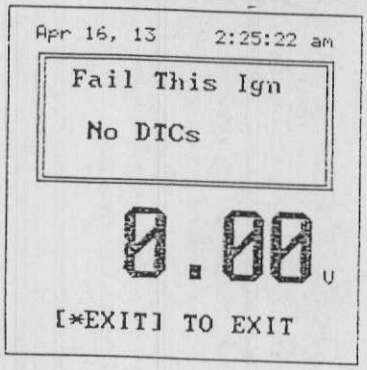
Intermittent. This would be the best way to test drive the vehicle and watch the DTC status as the Diagnostic Executive displays the tests from the hopefully corrected DTC.

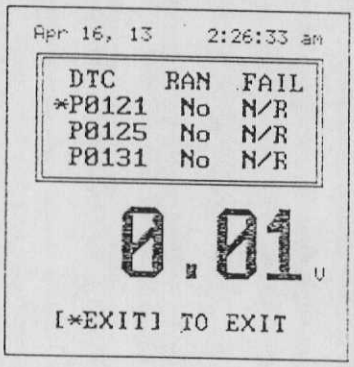


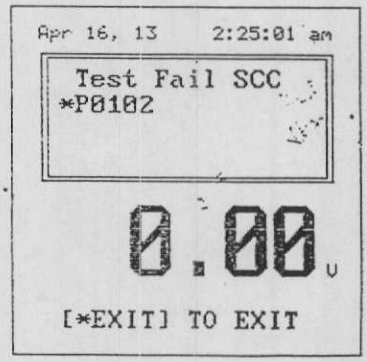


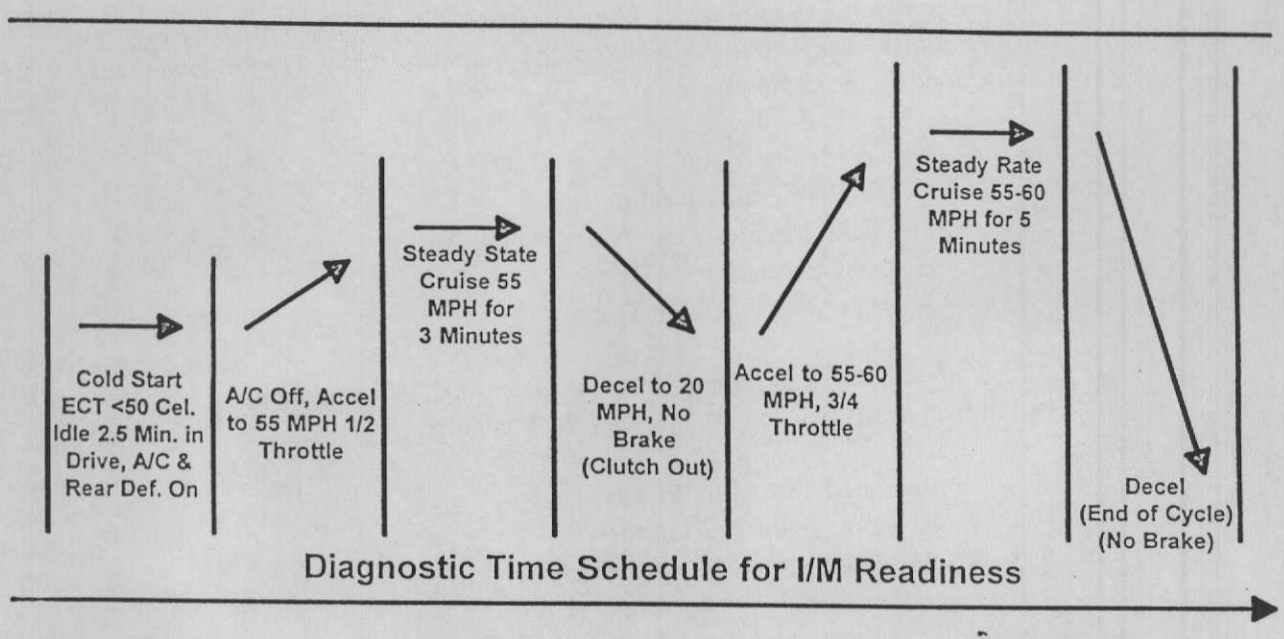
OBD II DTC Status Chart

FAIL	DTC	RAN
YES	P0131	YES
INT	P0118	INT
-------	P0116	NO








Cold Start ECT <50 Cel. Idle 2.5 Min. in Drive, A/C & Rear Def. On
A/C Off, Accel to 55 MPH 1/2 Throttle
Steady State Cruise 55 MPH for 3 Minutes
Decel to 20 MPH, No Brake (Clutch Out)
Accel to 55-60 MPH, 3/4 Throttle
Steady Rate Cruise 55-60 MPH for 5 Minutes
Decel (End of Cycle) (No Brake)
Total Time = 12 Minutes
Diagnostic Time Schedule for I/M Readiness
HO2 Heater, AIR, Purge
Misfire, Fuel Trim, Purge
EGR, AIR, HO2, Purge
EGR, Purge
Misfire, Fuel Trim Purge
CMS, Misfire, EGR, Fuel Trim, HO2, Purge
EGR, Purge

NOTES

Typical General Motors Drive Cycle

Warm Up Cycle

A test of the oxygen sensor heater is performed during warm up and must be completed prior to driving. Using a scan tool, verify the engine is at normal operating temperature and is ready to begin the test drive.

Driving Instructions

1. *Idle engine for 2 ½ minutes. Then, to assist in identifying a misfire, supply an added load by turning on the A/C and rear window defroster.* The following tests will be performed by the computer:

- Engine Misfire Monitor Test
- Evaporative Purge Monitor Test
- Fuel Trim Monitor Test (test of fuel delivery)
- Heated Oxygen Sensor Heater Test
- Secondary Air Injection Test

2. *Turn off the A/C and rear window defroster and half-throttle accelerate to 55 MPH.* The following tests will be performed by the computer:

- Engine Misfire Monitor Test
- Evaporative Purge Monitor Test
- Fuel Trim Monitor Test (test of fuel delivery)

3. *Continue to drive vehicle steady at 55 MPH for 3 minutes.* The following tests will be performed by the computer:

- Engine Misfire Monitor Test
- EGR Monitor Test
- Evaporative Purge Monitor Test
- Fuel Trim Monitor Test (test of fuel delivery)
- Heated Oxygen Sensor Response Test (test for slow reaction)
- Secondary Air Injection Test (intrusive testing)

4. *Without using the brake or clutch (on M/T Models), decelerate the vehicle to 20 MPH.* The following tests will be performed by the computer:

- EGR Monitor Test
- Evaporative Purge Monitor Test
- Fuel Trim Monitor Test (test of fuel delivery)

Typical General Motors Drive Cycle *(Continued)*

5. *Three-quarter throttle accelerate to 60 MPH.* The following tests will be performed by the computer:

- Engine Misfire Monitor Test
- Evaporative Purge Monitor Test
- Fuel Trim Monitor Test (test of fuel delivery)

6. *Continue to drive vehicle steady at 60 MPH for 5 minutes.* The following tests will be performed by the computer:

- Catalytic Converter Monitor Test
- Engine Misfire Monitor Test
- EGR Monitor Test
- Evaporative Purge Monitor Test
- Fuel Trim Monitor Test (test of fuel delivery)
- Heated Oxygen Sensor Response Test (test for slow reaction)
- Secondary Air Injection Test (intrusive testing)

7. *Without using the brake or clutch (on M/T Models), decelerate the vehicle to 20 MPH.* The following tests will be performed by the computer:

- EGR Monitor Test
- Evaporative Purge Monitor Test
- Fuel Trim Monitor Test (test of fuel delivery)

A scan tool can be used to monitor each test completion; however, do not use the ALDL mode with the scanner as the idle air control monitor will be blocked. Find the conditions that were present when the code was set by using the freeze frame data. This data can also be used to assist in locating the areas that need tested. **Note: Some codes take two trips to active the MIL and this test drive accounts for only one trip.**

OBD II I/M System Status Flags

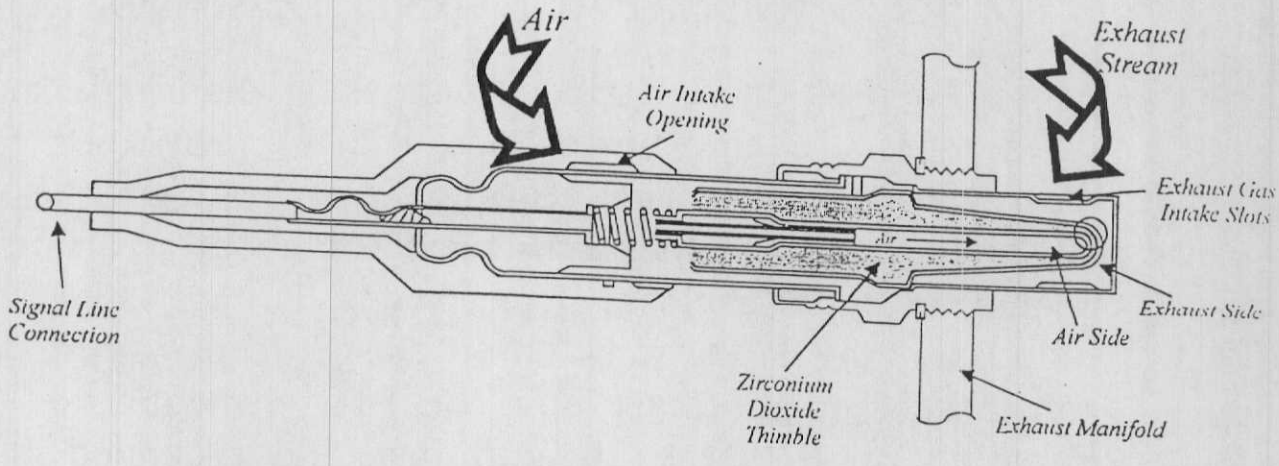
Complete	Test
Y	EVAP
Y	EGR SYSTEM
Y	HO2S HEATER
Y	HO2S
Y	CATALYST

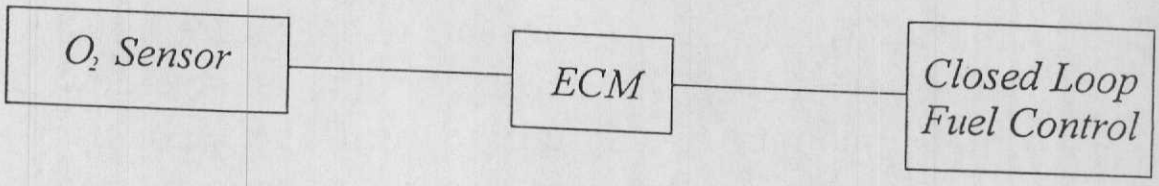
- Not all Scan Tools answer 'Yes' or 'No'

HO2S INTERFACE AND DIAGNOSIS

To meet more stringent emission standards most 02 sensors are now heated and indicated by the abbreviation HO2S. The heating element allows the HO2S to reach an operating temp. of about 670°F sooner to enter a closed loop mode. By most EPA standards the PCM must enter closed loop within 3 minutes of engine start up. The PTC element is powered up thru the 20 amp fuse and grounded at the block. When the 02 sensor temperature is low the ohmic value of the heater circuit is also low allowing high amounts of current to heat the element. As its temperature goes up so too does its ohmic value which limits the current flow.

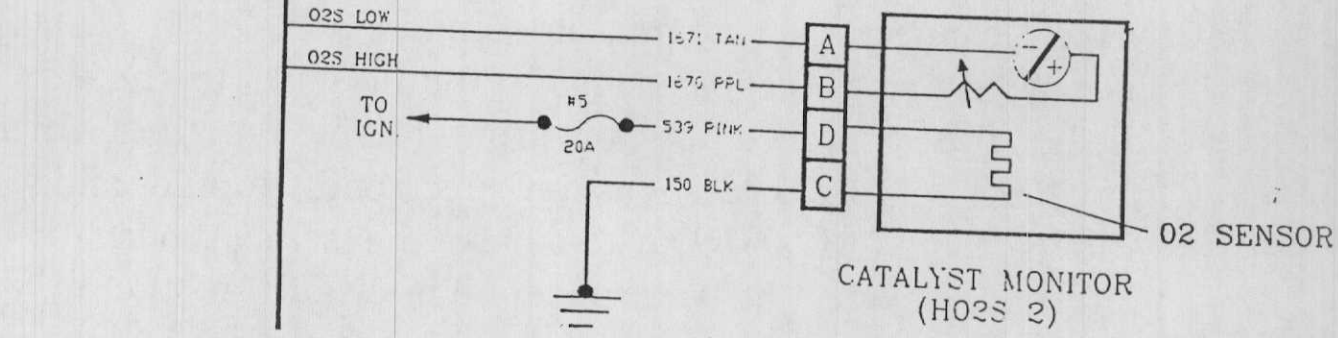
The H02S sensor is wired differently to the PCM on GM OBD II systems. The HO2s od OBD II systems have a high reference and a low reference, which connect to a comparator inside the PCM. Instead of hard wiring the 02 sensor ground wire to the block, the reference low or ground now is wired thru the PCM and is known as an electronic ground and allows the PCM and O2 to share the same ground reference level. The reference high circuit is the voltage signal generated by the 02 sensor in relationship to exhaust 02 content. Should the harness need to be unhooked to check the 02 signal with a DVOM or lab scope, it will be necessary to jumper the reference low wire to ground.





VCM/PCM

HEATED 02 SENSOR DIAGNOSTICS



NOTES

02 SENSOR DESIGNATIONS

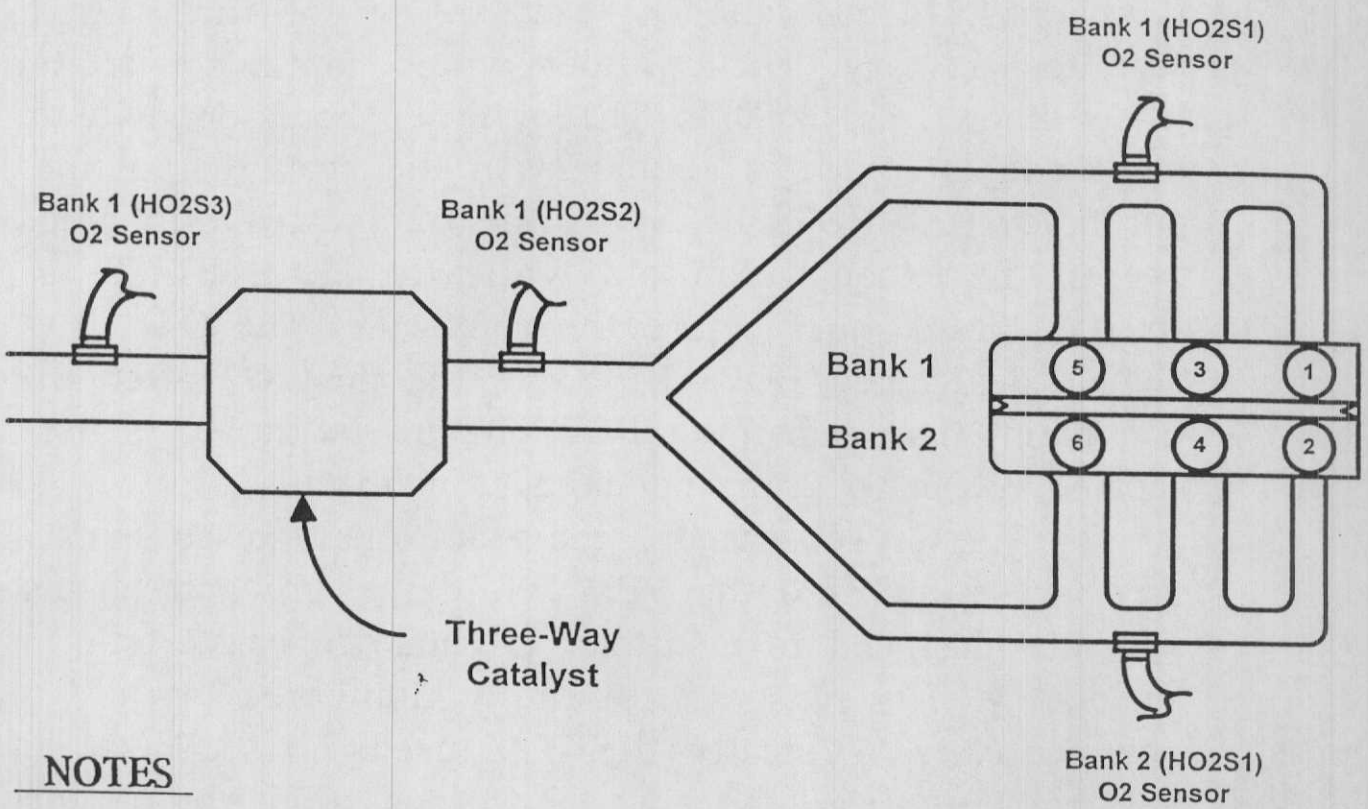
You may see as many as 6 02 sensors on OBD II systems. Identification of each 02 sensor thru the scan tool is easy. The cylinder which contains cylinder #1 is known as bank 1. The cylinder bank opposite of bank one is known as bank 2. In the scan tool print out below the HO2S B1 S1 is the 02 located off bank one in the exhaust manifold while the HO2S B1 S2 is the 02 located just before the converter. The O2 sensor designated HO2S B1 S3 is the post O2 after the converter. The remaining HO2S B2 S1 is the 02 sensor located off bank 2 in the exhaust manifold.

The S1 sensors are the traditional closed loop feedback input into the PCM while the pre and post 02s are designed to monitor the catalytic converter efficiency. The sensors are simply numbered consecutively. Typically the PCM needs to see 60% less activety from the post 02 versus thhe pre 02 for good catalyst efficiency. The individual performance of each 02 sensor can be monitored by the scan tool in three areas:

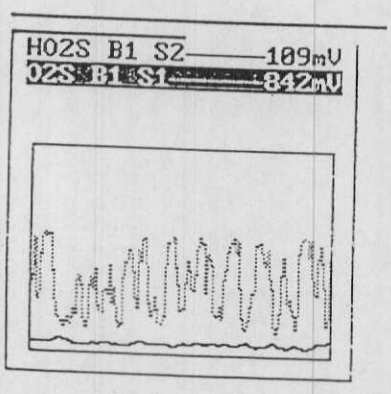
1. Time to activity
2. Response time
3. Sensor voltage

```
O2 SENSOR TEST (B1 - S1)

R>L O2S V..............  0.495V
L>R O2S V..............  0.495V
LOW SW V...............  0.295V
HIGH SW V..............  0.595V
R>L SW TIM.............  0.044s
L>R SW TIM.............  0.020s
```



NOTES

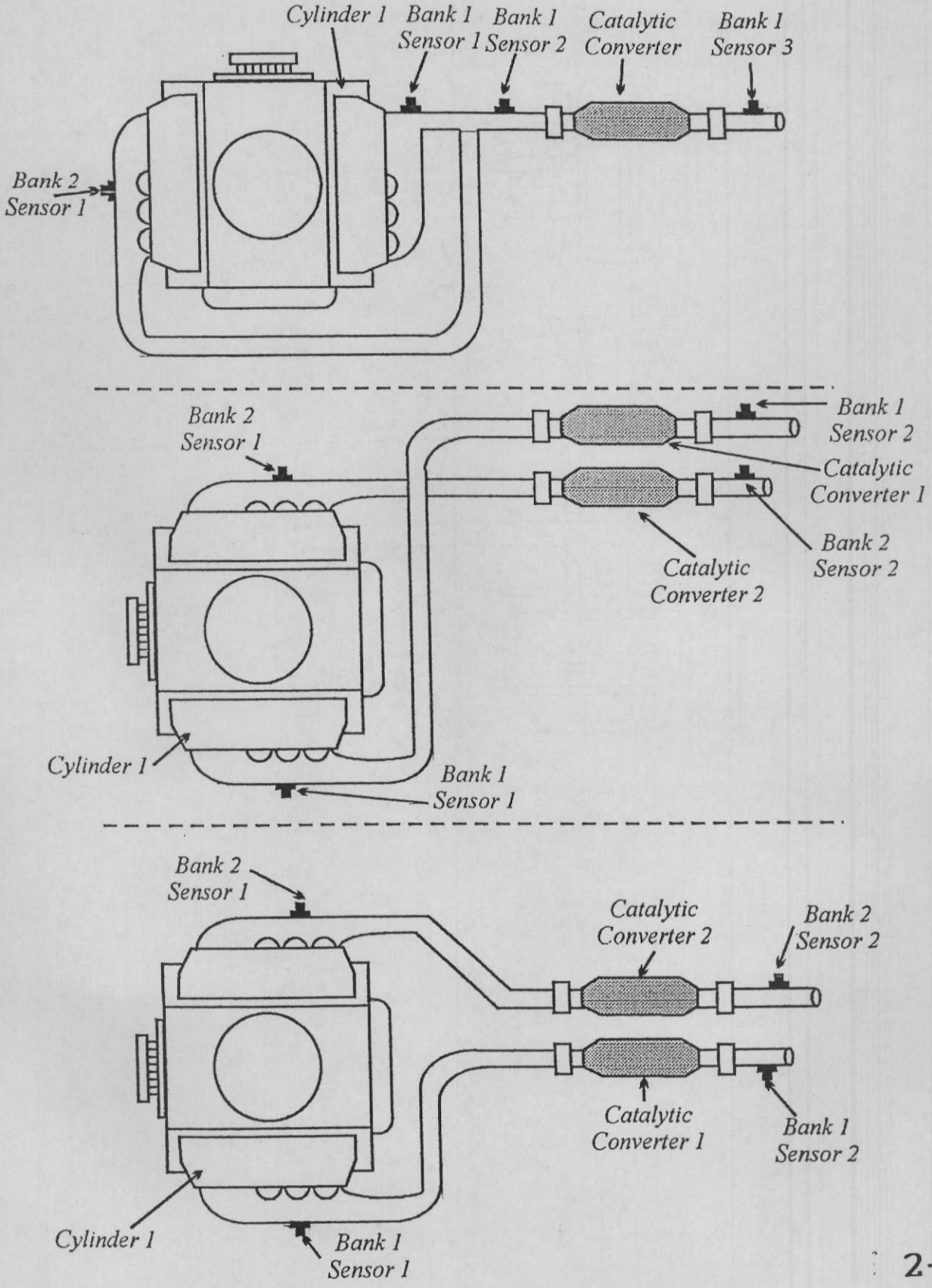


EST (B2 - S1)

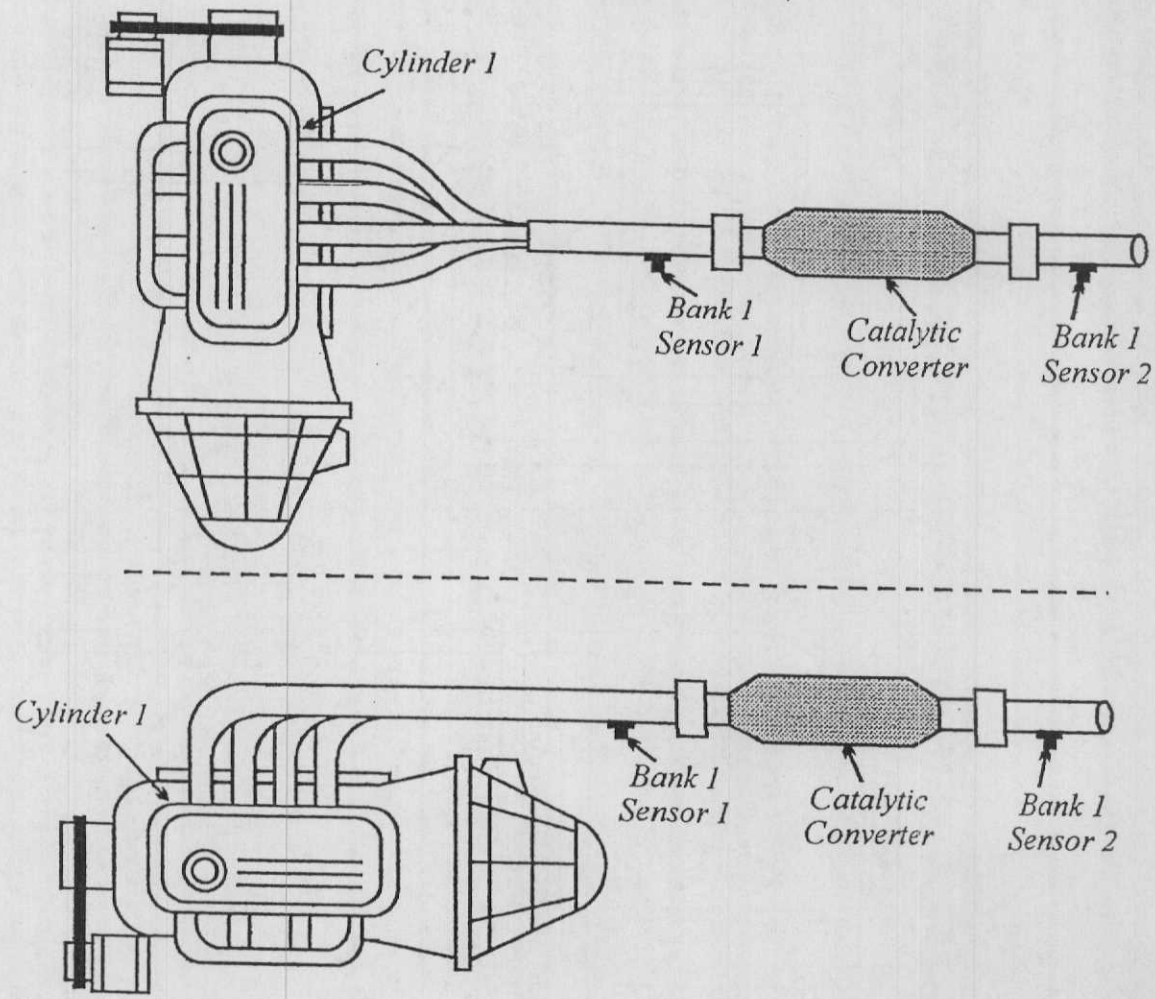
R↘L O2S V	0.495V
L↘R O2S V	0.495V
LOW SW V	0.295V
HIGH SW V	0.595V
R↘L SW TIM	0.032s
L↘R SW TIM	0.020s
TID $70	241CNT
TID $71	237CNT
TID $81	53

Eight Cylinder Oxygen Sensor Designations

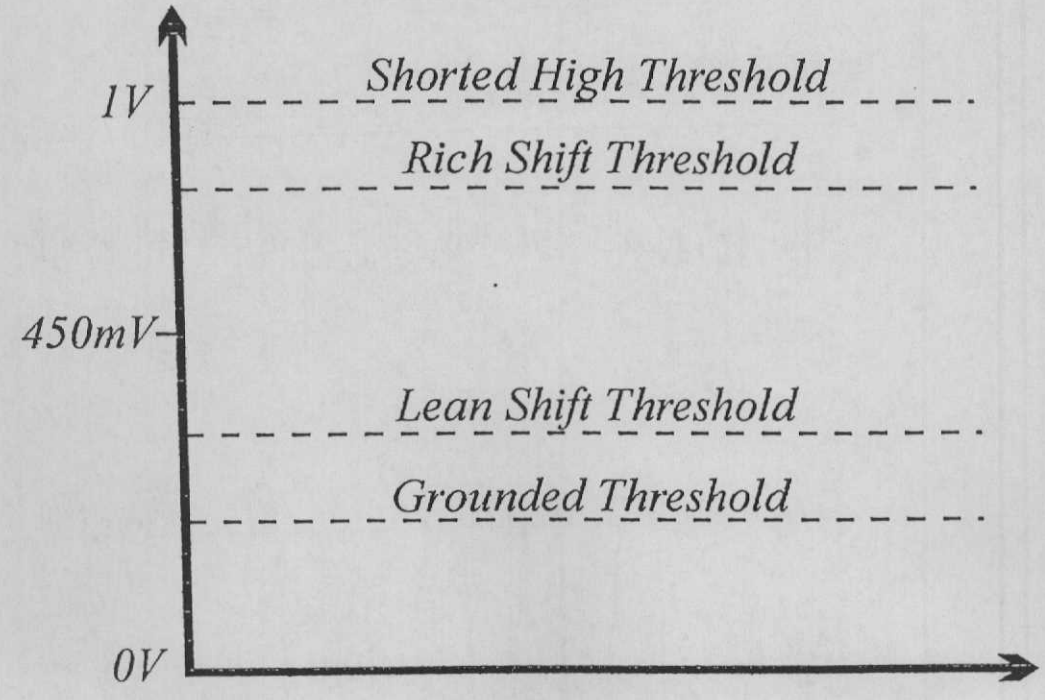
(1996 through 1998 vehicles)



Four Cylinder Oxygen Sensor Designations
(1996 through 1998 vehicles)



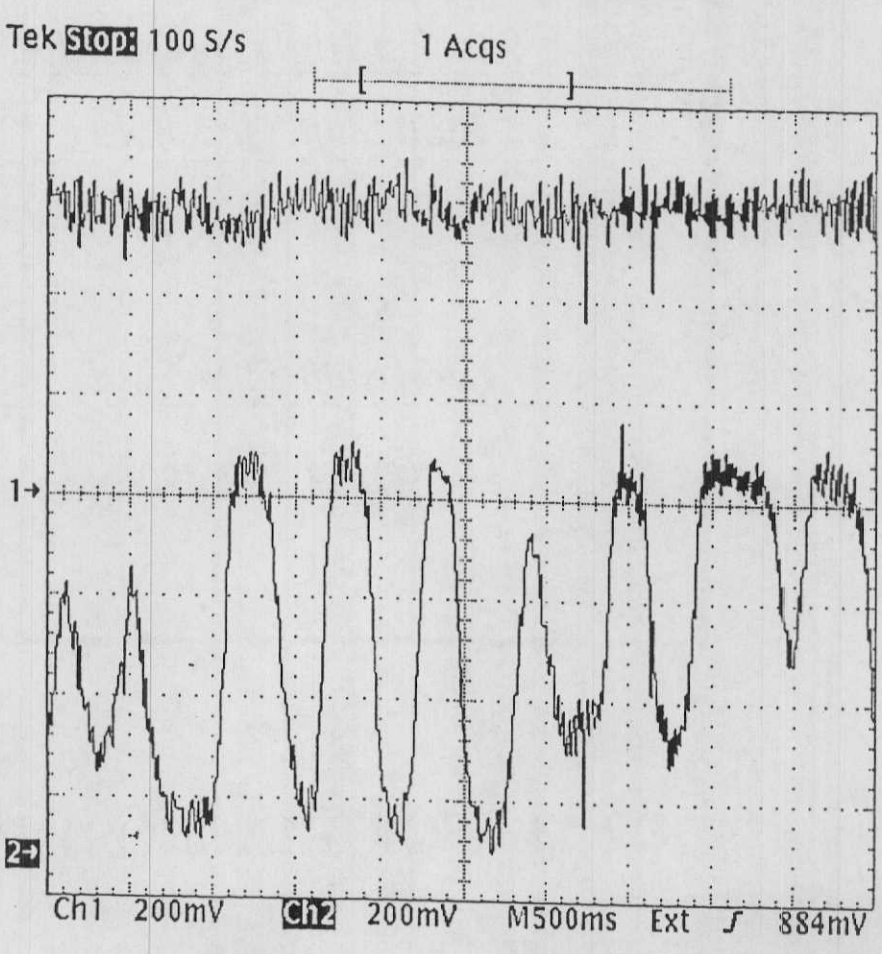
HO2S Voltage Test



O2 SENSOR DIAGNOSTICS

The voltage thresholds for a rich/lean transition will vary slightly by the engine VIN application and is sometimes indicated by the scan tool in the enhanced mode. On OBDII systems, the PCM will actually monitor the number of transitions and the rise time as well as the fall time of the O2 signal. There are numerous DTCs in GMs OBDII systems to flag slow and sluggish sensors as well as sensors that stay the the lean or rich area too long. In addition, the PO and P1 code charts in this manual will indicate by the body and engine specifics the code conditions which include the number of transitions and the switching times needed to set a DTC in this area.

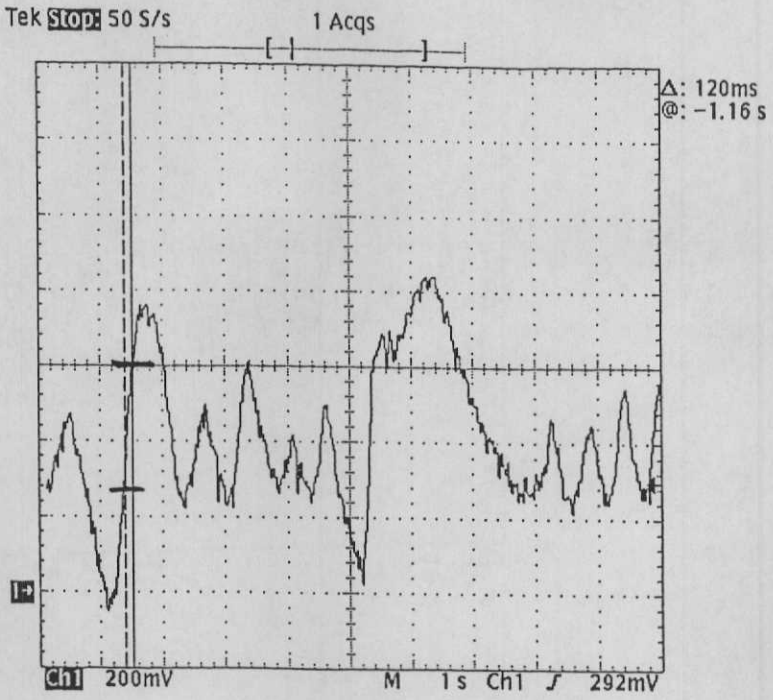
PRE AND POST O2



NOTES

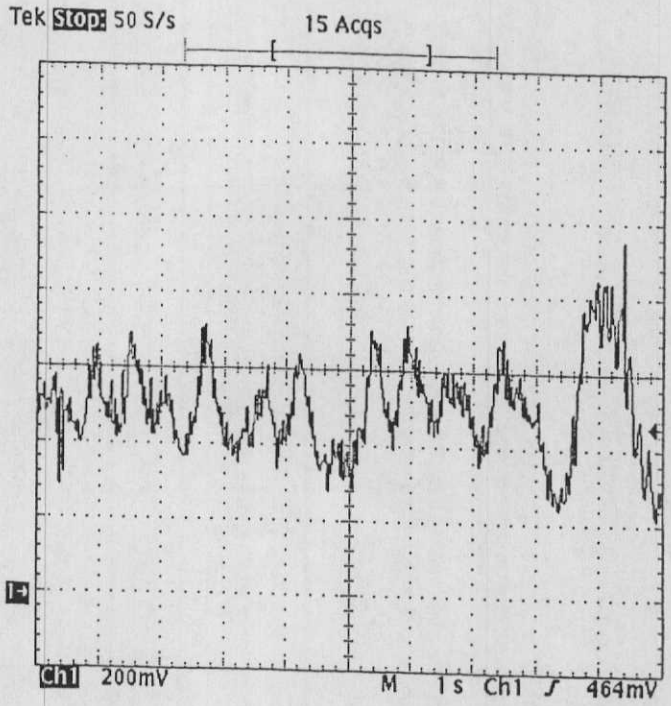
O2 SENSOR DIAGNOSTICS

This O2 sensor waveform captured off a high miliage OBD1 systems 02 sensor is indicating a slow sluggish response time. Note the cursors are measuring a lean to rich ramping from a induced enrichment. Notice that it took 120 milliseconds to ramp from 300 millivolts to 600 millivolts. Normally, the reaction time should not exceed 100 milliseconds. If you induce a lean condition the same time should not be exceeded. In addition, the zirconium type 02 sensor normally will take longer to make a rich to lean swing than a lean to rich swing.



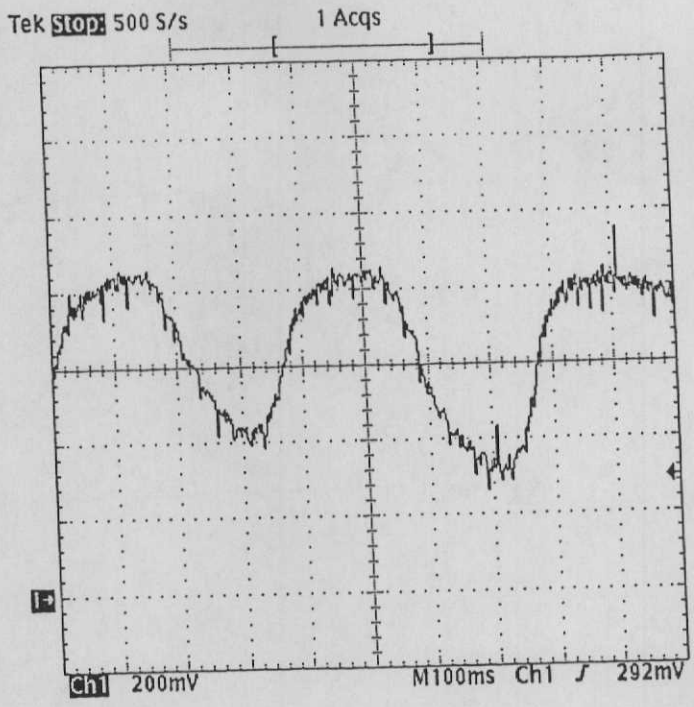
02 SENSOR DIAGNOSTICS

Beware of 02 sensor waveforms that show excessive hash. This is caused by incomplete combustion from anything that can create a misfire or a partial misfire. Keep in mind that the 02 sensor waveform only indicated a problem. Your ignition scope or lab scope will pinpoint the cylinder by viewing the spark line on the problem cylinder under various engine loads if needed.



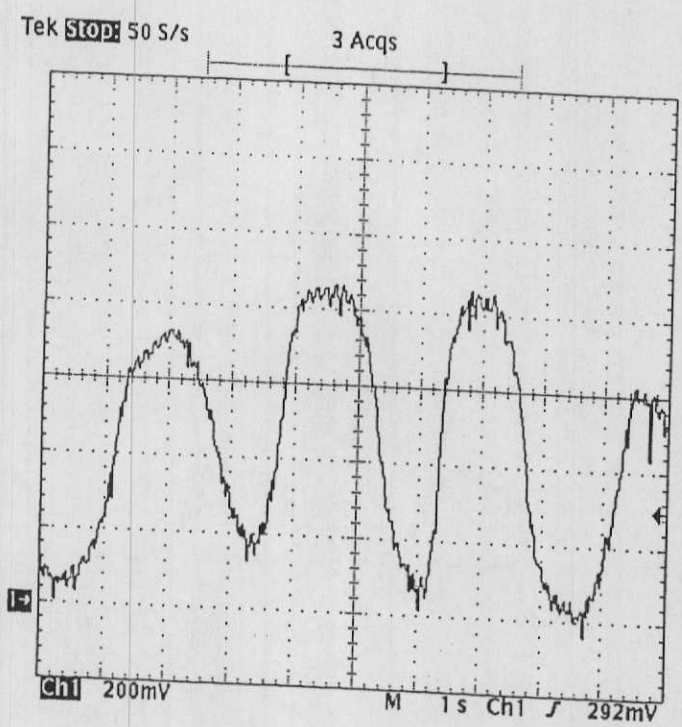
02 SENSOR DIAGNOSTICS

This waveform captured off a V-6 VIN W package is indicating a problem without the luxury of a fault code. Notice the number of transitions on the scope screen in the rich area numbers 5. This would be a normal amount of transitions on a 10 second window but notice the scope time base is set on 100 milliseconds per division which with 10 divisions of the screen horizontally represents a time of 1 second. Normally any more than 2 transitions during a 1 second period spells an air/fuel ratio problem. This problem was caused by leaking poppet nozzles.

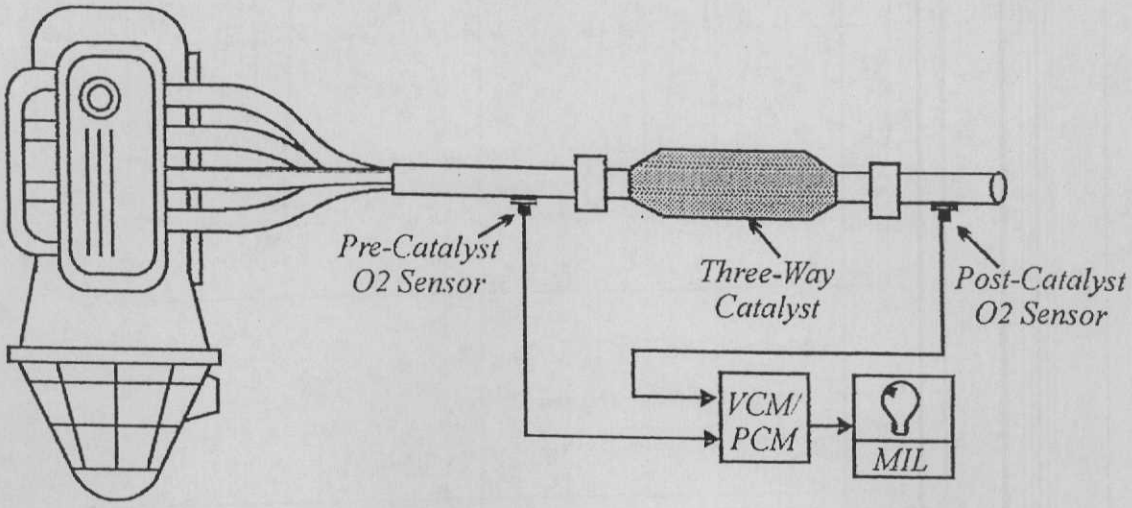


02 SENSOR DIAGNOSTICS

This waveform captured of the previous vehicle with the bad poppet valves is now indicating a good 02 sensor waveform with the problem fixed. Notice now with the scope set on a 1 second per division time base representing a full 10 seconds of time shows a normal lean to rich and rich to lean swing and a number of transitions numbering 7. The GM OBD1 systems did not have the diagnostics to monitor these factors whereas the OBDII systems are supposed to. TIME WILL TELL!



Idle Catalyst Diagnostic

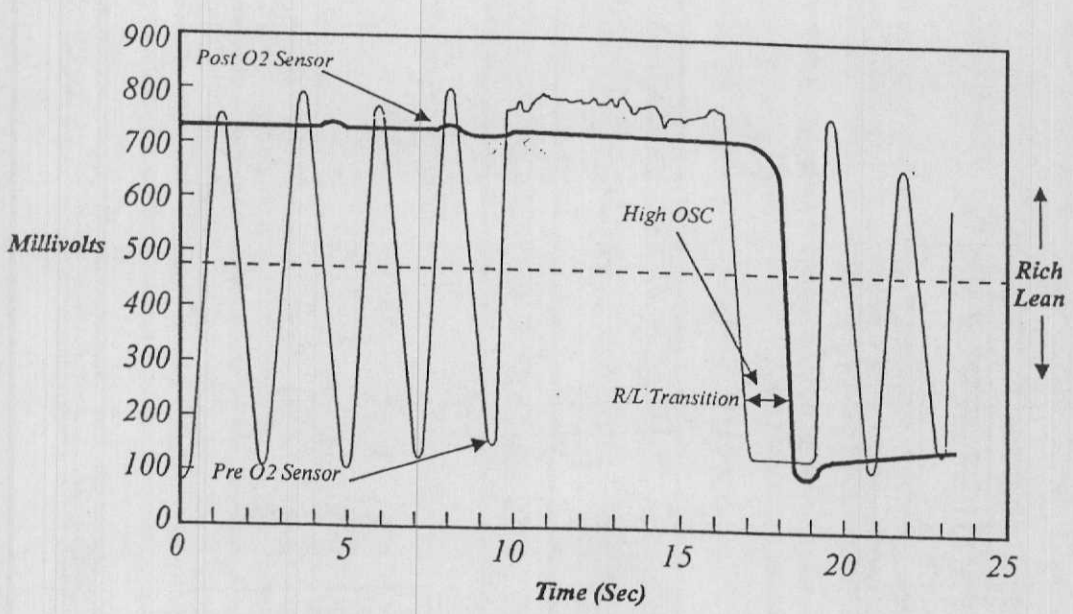


Beginning in 1998 a new diagnostic monitor has been added called the "idle catalyst monitor". The PCM will monitor the ability of the catalytic convertor to store oxygen molecules. During this strategy when the enable criteria has been met the PCM will drive the system rich to lean and then from lean to rich while monitoring the response time of the post O2 sensor in relationship to the pre O2 sensor. This monntor is designed to find degraded catalyst that cannot store the needed Oxygen molecules to support the reductoin of HC and CO.

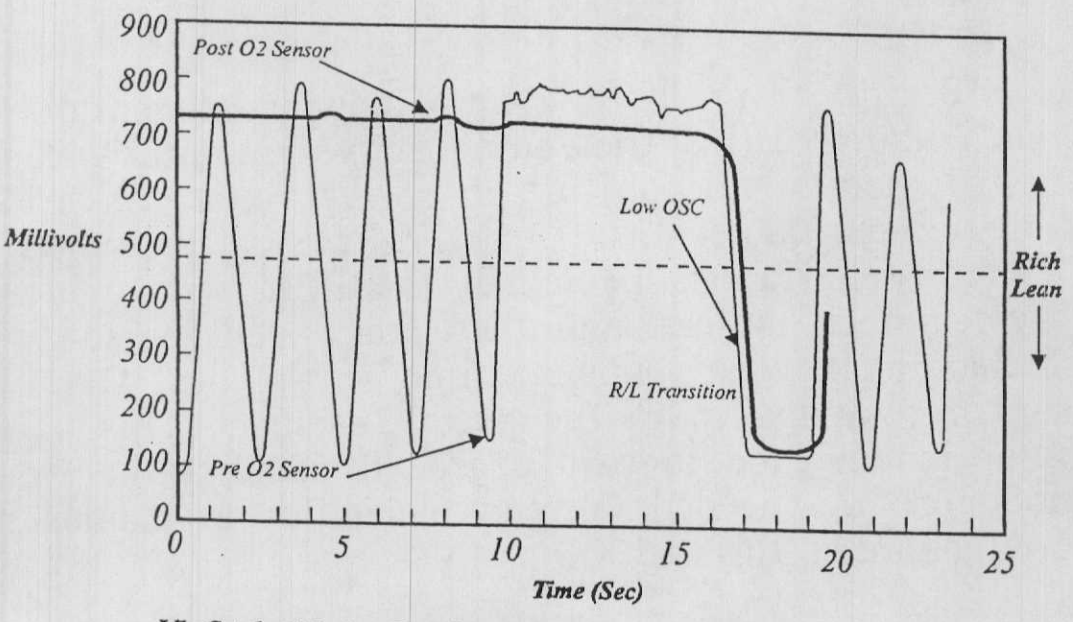
IDLE CATALYST MONITOR ENABLE CRITERIA

1. Must be within 150 RPM of desired idle.
2. In drive for an automatic transmission or neutral for a standard.
3. TPS AT 0%
4. ECT above 167°F.
5. IAT above -4°F and less than 176°F.
6. Short term fuel trim between -20% and +20%.

THE ENABLE CRITERIA VARIES SLIGHTLY WITH DIFFERENT ENGINGE PACKAGES.



Idle Catalyst Monitor (High Oxygen Storage)



Idle Catalyst Monitor (Low Oxygen Storage)

FUEL TRIM MONITORING

The PCM monitors the the averages of the long and short term fuel trim. If fuel trim values stay at their maximum limits for a period of time, a DTC will be set. Fuel Trim and misfire codes get priority from the Diagnostic Executive. As long as the Fuel Trim values remain inside the 10% window no faults will be detected and the 02 sensor has control authority. An example would be if a rich condition exists and and fuel authority stayed outside the the fail threshold the a DTC would be set for a rich condition. The PCM would also conduct an intrusive test to determine if the rich condition was being caused the EVAP canister.

There are 3 weighted cells out of the 16 cells. Each cell represents a specific RPM and load. The weighted cells are what the Diagnostic Executive pays attention to because these are popular engine speeds and loads. A fuel trim DTC can only be set if the fail threshold is exceeded in the weighted cells. What should be remembered is that the engine could have a lean density misfire occuring at idle or just off idle and the fuel trim monitors would not see it.

NOTES

FUEL TRIM DIAGNOSTICS

The fuel system is continuosly monitored during closed loop operation from feedback from the 02 sensor and engine load. The scan tool read out is given in a % value. 0% is ideal and is considered stoichiometric. Normally you will see the the Long Term and Short Term Fuel Correction drift in the range of -10% to a +10%. The + is an indication that the PCM is adding fuel and the - is an indication that the PCM is subtracting fuel. Numbers that consistently stay outside of the 10% area indicate a fuel trim problem.

NOTES

BLM Information

Perfect A/F Ratio 14.7 to 1

128	128	128	128
128	128	128	128
128	128	128	128
128	128	128	128

Slightly Lean Mixture

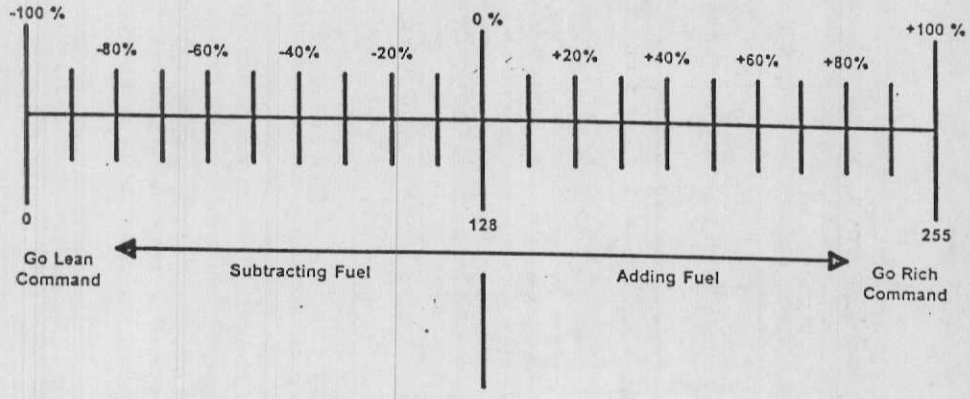
128	130	128	129
129	130	130	131
133	136	129	128
135	132	129	130

- High Numbers Indicate Lean Exhaust
- O2 Readings Low
- Computer Adds Fuel

Slightly Rich Mixture

121	124	128	128
119	120	119	121
115	117	116	121
122	119	126	120

- Low Numbers Indicate Rich Exhaust
- O2 Readings High
- Computer Subtracts Fuel



No Corrections 14.7 to 1 A/F Ratio

NOTES

HCE
(Hot Coolant Enrichment)

- **Enrichment Function**
- **DTC (P1483)**
- **No MIL**

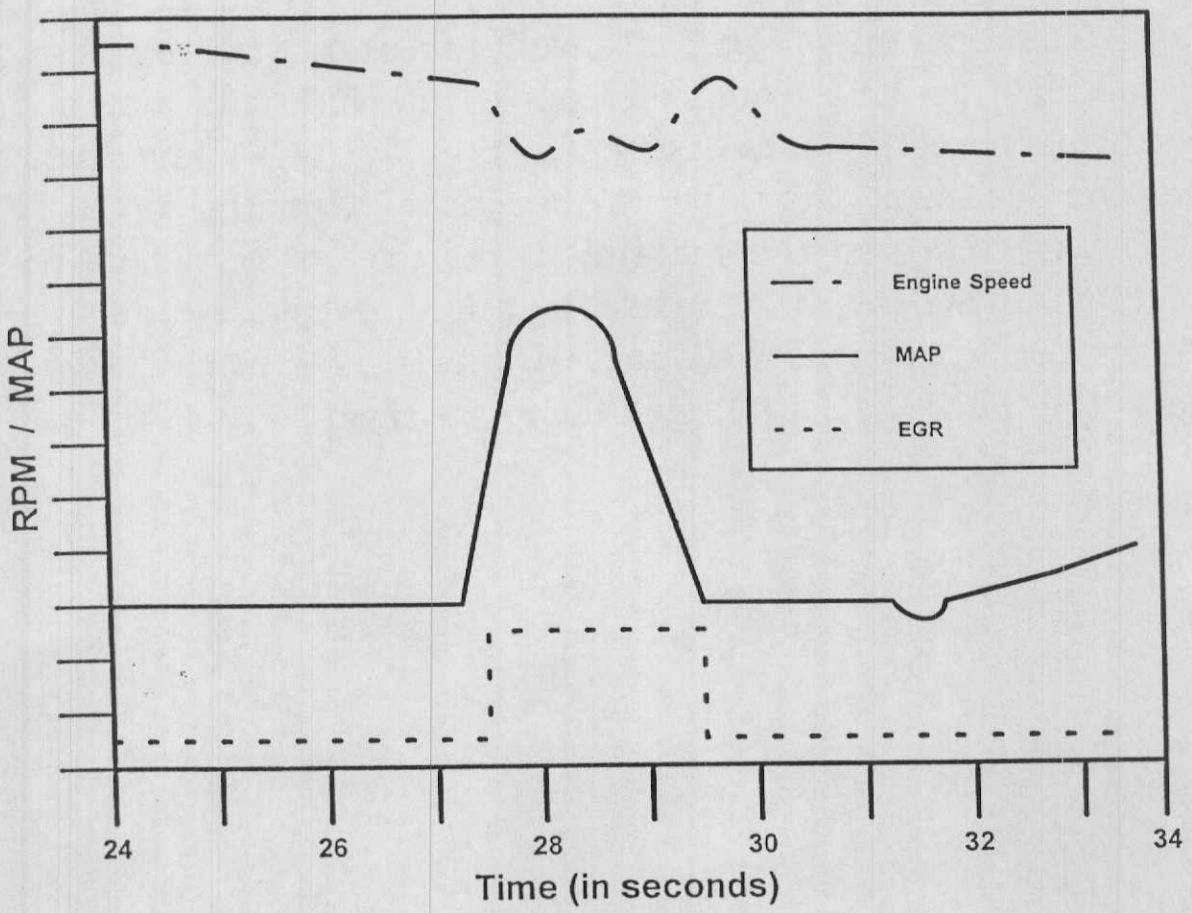
HOT COOLANT ENRICHMENT MODE (HCE)

Beginning in model year 1998 a new mode called Hot Coolant Enrichment mode has been added on some GM engine packages. This strategy is designed to richen up the air fuel ratio during hot engine conditions to reduce engine temperatures. Early HCE can be found on the 3.1 W car, the 3.4 U van. These systems will enter HCE when the temperature light comes on. Premium V-6 engines such as the 4.0 and 4.6 Olds and Cadillac engines will enter HCE before the Hot light comes on.

EGR DIAGNOSTICS

The amount of EGR allowed to enter the intake is critical for both emission control of NOX and engine performance. GM monitors the amount of EGR based on the the feedback from the MAP sensor. Opening up the EGR will increase the manifold pressure or MAP while decreasing EGR will decrease manifold pressure and lower the MAP sensor voltage. Using this strategy will help the PCM detect clogged EGR passages.

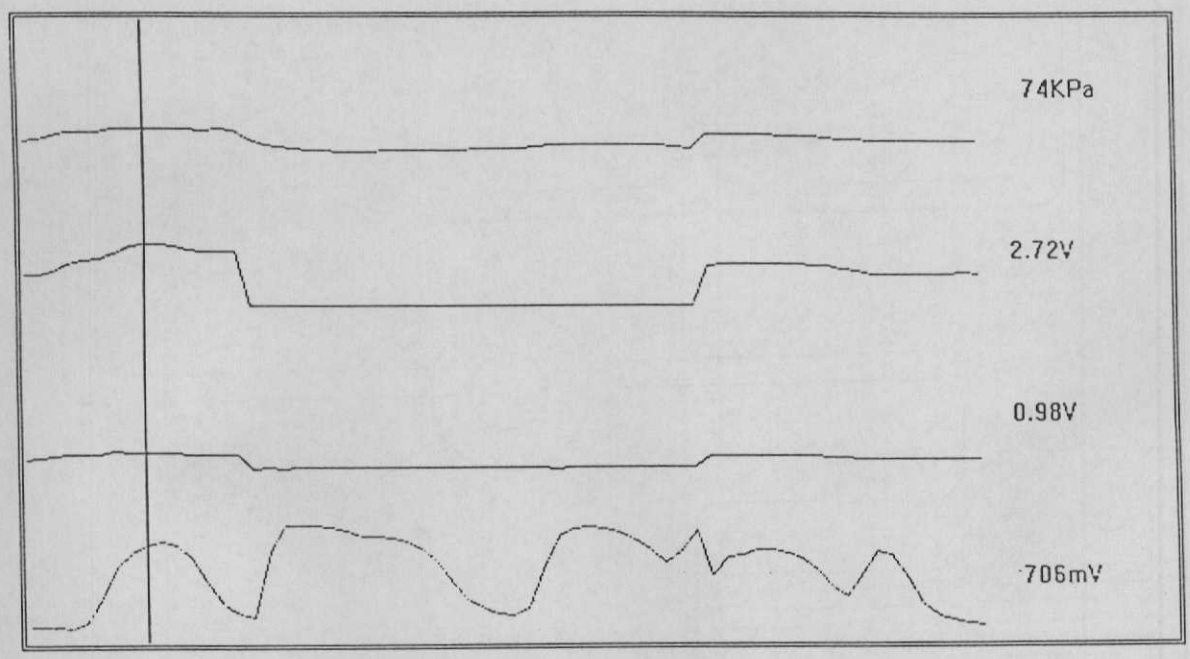
NOTES



NOTES

OHIO AUTOMOTIVE TECHNOLOGY

Snapshot "C:\WINDOWS\WINDOWS~1\TVP\SNP\VAN2.SNP" [-63 to 0] Sample # -55



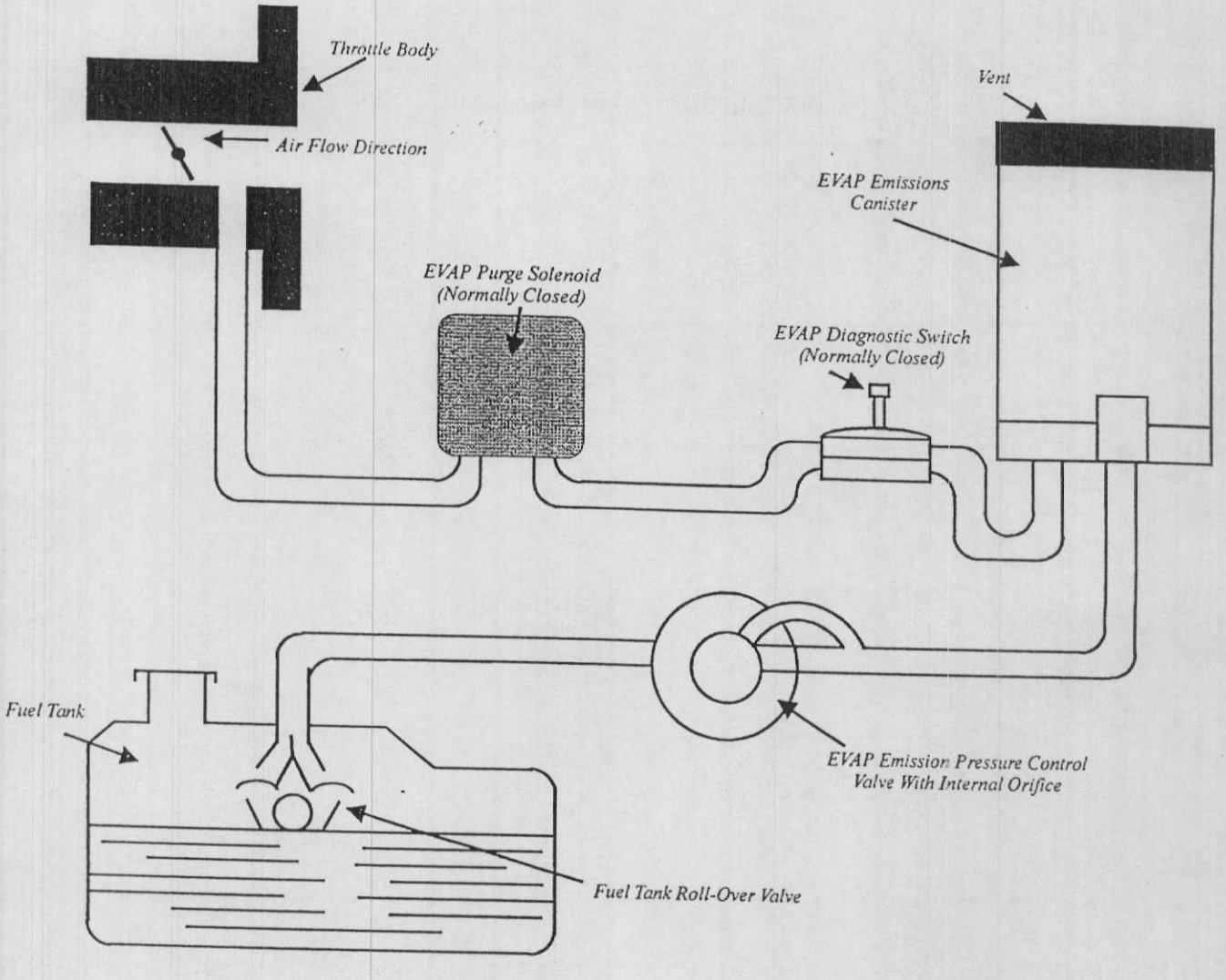
MAP (P)
select 1

EGR Position
select 2

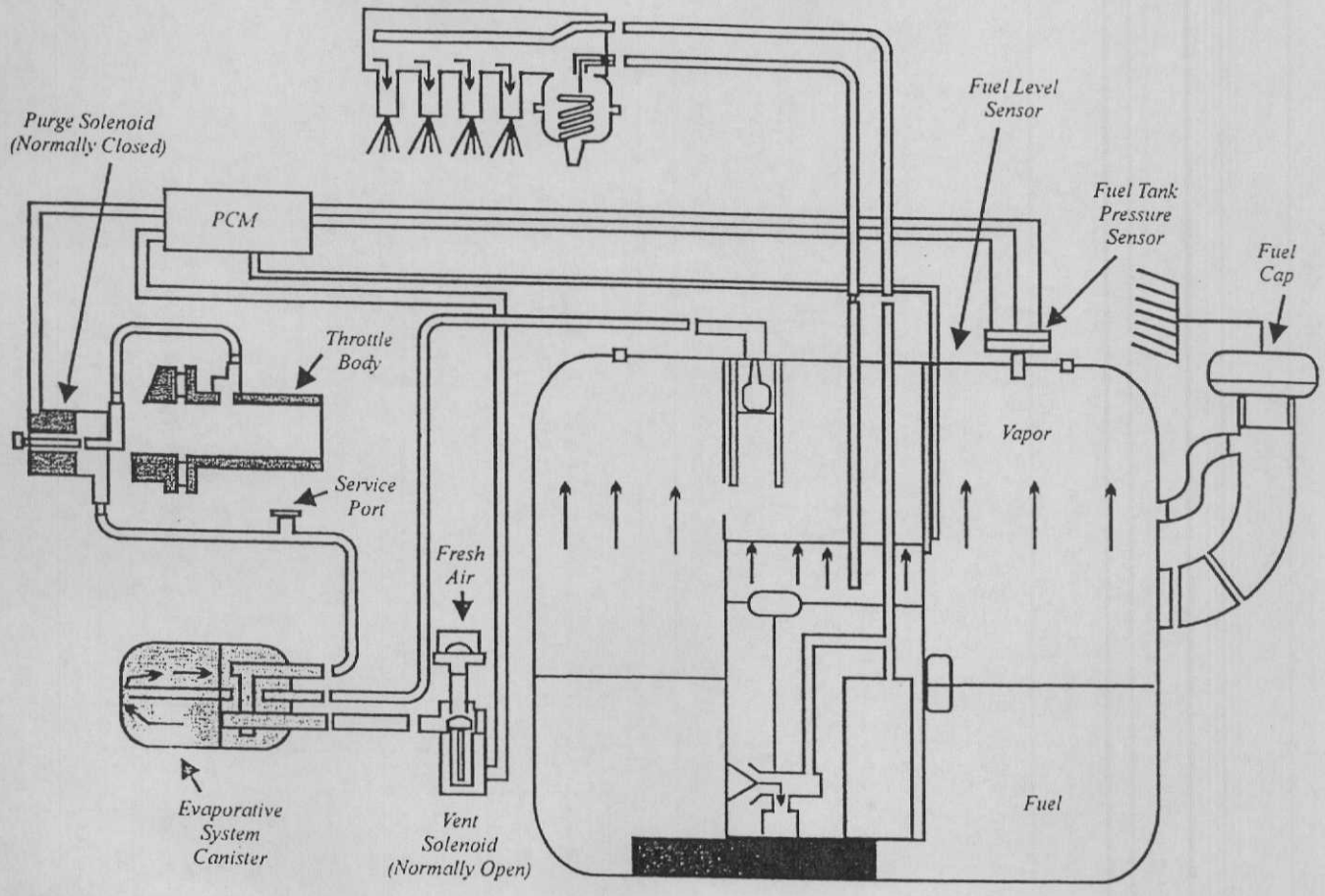
Throttle Pos
select 3

O2 Sensor
select 4

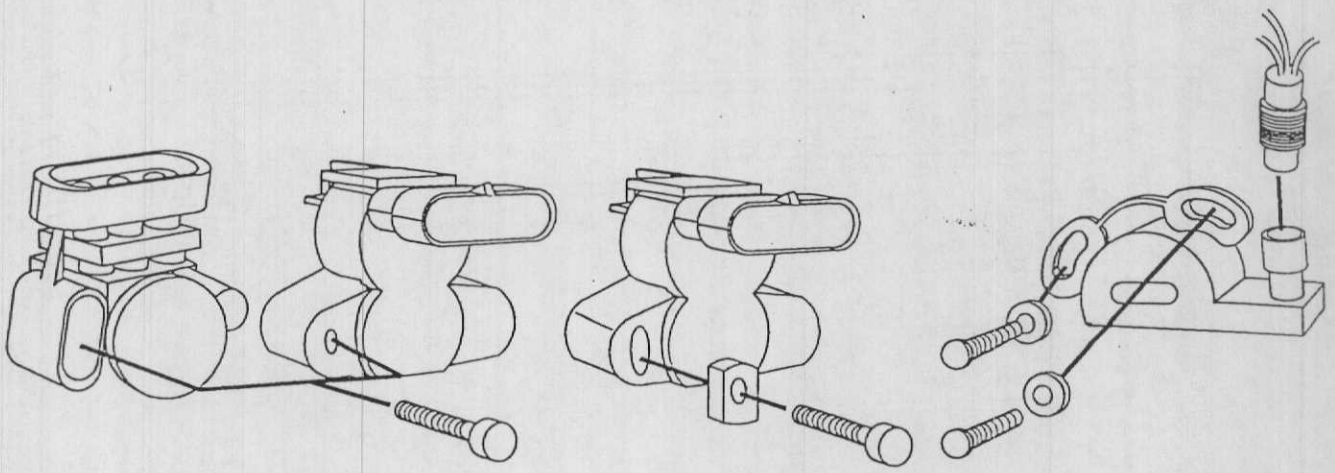
NOTES

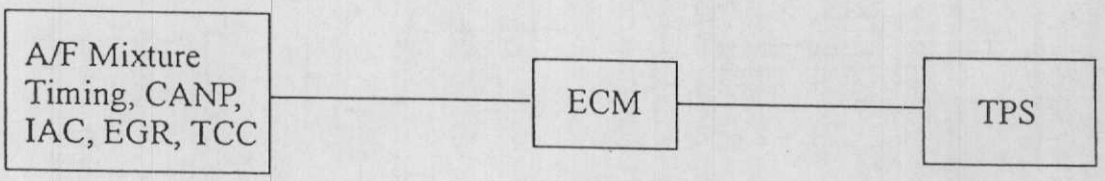


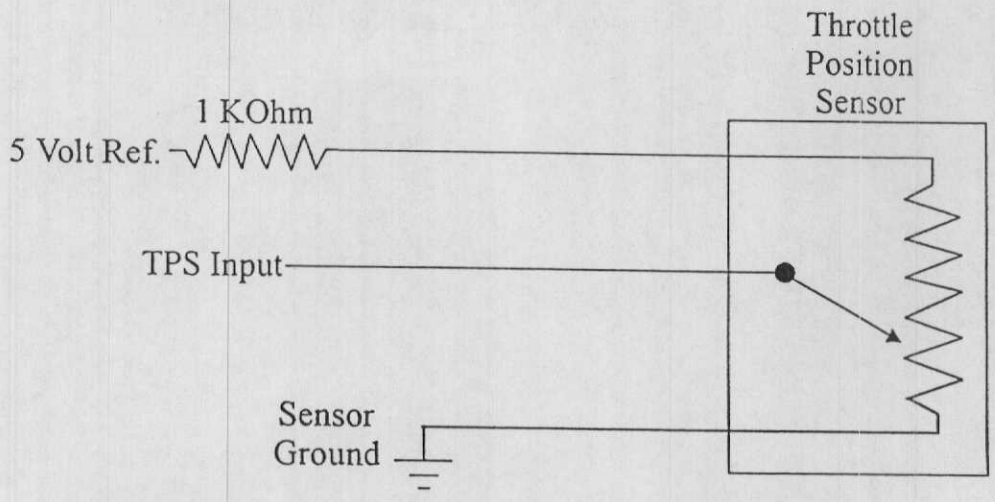
NON ENHANCED EVAP



ENHANCED EVAP

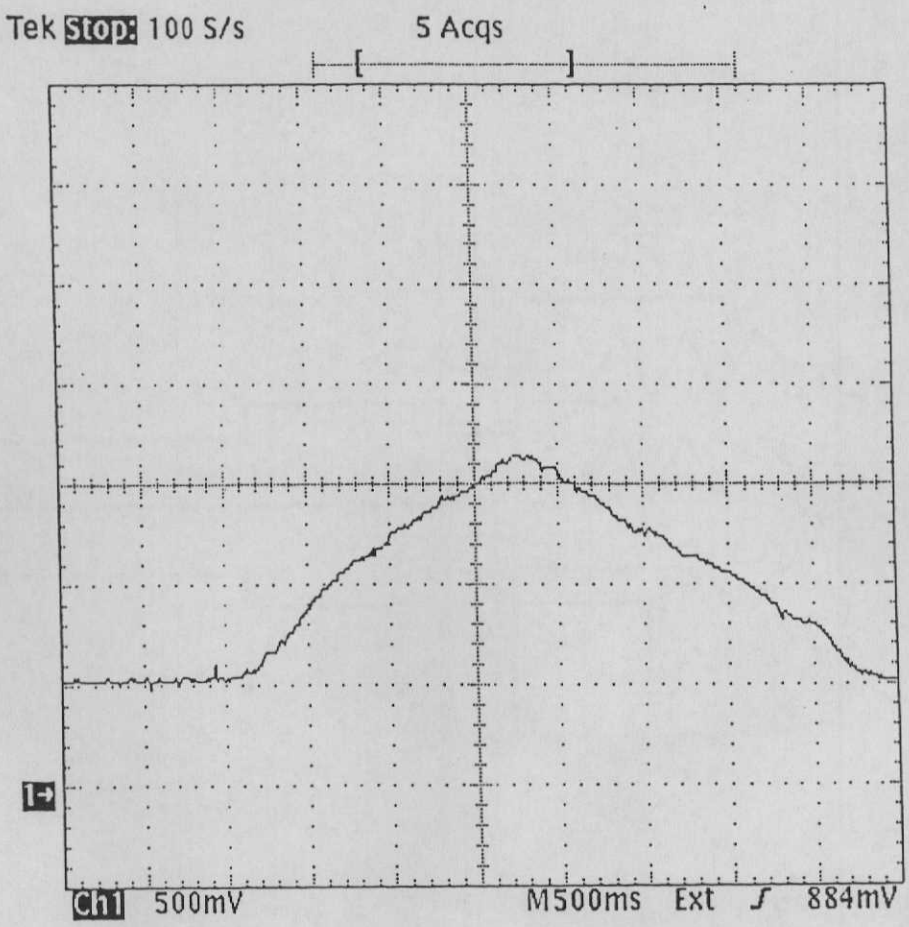



A/F Mixture
Timing, CANP,
IAC, EGR, TCC
ECM
TPS


Throttle
Position
Sensor
1 KOhm
5 Volt Ref.
TPS Input
Sensor
Ground

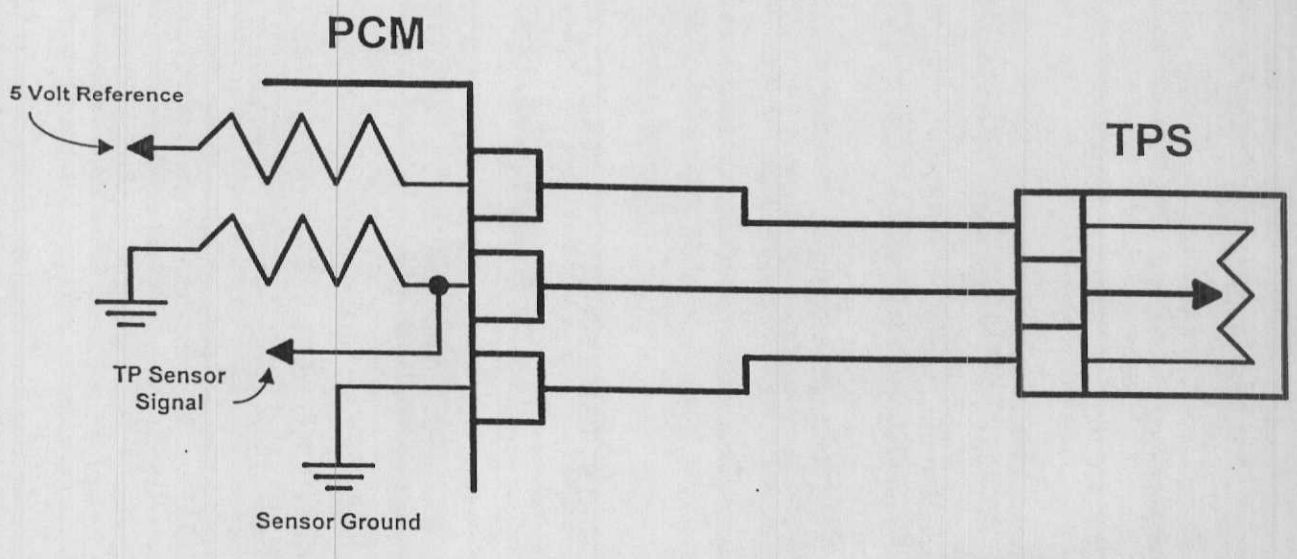
NOTES

TPS SWEEP



KOEO 200MV @ 500MS (DO NOT EXCEED 2 VOLTS)

KOER 500MV @ 500MS

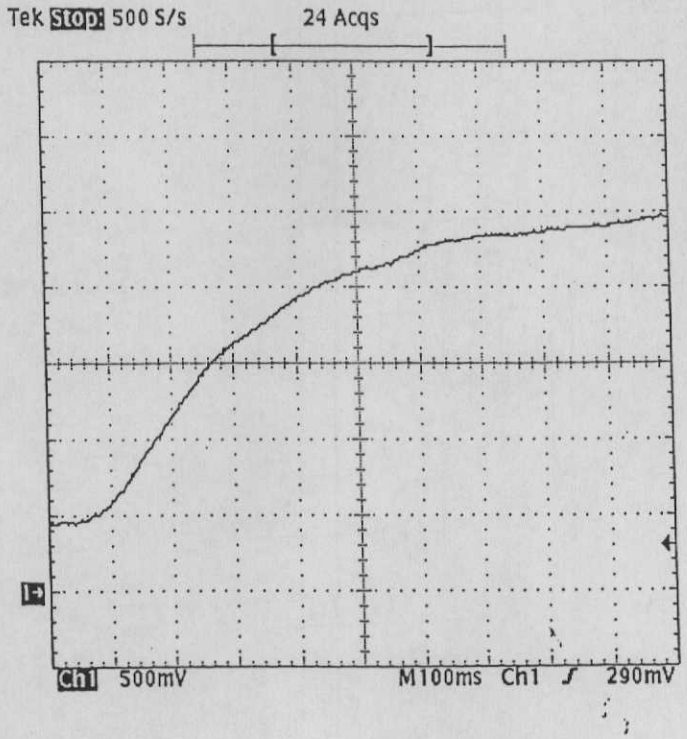


NOTES

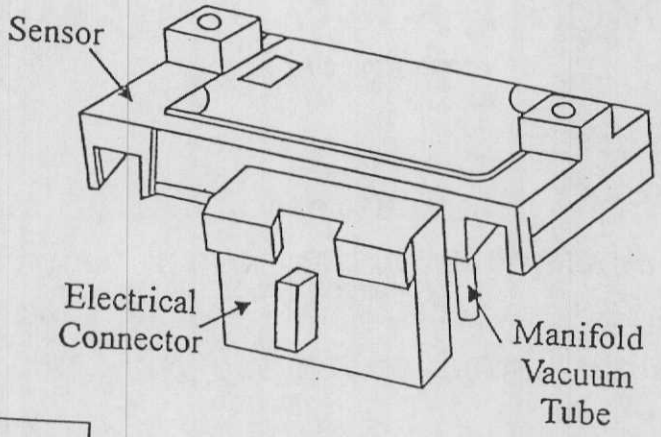
TPS MONITORING DIAGNOSTIC OPERATION

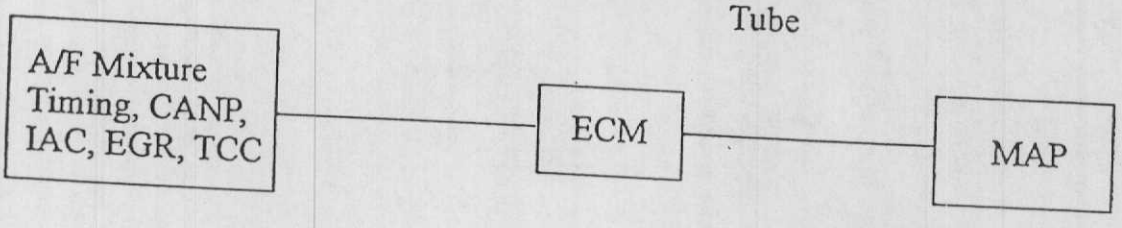
The PCM will monitor the operation of the TPS for voltage values outside the normal range. The rationality check involves the PCM to look at calculated values based on engine RPM and MAP values.

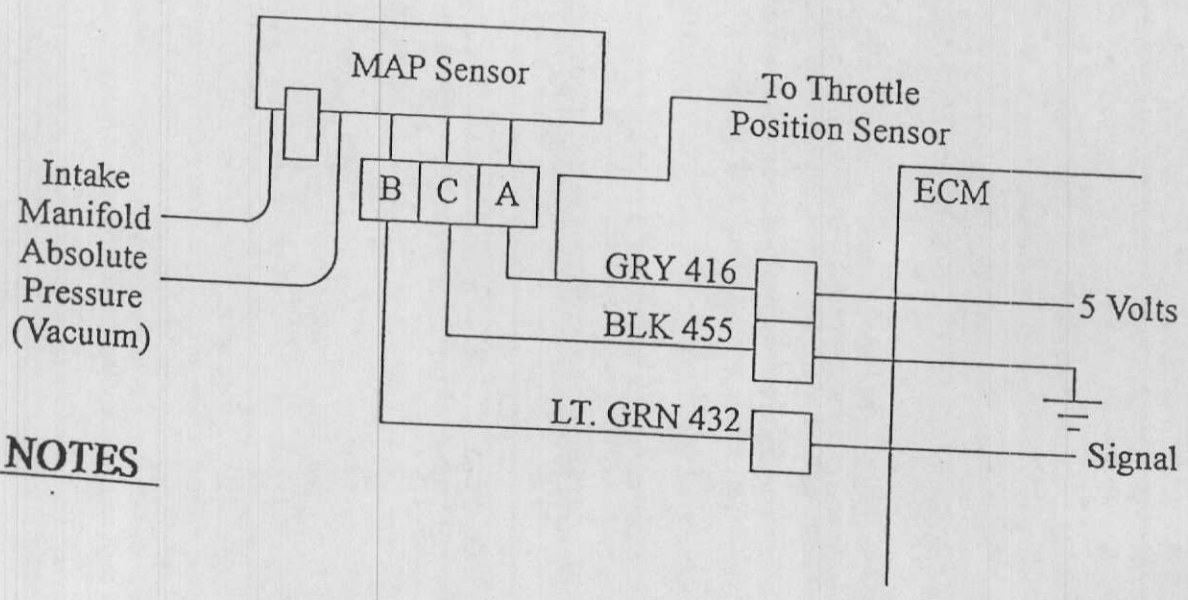
NOTES



Notice the nice smooth linear change of the above TPS waveform. It is important to not only test for glitches but in addtion it is important to check for a good smooth linear change. **ON MODERN DAY SYSTEMS THIS IS THE MAJOR INPUT INTO THE TRANSMISSION FOR SHIFT POINTS!**

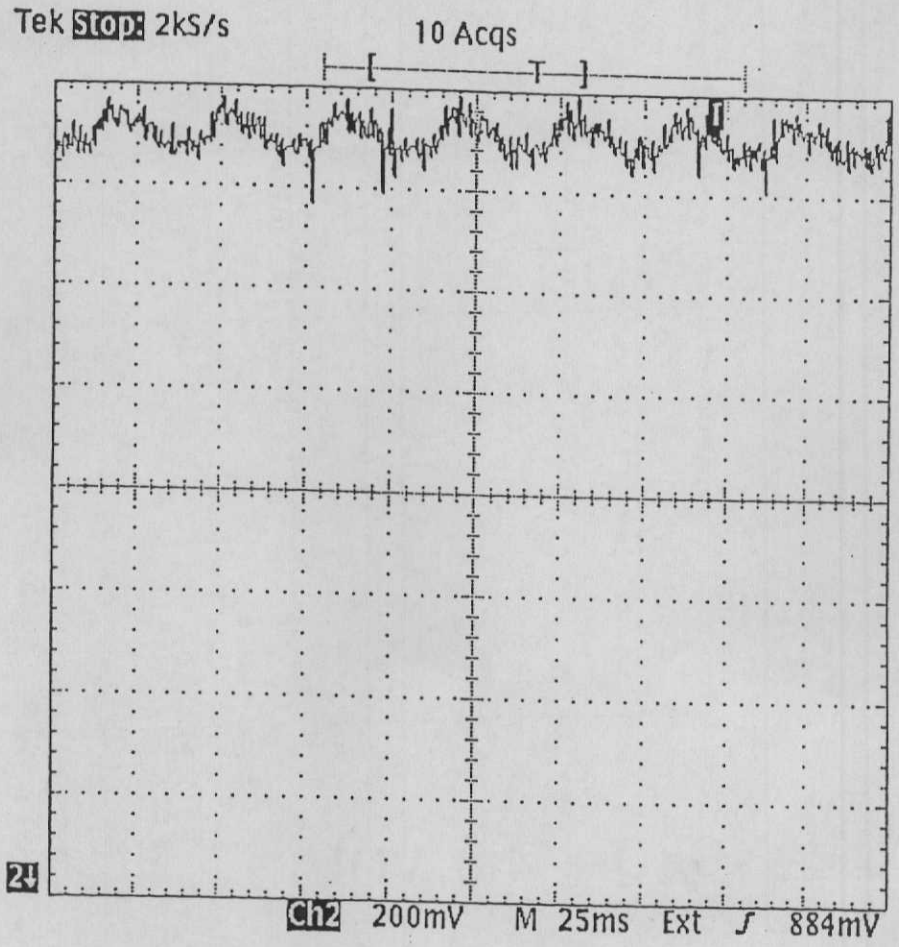

Sensor
Electrical Connector
Manifold Vacuum Tube


A/F Mixture Timing, CANP, IAC, EGR, TCC
ECM
MAP

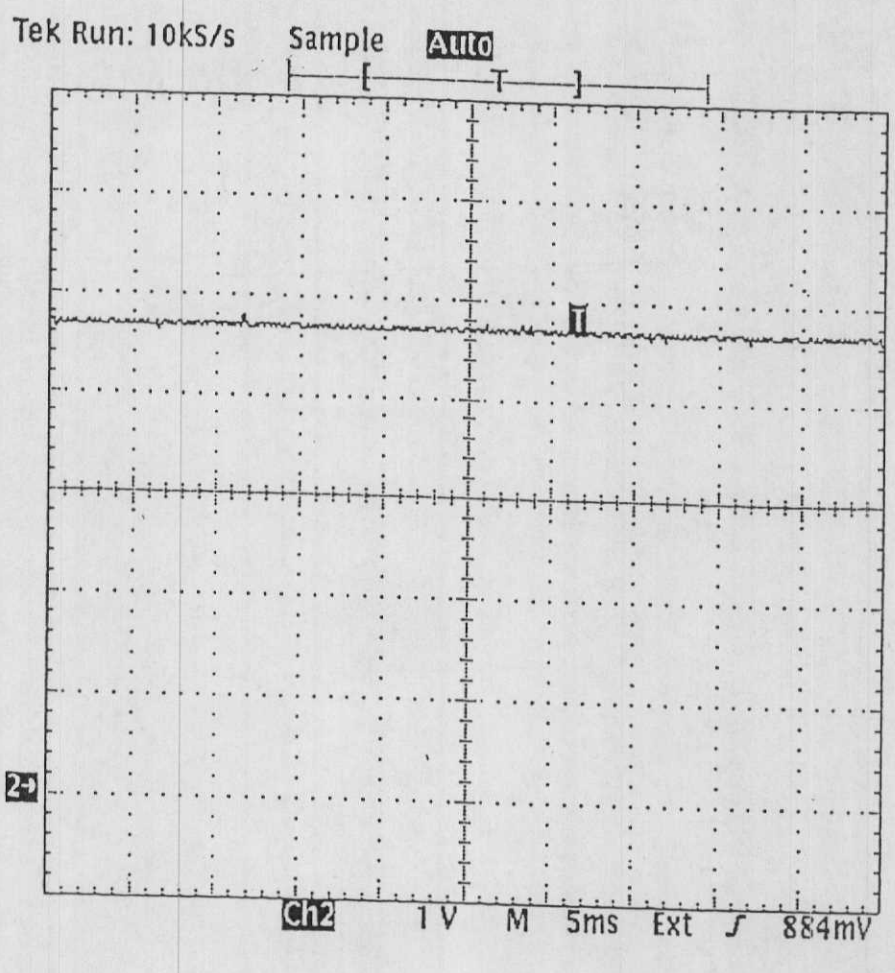

MAP Sensor
To Throttle Position Sensor
Intake Manifold Absolute Pressure (Vacuum)
B
C
A
ECM
GRY 416
5 Volts
BLK 455
LT. GRN 432
Signal

NOTES

MAP @ IDLE TESTING FOR MECHANICAL INTEGRITY



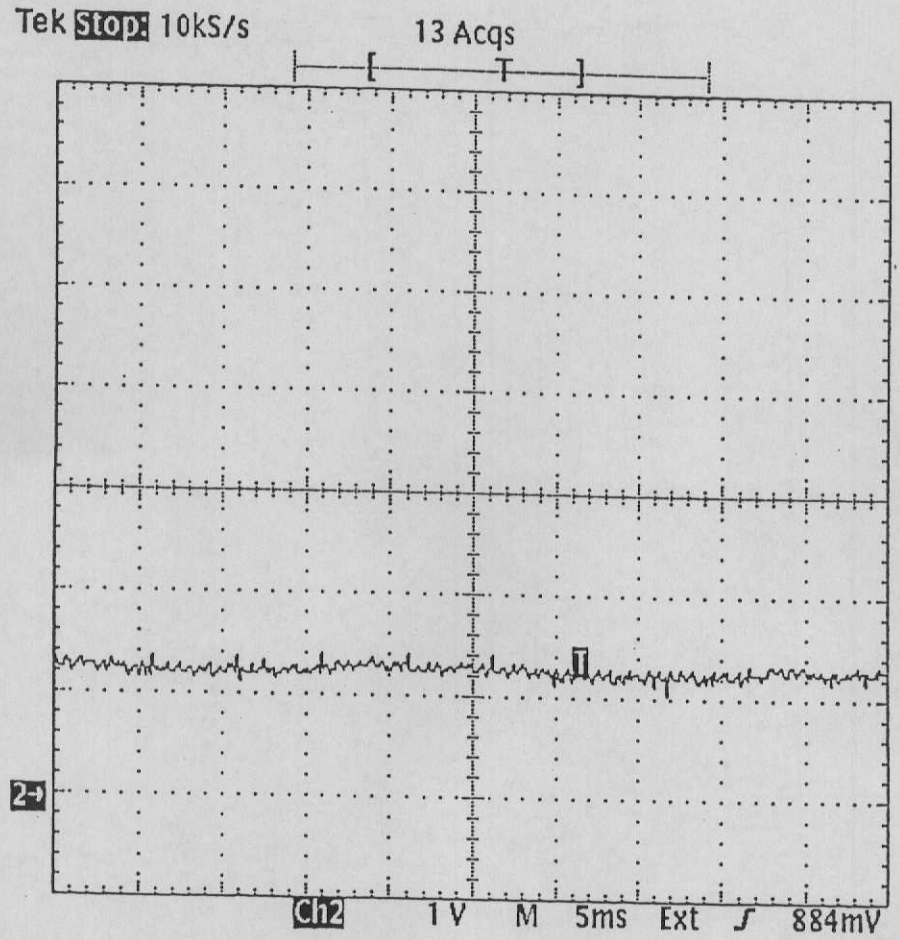
NOTES



MAP KOEO- 4.8 VOLTS

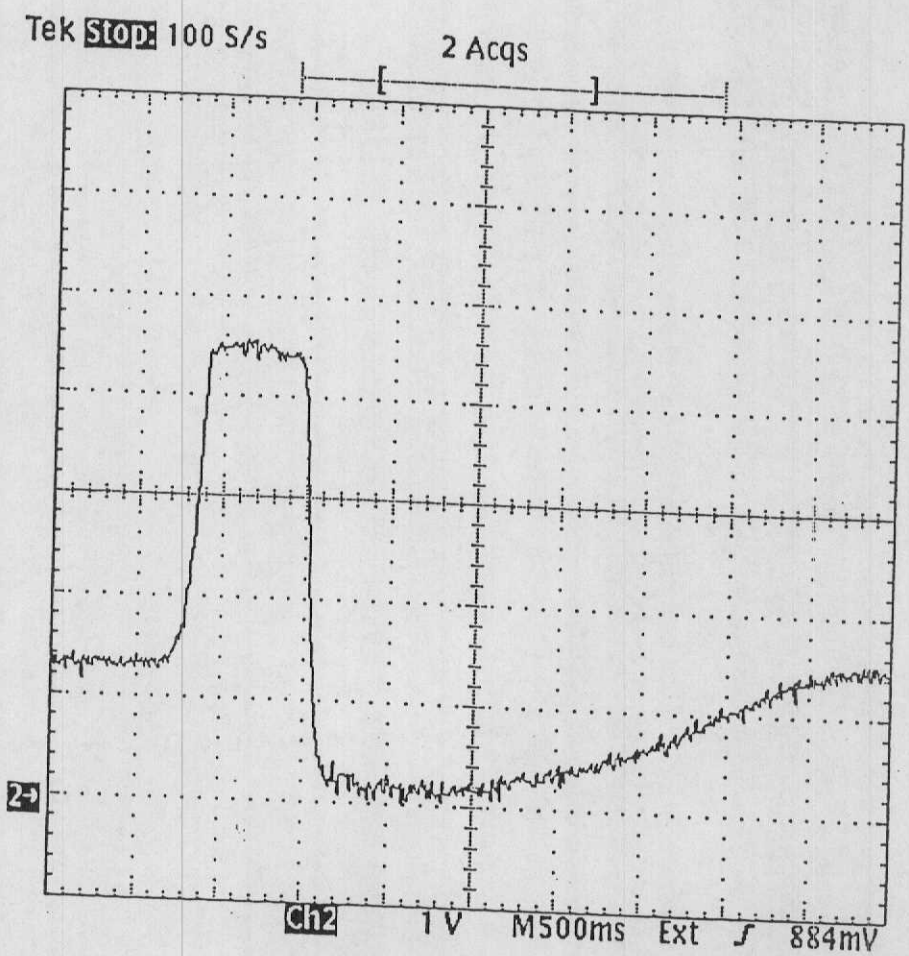
NOTES

MAP KOER @ IDLE- 1.3 VOLTS

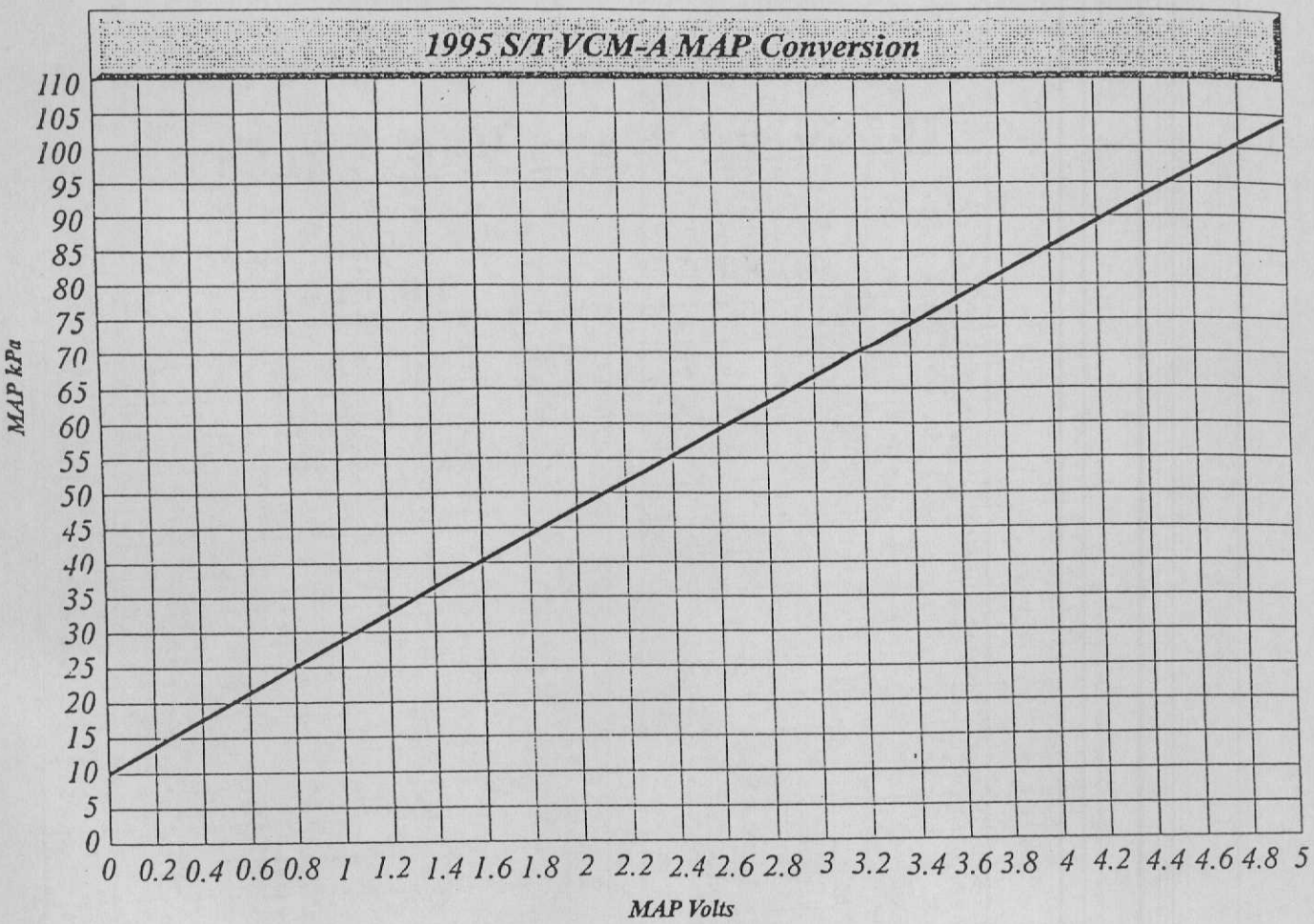


NOTES

MAP @ WOT SNAP TEST

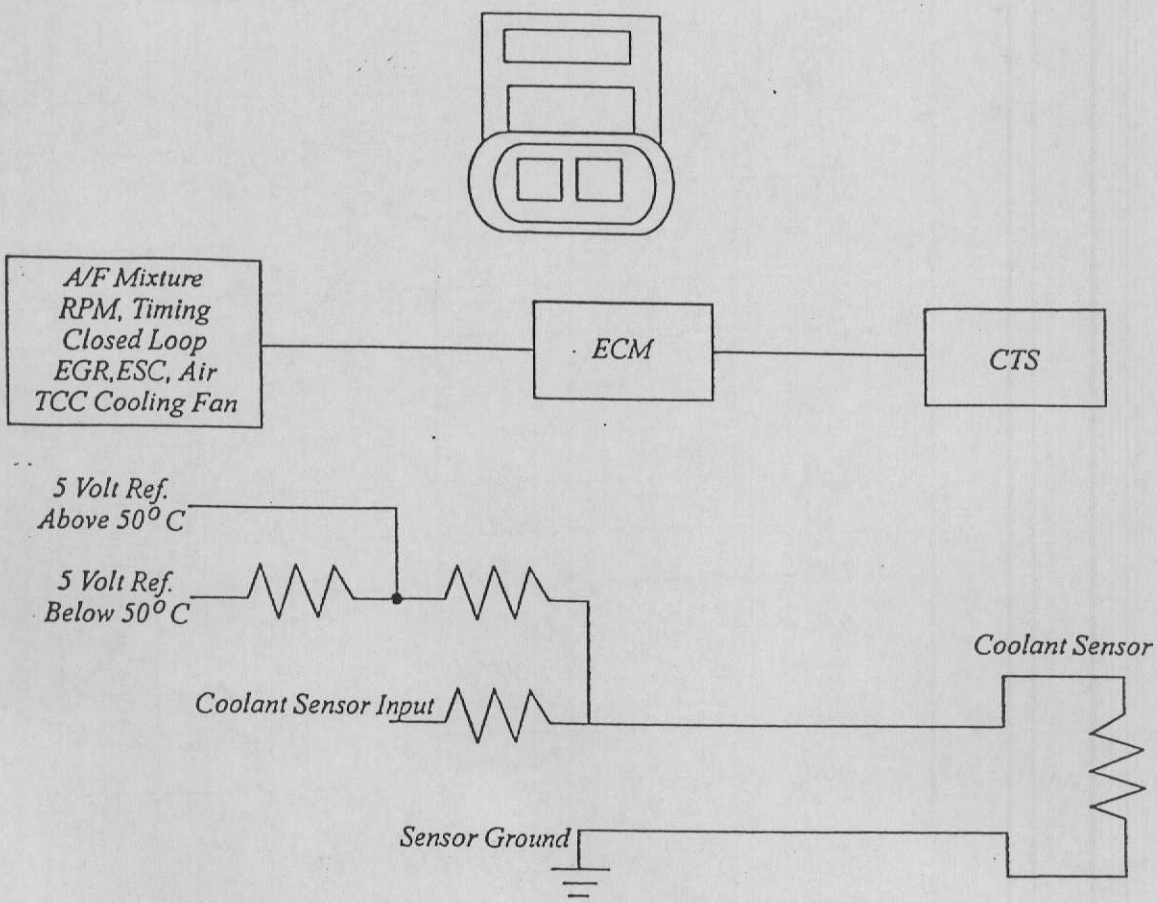


NOTES


1995 S/T VCM-A MAP Conversion
MAP kPa
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6 3.8 4 4.2 4.4 4.6 4.8 5
MAP Volts

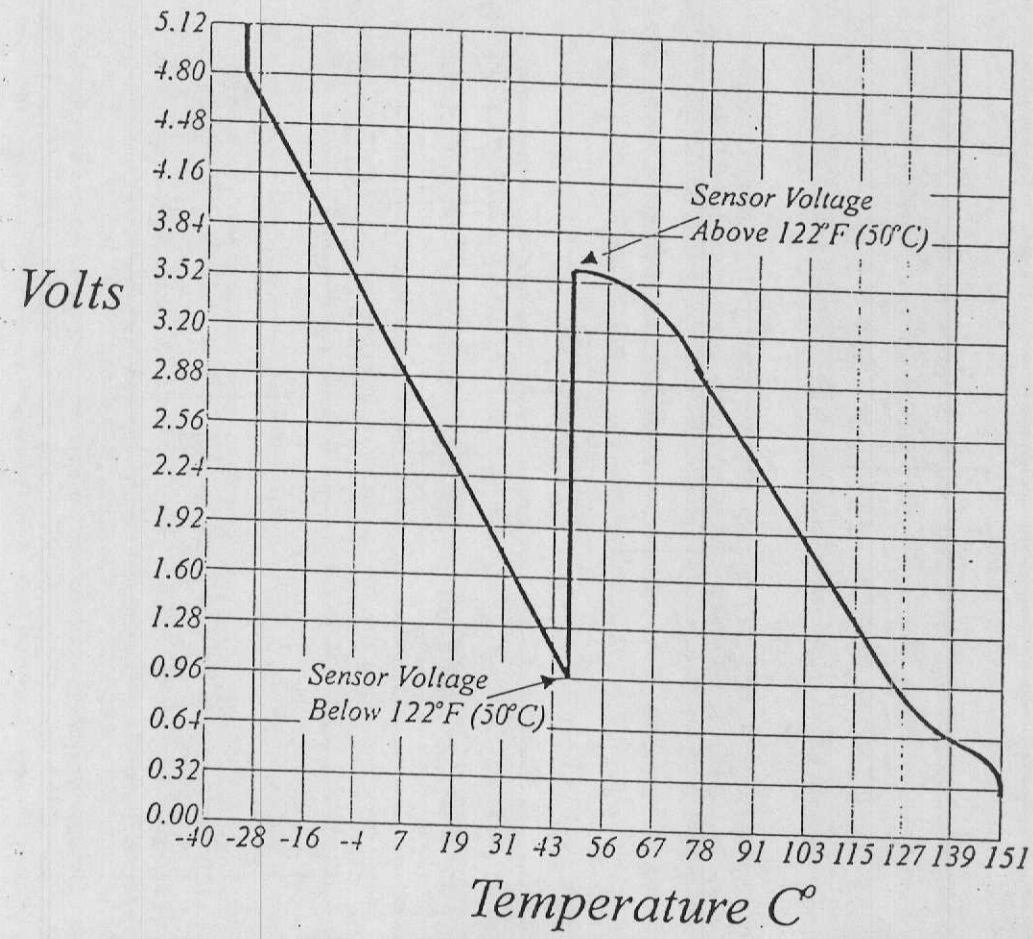
Pressure Versus Vacuum Chart

KPA	VACUUM 1000FT	VACUUM 2000FT	VACUUM 3000FT
101	0		
98	1	0	
94	2	1	0
91	3	2	1
87	4	3	2
84	5	4	3
81	6	5	4
77	7	6	5
74	8	7	6
71	9	8	7
67	10	9	8
64	11	10	9
60	12	11	10
57	13	12	11
54	14	13	12
50	15	14	13
47	16	15	14
44	17	16	15
40	18	17	16
37	19	18	17
33	20	19	18
30	21	20	19
27	22	21	20
23	23	22	21
20	24	23	22
17	25	24	23
13	26	25	24
10	27	26	25
6	28	27	26
3	29	28	27
0	30	29	28



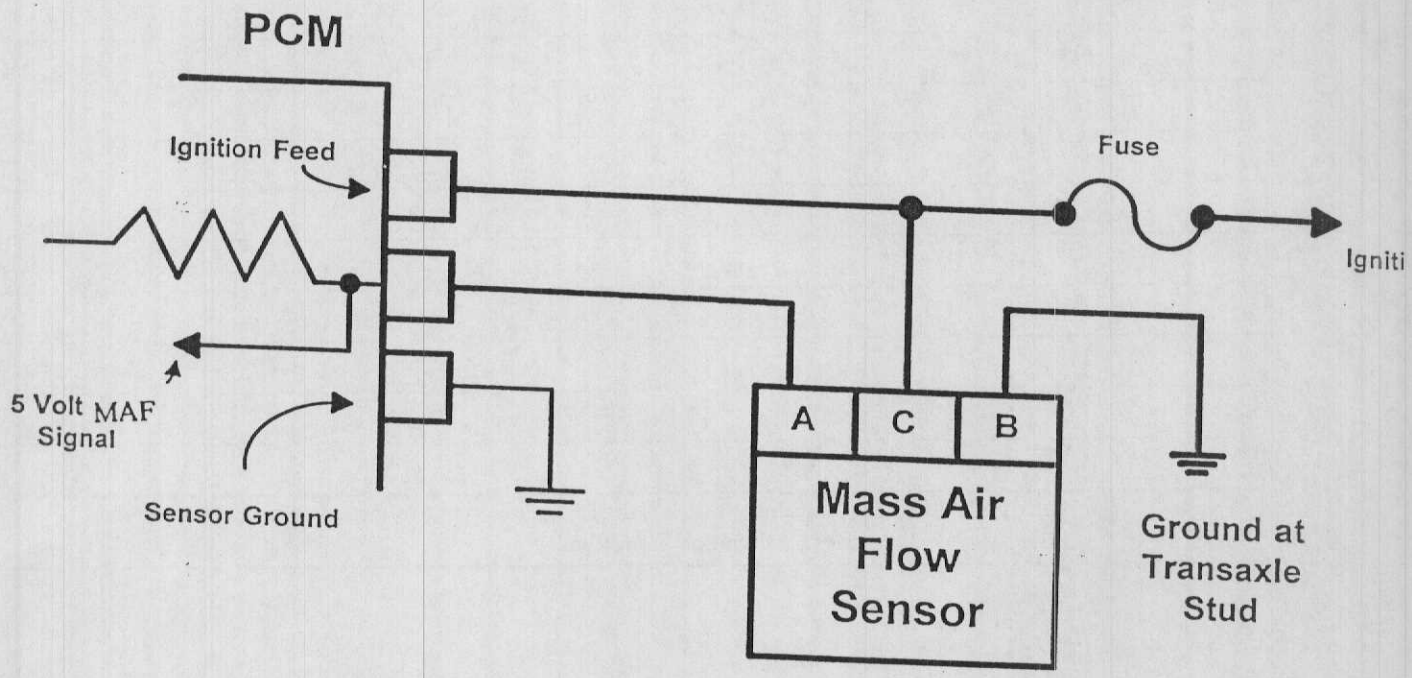
COOLANT SENSOR CIRCUIT

NOTES



ECT Sensor Resistance Values	
°F / °C	Ohms
212 / 100	177
194 / 90	241
176 / 80	332
158 / 70	467
140 / 60	667
122 / 50	973
113 / 45	1188
104 / 40	1459
95 / 35	1802
86 / 30	2238
77 / 25	2796
68 / 20	3520
59 / 15	4450
50 / 10	5670
41 / 5	7280
32 / 0	9420
23 / -5	12,300
14 / -10	16,180
5 / -15	21,450
-4 / -20	28,680
-22 / -30	52,700
-40 / -40	100,700

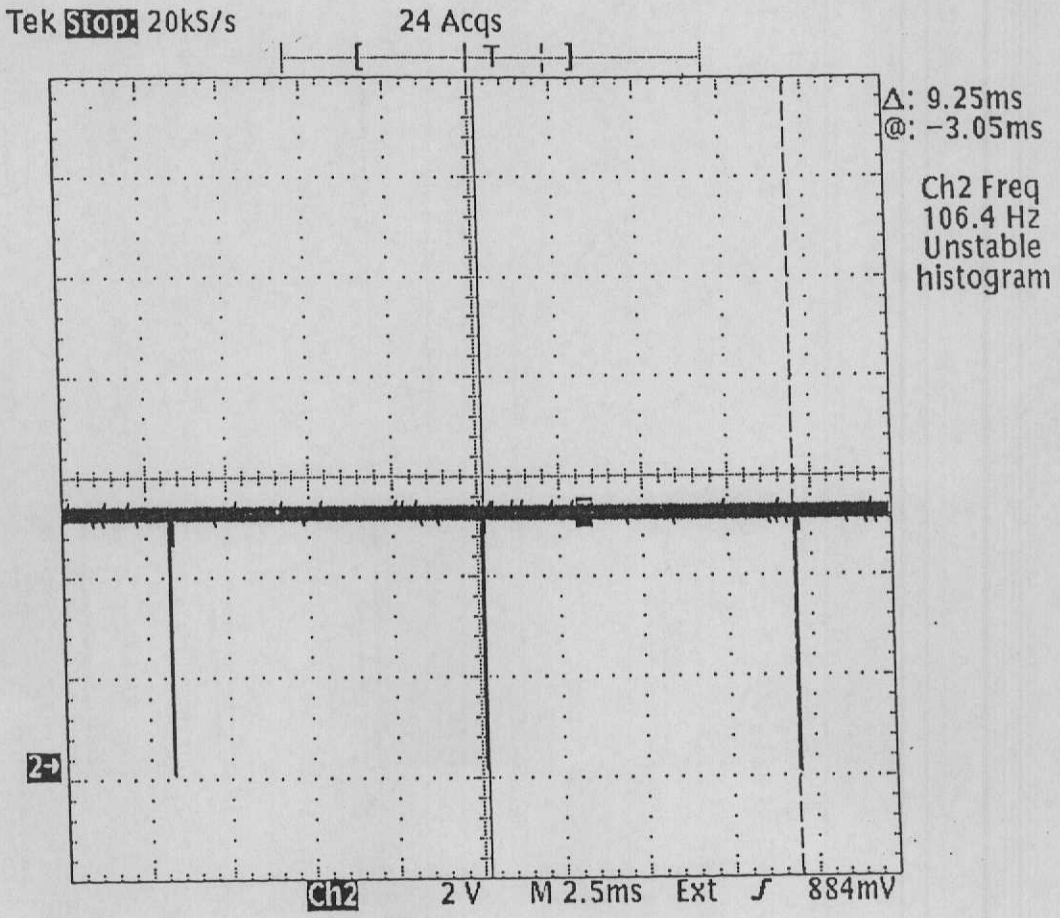
INTAKE AIR SENSOR TEMPERATURE VS. RESISTANCE VALUES			
^{o}C	^{o}F	*Ohms*	*Voltage Signal*
-40.0	-40.0	Infinity	5.02
-6.0	21.0	11340	4.65
0.0	32.0	9500	4.55
10.0	50.0	5160	4.21
20.0	68.0	3100	3.80
30.0	86.0	1905	3.41
40.0	104.0	1400	2.95
50.0	122.0	980	2.52
60.0	140.0	692	2.10
70.0	158.0	487	1.66
80.0	176.0	321	1.23
90.0	194.0	240	1.02
100.0	212.0	182	0.82
Note: Unlike the coolant sensor circuit, the IAT sensor is nto shunted and has completely different specific values. All values approximate.			



A/C DELCO MODULAR MAF

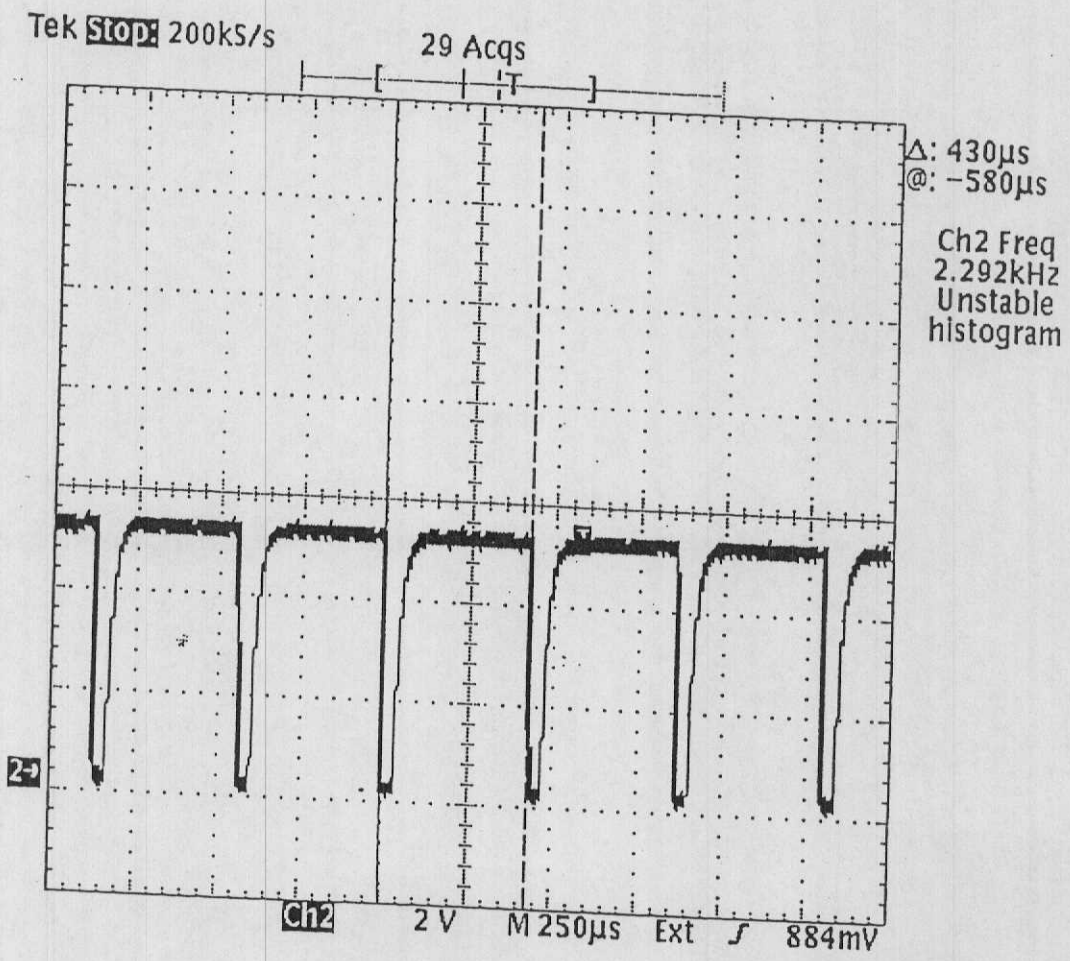
THIS NEWEST TYPE OF MASS AIR FLOW SENSOR IS KNOWN AS THE MODULAR STYLE USED ON THE 3.4 VIN S AND THE 5.7 LITRE LTI AND THE 4.3 L99 ENGINES. THIS SENSOR GENERATES A UNIQUE INVERTED SAW TOOTH PATTERN IN A FREQUENCY READ BY THE PCM. THIS HOT WIRE DESIGN USES NO BURN OFF FUNCTION.

NOTES

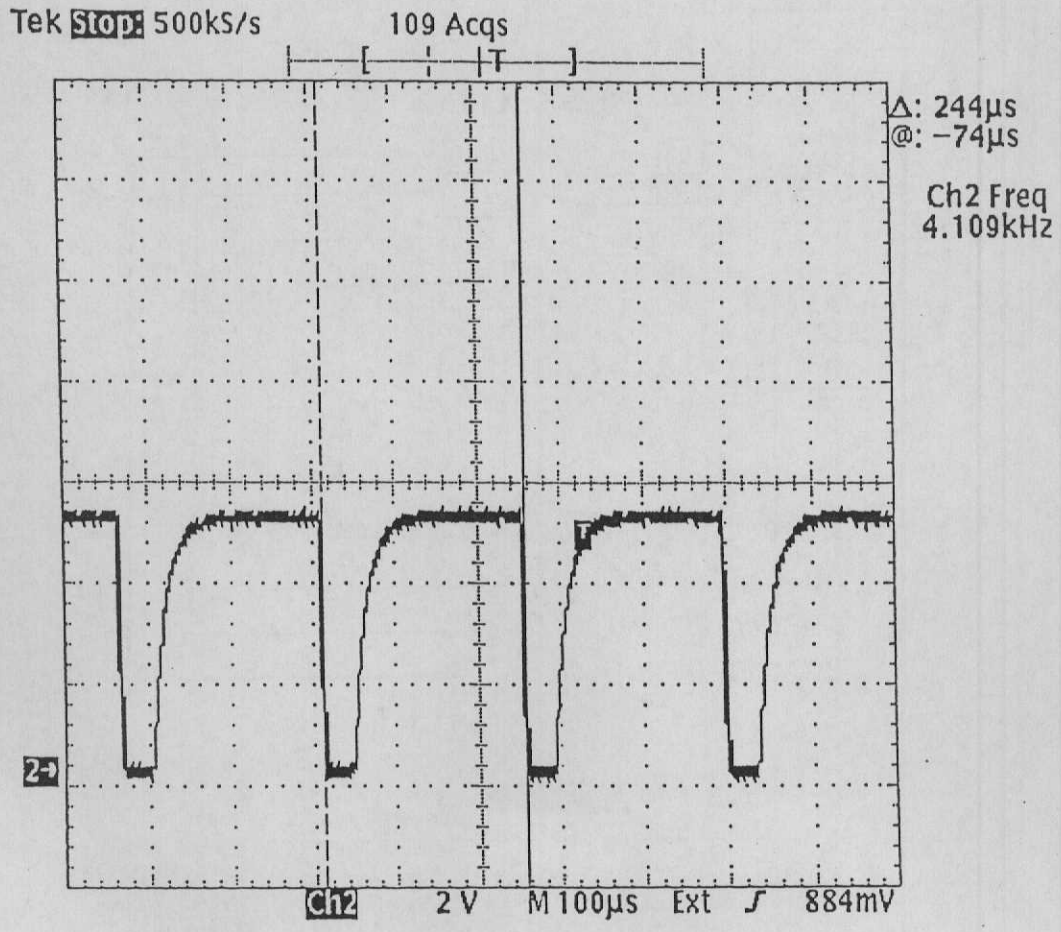


MODULAR STYLE MAF KOEO- 100 HZs

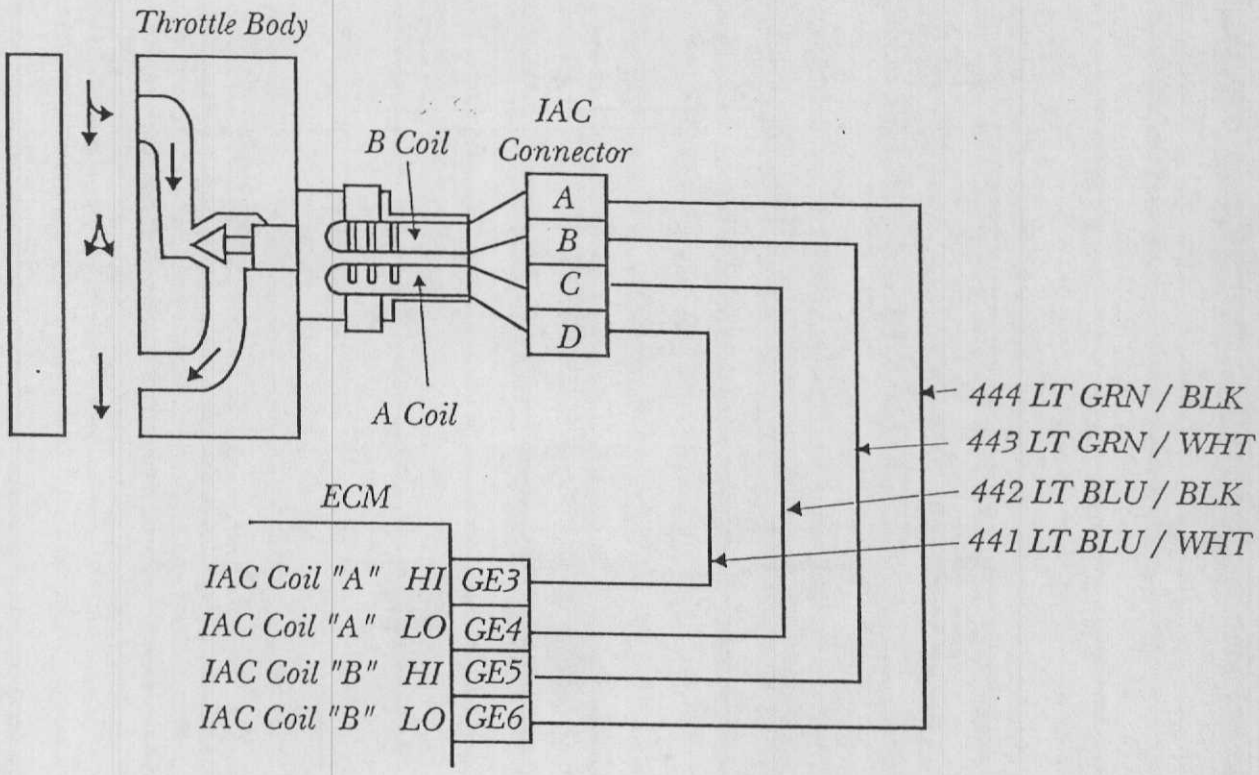
NOTES

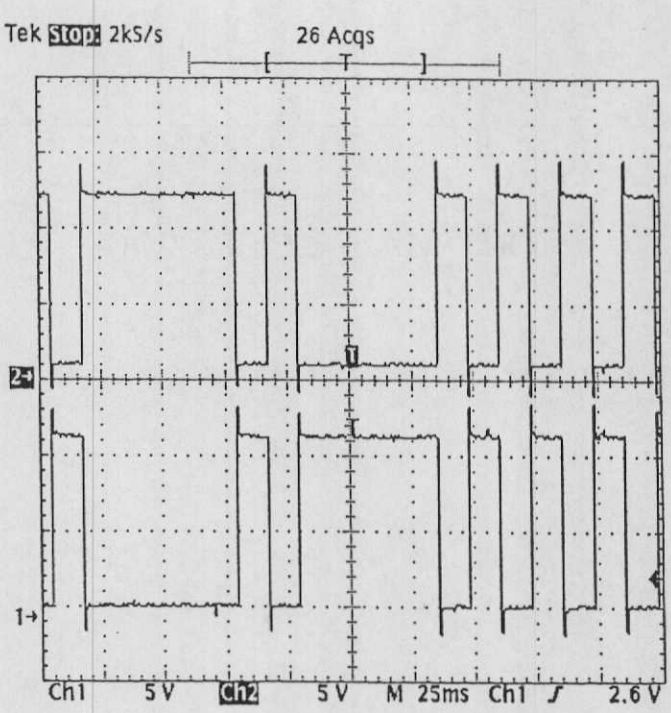


MODULAR STYLE MAF KOER IDLE- 2.3KHZs

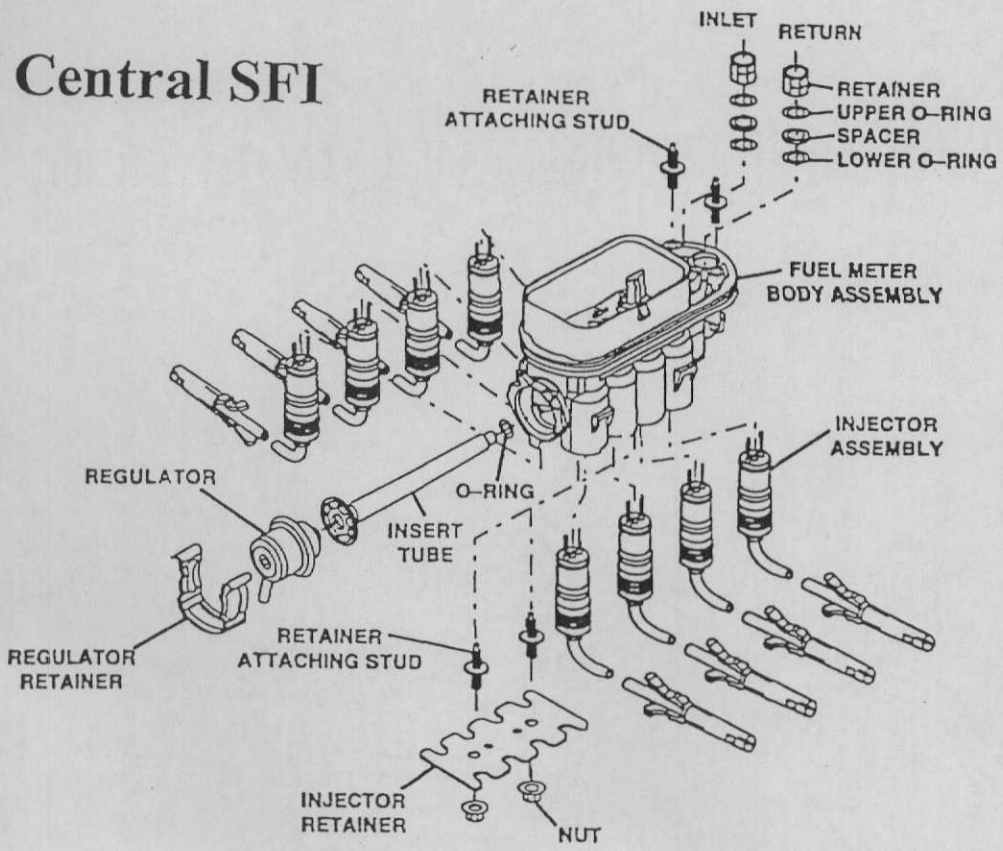


MODULAR STYLE MAF KOER 2000 RPM-4000HZs


Throttle Body
B Coil
IAC
Connector
A
B
C
D
A Coil
444 LT GRN / BLK
443 LT GRN / WHT
442 LT BLU / BLK
441 LT BLU / WHT
ECM
IAC Coil "A" HI GE3
IAC Coil "A" LO GE4
IAC Coil "B" HI GE5
IAC Coil "B" LO GE6

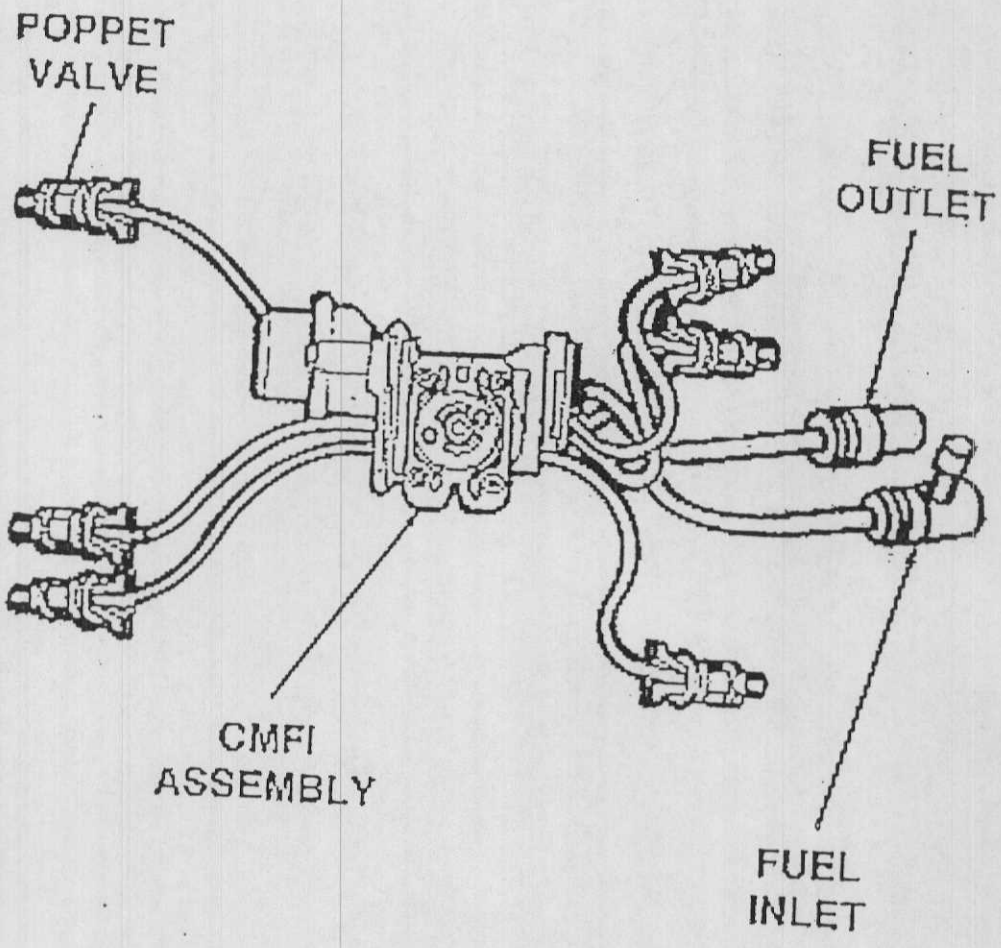

Tek Stop: 2kS/s
26 Acqs
Ch1 5 V
Ch2 5 V
M 25ms Ch1 ƒ 2.6 V

Central SFI

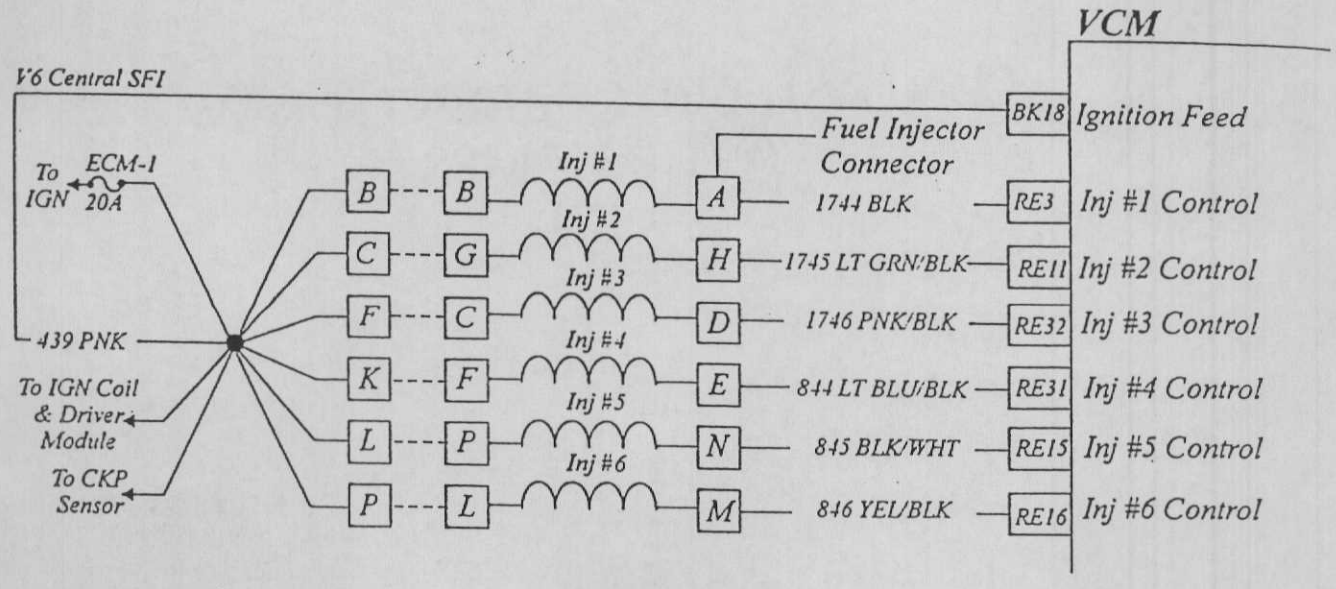


NOTES

CMFI
(CENTRAL MULTIPORT FUEL INJECTION)



NOTES

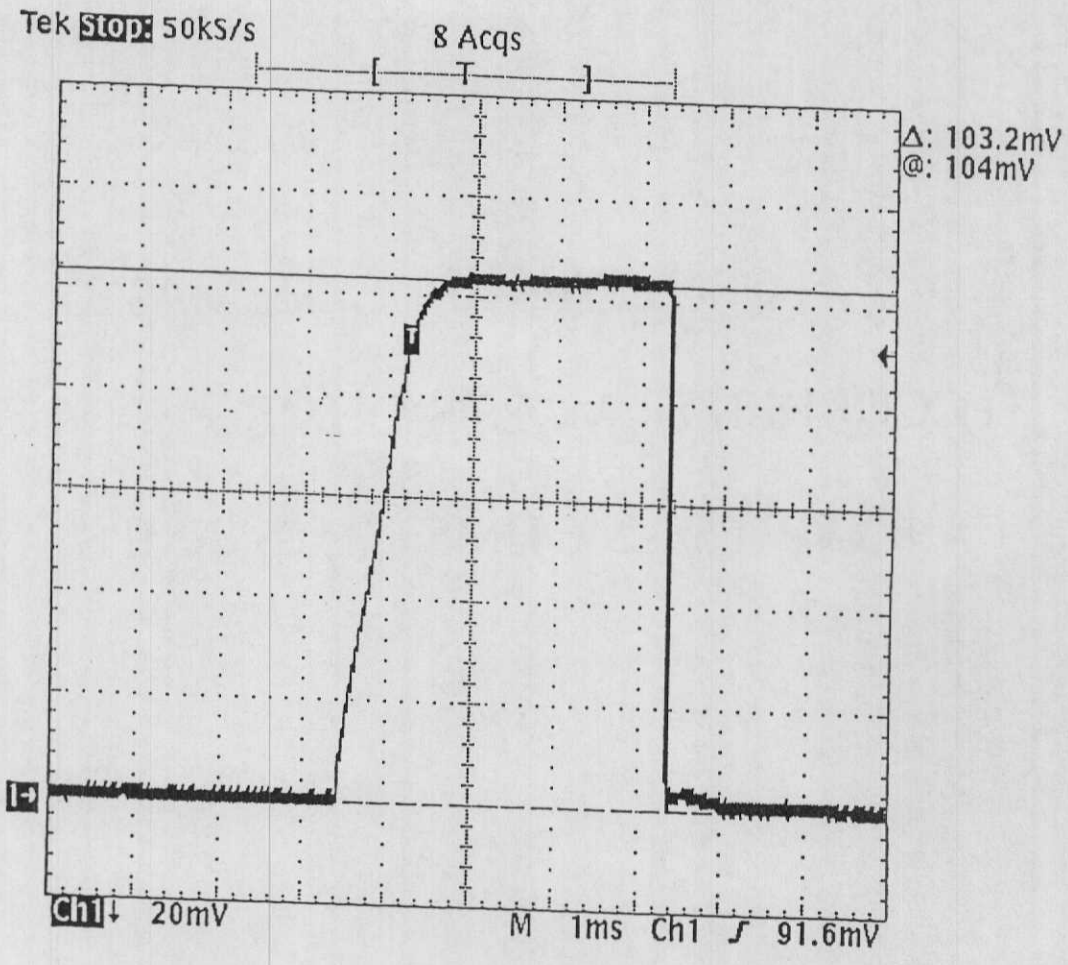


CENTRAL SFI SCHEMATIC

(I) CURRENT= VOLTS/OHMS

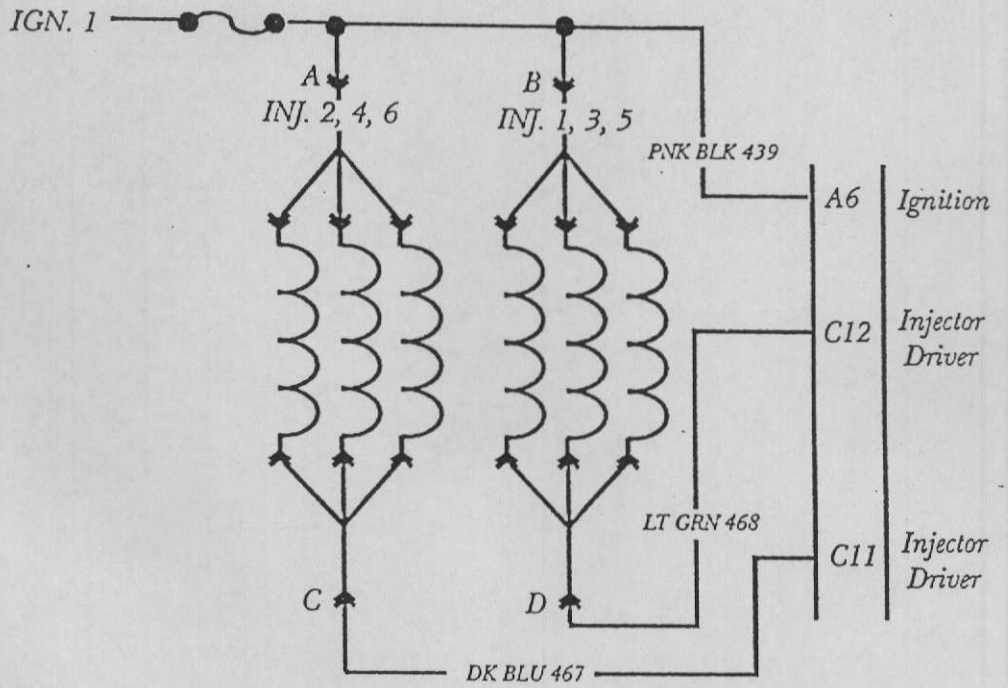
13.9 VOLTS/12 OHMS= 1.15 AMPS

CENTRAL SFI CURRENT DRAW
@ 1.03 AMPS



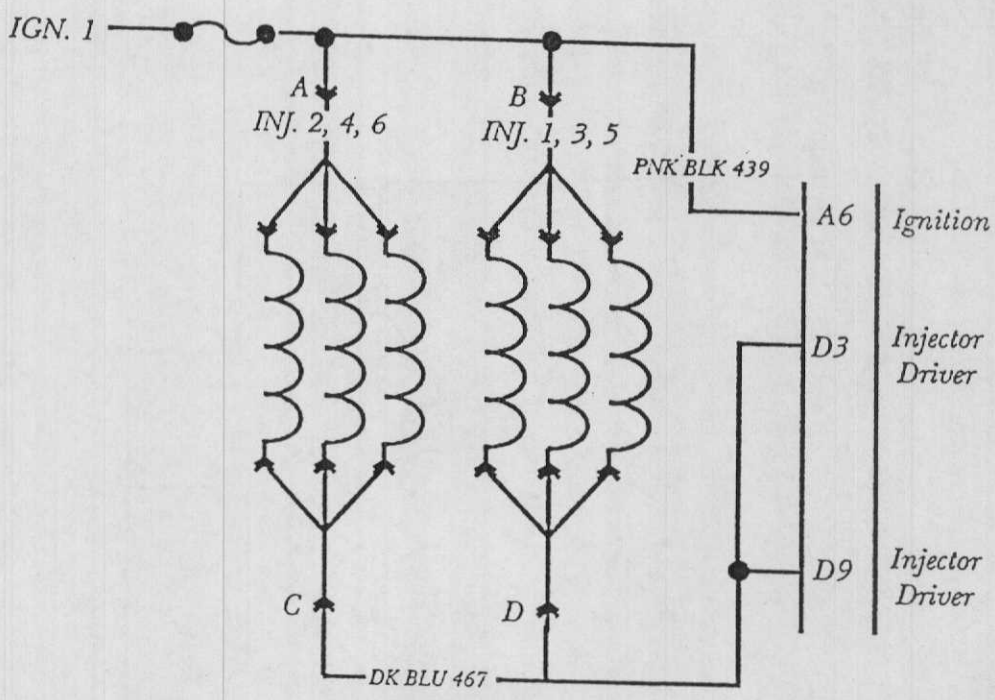
SIMULTANEOUS FIRED GROUPED INJECTOR CIRCUIT

NOTES



NOTES

BATCH FIRED INJECTOR CIRCUIT



NOTES

ECM Replacement Check for 1982-1990 Models

- Remove the ECM from the vehicle. Identify the service number of the ECM and determine, via QDR application charts, if the ECM has QDRs. Is the ECM listed?

YES

NO → Replace ECM

1. Verify QDR output terminals.
2. Measure the resistance, using the 100/200K Ohms scale on DVOM*, between the ECM case and each ECM terminal, black (NEG) lead to case and red (POS) lead to ECM terminal.

Note: Some ECMs have a pull-up resistor on the TCC output terminal. This resistor will cause the ECM to fail the 50KΩ resistance test measured at terminal A-7 on some ECMs.

Do all Quad driver terminals have resistance of 50K Ohms or more?

NO

A QDR in the ECM has been damaged. Prior to replacing the ECM, locate and repair the circuit or component that caused the damage. Failure to do so, may result in additional faults with the newly replaced ECM.

Any terminal with a resistance under 50K Ohms is connected to a defective QDR. The terminal with the lowest resistance is connected to the circuit that most likely caused the QDR failure.

- Disconnect the component in that particular circuit and check for a short-to-voltage. If it is not shorted-to-voltage, replace the component in that circuit and the ECM.

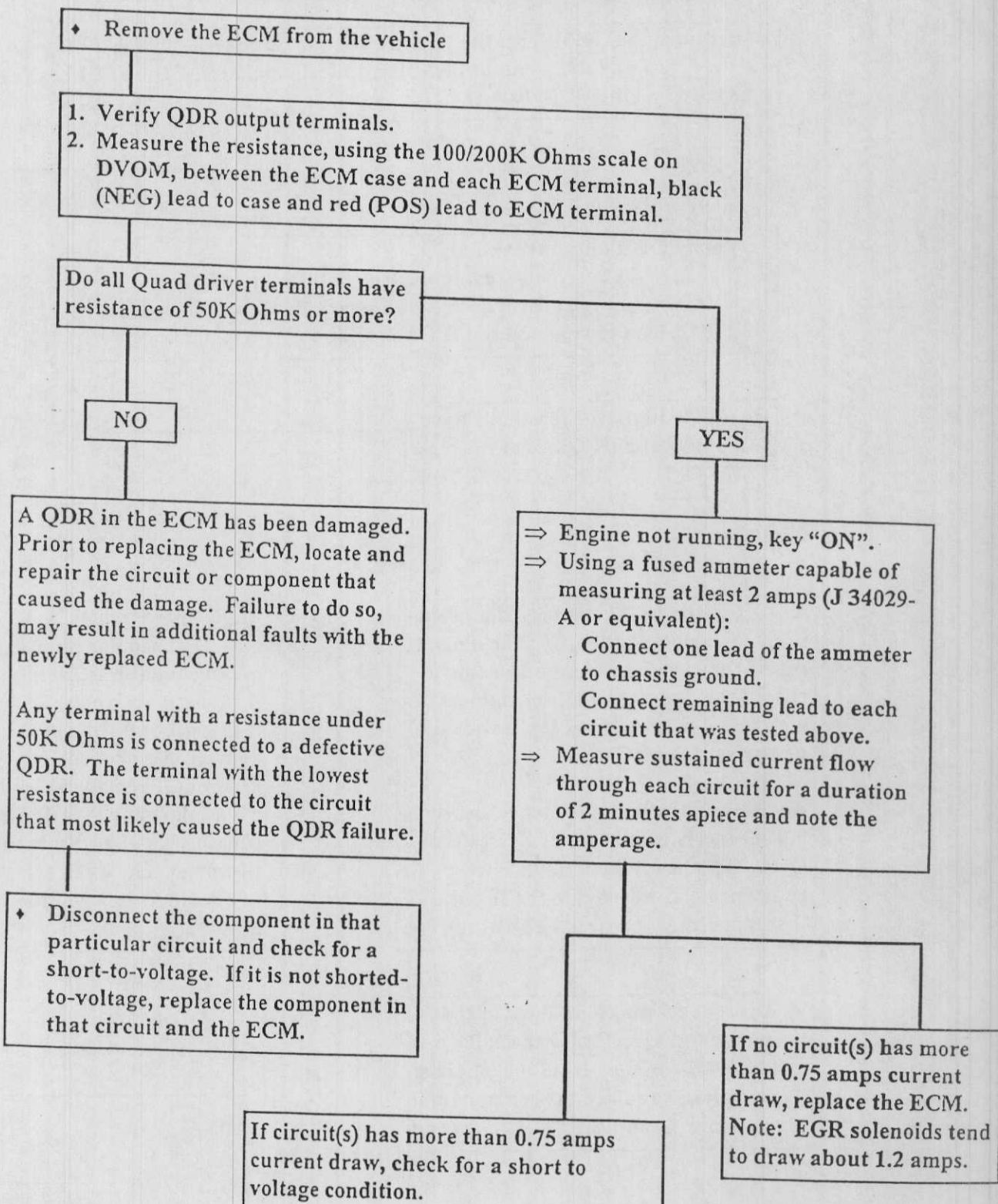
YES

⇒ Engine not running, key "ON".
⇒ Using a fused ammeter capable of measuring at least 2 amps (J 34029-A or equivalent):
Connect one lead of the ammeter to chassis ground.
Connect remaining lead to each circuit that was tested above.
⇒ Measure sustained current flow through each circuit for a duration of 5 minutes apiece and note the amperage.

If circuit(s) has more than 0.75 amps current draw, check for a short to voltage condition. If no short to voltage exists, replace related solenoid or relay.

If no circuit(s) has more than 0.75 amps current draw, replace the ECM.

QDR Check Chart for 1992-1994 Models



MFI Engine QDR Application Chart

ECM Service Number	QDR Number	ECM Output Terminal #1	ECM Output Terminal #2	ECM Output Terminal #3	ECM Output Terminal #4
1984-1986					
1226458 and 1226460	U-14 (1)	C1	C2	A2	A3
	U-15 (2)	A4	A5	A7	A7
1226461	U-14 (1)	A2	A4	A4	A5
	U-15 (2)	A3	A3	D2	D2
	U-26 (3)	A7	A7		C2
1226459 (SFI)	U-5 (1)	A3	A3	D3	D3
	U-6 (2)	A7	A7		D2
	U-20 (3)	A2	A4	A4	A5
1985-1987					
1226859, 1226870, 1226948,	U-14 (1)	A2	A4	A4	A5
1227065, 1227784	U-15 (2)	A3	A3	D2	D2
	U-26 (3)	C2		A7	A7
1986					
1227151	U-14 (1)	C1	C2	A2	A3
	U-15 (2)	A4	A5	A7	A7
1986-1987					
1227057 *	U-8 (1)	A3	A7	D2	D3
	U-7 (2)	A4	A5	B2	B9
1227148, 1227783*, 1227886,	U-5 (1)	A3	A3	D3	D3
1227148, 1227783, 1227886	U-6 (2)	A7	A7		D2
	U-20 (3)	A2	A4	A4	A5
1227165*, 1227303*, 1227752*,					
1227808	U-3 (1)	A3	A7	C2	D12
	U-6 (2)	A2	A4	A5	C1
1227153, 1227170, 1227302	U-14 (1)	A2	A4	A4	A5
	U-15 (2)	A3	A3	D2	D2
	U-26 (3)	A7	A7		C2
* Has TCC Pull-Up Resistor					
1988					
1226253	U-8 (1)	J1C2	J1C2	J1C3	J1D2
	U-9 (1)	J3C11	J3C1	J3C2	J3C2
	U-10 (3)	J3C14	J3C15	J3C16	J2B5
	U-11 (4)	J3C9	J3C9	J3C10	J3C4
1987					
1227750	Q-1 (1)	2A1	2A8	2A10	2A11
	Q-2 (2)	3C7	3C8	3C9	3C10
	Q-3 (3)	3D5	3D5	3D6	3C6
	Q-4 (4)	3C4	3C5	3C5	3D4
1987-1989					
1227727, 1227730, 1228706	U-18 (1)	E7	E8	E9	F7
	U-19 (2)	F1	F2	F3	F4
	U-20 (3)	F5	F5	F6	F8
No Year					
MFI Service Number 16134847	Q1	C11	C12	C13	C14

TBI Engine QDR Application Chart

ECM Service Number	QDR Number	ECM Output Terminal #1	ECM Output Terminal #2	ECM Output Terminal #3	ECM Output Terminal #4
1982 ½ -1983 1225610, 1226100, 1226026, & 1226430	U6 U7	Black 9 Black 7	Black 14 Black 22	Black 16 White 19	White 20 White 19
1983 ½ -1984 1226156	U6	White 20	-----	Black 7	Black 9
1984 1226026	U6 U7	Black 9 Black 7	Black 14 Blue 22	Black 16 White 19	White 20 White 19
1984-1985 1226458 & 1226460	U14 U15	C1 A4	C2 A5	A2 A7	A3 A7
1985-1986 1226884	U17	Black 7	Black 9	-----	White 20
1228957	U14 U15	A2 C1	A3 A5	A4 A7	C2 A7
1985-1992 1226858, 1227746, 1227747, 1227137, 1227429, 1228062, 1228063, 1228838, 1228934	U14 U15	A2 A4	A3 A5	C1 A7	C2 A7
1987 1227748, 1228321	U2 U4	Black 7 Black 3	Black 7 Black 4	Black 18 Black 21	Black 18 Black 22
1227749, 1228707	U18 U19	E7 F1	E8 F2	E9 F3	F7 F4

PCM REPLACEMENT CHECK LIST
OBDI SYSTEMS

1. DID THE DIAGNOSTIC CIRCUIT TEST FLASH A CODE 12?
2. HAVE YOU OHM TESTED FOR SHORTED DRIVERS?
3. HAVE YOU TESTED FOR A GOOD D/REF SIGNAL?
4. HAVE YOU VOLTAGE DROP TESTED THE PCM MAIN GROUNDS AND SENSOR GROUNDS?
5. HAVE YOU TESTED FOR GOOD SUPPLY VOLTAGE TO THE PCM?
6. HAVE YOU CHECKED FOR A GOOD 5 VOLT VREF?
7. DOES THE FUEL PUMP RELAY TURN ON FOR 2 SECONDS OF KOEO?
8. MAKE CERTAIN AN OUTPUT DEVICE HAS NOT SHORTED OUT AND BLOWN AN PCM DRIVER!

NOTES

PROM PROGRAMMING OR REPROGRAMMING

Proms as we have known them from OBD 1 systems were replaceable and programmed bv the manufacturers to meet the calibration on the specific systems. GMs OBD II systems are now using an Electronically Erasable Programmable Read Only Memory (EEPROM) that is neither replaceable nor programmable by most aftermarket technicians. Upon replacement of a PCM the technician will have to have the EEPROM programmed or reprogrammed at the dealership level. Hopefully, this may change in the future. GM has a Service Programming System known as SPS. There are three methods:

DIRECT PROGRAMMING is done directly thru the Data Line Communication Link. This is done at the dealership level thru the techline terminal by a PC.

REMOTE PROGRAMMING uses the tech 1 or master tech scan tool with a GM Mass Storage Cartridge (MSC) and a PCM using the techline terminal. Most after market shops do not have access to the techline data.

OFF BOARD PROGRAMMING is used if the PCM must be programmed away from the vehicle as in a PCM replacement. The dealerships are equipped to do this for the independent technicians using an SPS off board programming kit known as a (OBPA) kit. The OBPA kit can be connected to either a tech 1 scan tool or a techline terminal for direct programming.

GM VEHICLES EQUIPPED WITH FLASH PROMS OR EEPROMS (ELECTRONICALLY ERASABLE PROGRAMMING READ ONLY MEMORY)

Year	Make	Model	Transmission	Engine	VIN
1997	All	All	All	All	All
1996	All	All	All	All	All
1995	Buick	Roadmaster	Auto	5.7(P)	B
1995	Cadillac	Fleetwood	Auto	5.7(P)	D
1995	Chevrolet	Camaro	Man/Auto	3.4L(S)	F
1995	Chevrolet	Camaro	Auto	3.8L(K)	F
1995	Chevrolet	Camaro	Man/Auto	5.7L(P)	F
1995	Chevrolet	Caprice	Auto	4.3L(W)	B
1995	Chevrolet	Caprice	Auto	5.7(P)	B
1995	Chevrolet	Cavalier	Auto	2.3L(D)	J
1995	Chevrolet	Corsica/Beretta	Auto	3.1L(M)	L
1995	Chevrolet	Corvette	Man/Auto	5.7(P)	Y
1995	Chevrolet	Monte Carlo/Lumina	Auto	3.1L(M)	W
1995	Chevrolet	S-10/Blazer	Man/Auto	4.3L(Z/W)	S/T
1995	Oldsmobile	Achieva/Cutlass Calais	Auto	3.1L(M)	N
1995	Oldsmobile	Cutlass Supreme	Auto	3.1L(M)	W
1995	Pontiac	Firebird	Man/Auto	3.4L(S)	F
1995	Pontiac	Firebird	Auto	3.8L(K)	F
1995	Pontiac	Firebird	Man/Auto	5.7L(P)	F
1995	Pontiac	Grand Am	Auto	3.1L(M)	N
1995	Pontiac	Grand Prix	Auto	3.1L(M)	W
1995	Pontiac	Sunbird	Auto	2.3L(D)	J

Year	Make	Model	Transmission	Engine	VIN
1994	Buick	Roadmaster	Auto	5.7L(P)	B
1994	Buick	Regal	Auto	3.1L(M)	W
1994	Cadillac	Fleetwood	Auto	5.7L(P)	D
1994	Chevrolet	Corsica/Beretta	Auto	3.1L(M)	L
1994	Chevrolet	Camaro	Auto	3.4L(S)	F
1994	Chevrolet	Camaro	Man/Auto	5.7L(P)	F
1994	Chevrolet	Caprice	Auto	4.3L(W)	B
1994	Chevrolet	Caprice	Auto	5.7L(P)	B
1994	Chevrolet	Corvette	Man/Auto	5.7L(P)	Y
1994	Chevrolet	S-10/Blazer	Manual	4.3L(Z)	S/T
1994	Oldsmobile	Achieva/Cutlass Calais	Auto	3.1L(M)	N
1994	Oldsmobile	Cutlass Supreme	Auto	3.1L(M)	W
1994	Pontiac	Firebird	Auto	3.4L(S)	F
1994	Pontiac	Firebird	Man/Auto	5.7L(P)	F
1994	Pontiac	Grand Am	Auto	3.1L(M)	N
1994	Pontiac	Grand Prix	Auto	3.1L(M)	W
1993	Chevrolet	Camaro	Man/Auto	3.4L(S)	F
1993	Chevrolet	Lumina/Monte Carlo	Auto	3.1L(T)	W
1993	Chevrolet	S-10/Blazer	Manual	4.3L(Z)	S/T
1993	Oldsmobile	Cutlass Supreme	Auto	3.1L(M)	W
1993	Pontiac	Firebird	Man/Auto	3.4L(S)	F
1993	Pontiac	Grand Prix	Auto	3.1L(T)	F
1992	Chevrolet	Cavalier	Man/Auto	2.2L	J
1992	Chevrolet	Corsica/Beretta	Man/Auto	2.2L	L
1992	Geo	Storm	Man/Auto	1.8L	R
1992	Geo	Storm	Man/Auto	1.6L	R
1991	Geo	Storm	Man/Auto	1.6L	R
1990	Geo	Storm	Man/Auto	1.6L	R

Glossary

Acronym – A word formed from the initial letter or letters of each successive part (or major parts) of a compound term. Example: PCM (Powertrain Control Module)

Active Testing – Testing where the PCM controls the system (or a component in an explicit action) while monitoring takes place.

Additive – A substance added in small amounts to another substance (such as gasoline) to improve and/or strengthen its properties.

AIR – An abbreviation for Secondary Air Injection. A Secondary Air Injection system is an emissions system that is primarily found on large-engine vehicles. It reduces HC and CO emissions by pumping fresh air into the exhaust stream.

Air Density – The relationship, stated in percent, of the weight to a specified volume of air at a given temperature, pressure, and humidity.

Air Fuel Ratio – The ratio of air to fuel, by weight, contained in a combustible mixture entering the engine. The best ratio for exhaust emissions control (in conjunction with the catalytic converter) is 14.7 air parts to 1 part fuel. This ratio, also known as the Stoichiometric ratio, is often expressed as 14.7:1.

Alternating Current (AC) Voltage – Electrical current, within a circuit, that first flows in one direction then another.

Altitude – Elevation, a measured in relationship to the earth's surface at sea level.

Ambient Air Temperature – The temperature of the air pertaining to the surroundings of a certain object, such as a vehicle.

Amperage – The total amount of current flowing in a circuit (measured in amperes).

Ampere (AMP) – The standard unit of measurement in relationship to the flow of electrical current.

Analog Signal – An electrical where the voltage varies in exact proportion to a measured quantity. (e.g., speed, pressure, temperature, etc.)

Anti-Knock Index – A measure of the fuel's ability to resist engine knock, stated as a number, which relates to the octane quality of the fuel.

Atmospheric Pressure – The pressure exerted on all things based on the weight of the air above them. This is approximately 14.7 pounds-per-square-inch atmospheric (psia) at sea level.

Atomize – To separate or reduce into fine/minute particles.

Glossary (Continued)

Back Pressure – The exhaust system's resistance to flow. It is measured in pounds per square inch (psi) or Kilopascals (kPA).

Baffle – A plate or shield that is used to direct the flow of a gas or liquid.

Balance Shaft – A shaft in the engine that, as it rotates, is designed to reduce or cancel some of the vibration produced by the engine.

Barometric Pressure – The measure of atmospheric pressure that reflects altitude and weather conditions. It is measured in inches of mercury (Hg).

Battery – An electro-chemical device that converts chemical energy to electrical energy.

Baud Rate - The speed at which bits of computer information are transmitted/received on a serial data stream. Measured in bits per second (bps).

Bi-directional Communication – Computer communication that utilizes serial data as an input and an output.

Bit – 1. The smallest unit of measurement that is recognized by a computer. 2. The individual voltage signal on a serial data stream.

Blow-By Gases – Combustion gases that leak (past the piston rings) into the crankcase during the compression and combustion stroke of the engine.

Boost – An increase, measured in pounds per square inch, in air pressure above atmospheric.

Bottom Dead Center (BDC) – The lowest position in the cylinder that a piston can travel without reversing its direction. It is the baseline measurement for determining the cubic inch displacement of a cylinder.

British Thermal Unit (BTU) – The amount of heat that is required to raise 1 pound of water 1° F at sea level.

Buffer – A circuit or component used to reduce the amount of interaction between two electronic circuits.

Byte – Eight bits of computer information that are processed as a unit and transmitted in sequence on a serial data stream.

Calpac (Also Calpak) – A device, inside the ECM, that is used (with fuel injection) to allow fuel delivery in the event of an ECM or PROM malfunction.

Glossary (Continued)

Carbon Dioxide (CO2) – A colorless, odorless, non-flammable gas that is produced during the combustion process. The degree of CO2 that is present in the exhaust can be used to assess the efficiency of an engine's combustion.

Carbon Monoxide (CO) – An odorless, colorless and highly poisonous gas that is formed by the incomplete combustion of gasoline.

Catalytic Converter – A stainless-steel canister in the vehicle's exhaust system that converts exhaust emissions into less harmful gases. It includes a layer of catalytic material spread over a large area of inert supports. A three-way converter refers to the conversion of the following three emissions: Carbon Monoxide, oxides of nitrogen, and hydrocarbons.

Class 2 – A type of digital data stream used in the majority of GM OBD II diagnostic systems. Class 2 utilizes two-bit pulse widths and toggles between 0 volts (passive) and 7 volts (active).

CO – An acronym for Carbon Monoxide, an odorless, colorless and highly poisonous gas that is formed by the incomplete combustion of gasoline.

Combustion – The burning of the air and fuel mixture in the engine's cylinders.

Combustion Chamber – The space left within the cylinder once the piston is at the top of its travel. The top of the piston and a cavity in the cylinder head forms it. Since most of the combustion takes place in this space, its design and shape can adversely affect the power, fuel efficiency, and emissions of the engine.

Compression Ratio – The ratio of the volume in the engine cylinder with the piston at BDC (bottom dead center) to the volume at TDC (top dead center).

Computer – A device that can perform high speed logical or mathematical calculations and otherwise process data.

Coolant – The liquid mixture contained within the engine cooling system.

Current – The rate, measured in amperes, at which electrons flow in a single direction on an electrical circuit.

Data – Information used as a basis for electronic or mechanical computation.

Detonation – A violent explosion in the combustion chamber that often causes a loud, audible knock. It is created by uncontrolled burning of the air/fuel mixture.

Diagnostic – On-board tests performed by the Diagnostic Management System that check for malfunctions, breakdowns, or errors in vehicle systems/components.

Glossary (Continued)

Diagnostic Executive – The software on the Diagnostic Management System that stores/records test results and controls the activation of lamps.

Diagnostic Management System – The PCM system accountable for powertrain components/systems testing, test result recording, and TEST FAIL processing.

Diagnostic Trouble Code (DTC) – A numeric or alphanumeric sequence, which indicates a fault in the vehicle's operating system. Each sequence represents a specific malfunction. DTCs can be obtained by reading them with a scan tool.

DIC – An acronym for Driver Information Center. The DIC alerts the driver (via messages) of instructions, warnings, and malfunctions. It may show alerts related to the TYPE C DTCs.

Digital Signal – An electrical signal that is either "on" or "off" with no in-between.

Direct Current (DC) Voltage - Electrical current, within a circuit, that flows in one direction.

DLC – An acronym for Data Link Connector. This connector, a standard 16 cavity connector under OBD II, allows diagnostic scan tools to connect directly to the vehicle (under driver-side instrument panel).

Driveability – The general evaluation of the powertrain's operating qualities. This includes idle smoothness, throttle response, cold and hot starting, power delivery, and tolerance for altitude changes.

Driver – An electronic device (usually a power transistor) that operates like a switch by turning circuits on and off by providing ground.

Dual Overhead Camshaft (DOHC) – An engine designed with two camshafts above each cylinder line, one for exhaust and one for intake.

Duration – A rating system utilized for engine camshafts that determines the amount of time the valve will be open, relative to the crankshaft movement in degrees.

Dwell – The amount of time (recorded on a dwell meter in degrees) that voltage passes through a closed switch.

ECT – An acronym for Engine Coolant Temperature sensor.

Electrode – A solid conductor through which current enters or leaves a substance, such as a gas or liquid.

Glossary (Continued)

Electromagnetic Interference (EMI) – An undesirable electronic signal. EMI is caused by the building up and collapsing of a magnetic field, which creates unwanted electrical interference on a nearby circuit.

Emissions – Gases and particles remaining after the combustion of an engine, or from a fuel system. Hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO_x) are the primary emissions of concern.

Enable Criteria – The precise conditions that are required for the performance of a diagnostic test.

Engine Control Module (ECM) - The on-board computer responsible for controlling the fuel, emissions, and diagnostics for the vehicle's engine management system.

Enleanment – The act of creating a leaner air/fuel mixture by reducing fuel delivery.

Enrichment – The act of creating a richer air/fuel mixture by increasing fuel delivery.

Environmental Protection Agency (EPA) - a federal government agency that establishes regulations and supervises the enforcement of law in relation to the environment. The content and amount of automotive emissions are in included in these regulations/laws.

Ethanol (Grain Alcohol) – A fuel oxygenate. It is primary used as an octane enhancer and is added to gasoline; however, pure ethanol can be used in specially designed vehicles.

Ethyl Tertiary Butyl Ether (ETBE) – An octane enhancer for gasoline. A fuel oxygenate that is created by reacting isobutylene with ethanol.

Evaporative Emissions (EVAP) – Utilized to prevent fuel vapors in the tank from entering the atmosphere as hydrocarbon emissions.

Exhaust Gas Re-circulation (EGR) - An emissions system that re-circulates some of the exhaust gas back to the intake manifold; therefore, reducing the NO_x (oxides of nitrogen) emissions.

Fail Record – A record that contains (stored) information regarding the operating conditions when a DTC was stored. Multiple Fail Records can be stored and updated.

Freeze Frame – The operating conditions that are stored (in PCM memory), the instant a DTC is set/stored and the MIL is activated. A Freeze Frame can only be overwritten under special conditions and is stored for only one DTC.

Frequency – The number of cycles within an electrical signal for a given period of time.

Glossary (Continued)

FTP – An acronym for Federal Test Procedure. The FTP is a strict series of tests that the EPA uses to gauge and certify the emissions output of US sold vehicles.

Fuel – A substance that is burned thereby producing heat and creating motion in an engine.

Fuel Injection – A system that meters fuel to the engine. It regulates flow and atomizes fuel through electronic or mechanical means by using a pump and injectors or nozzles.

Fuel Trim - An ECM function that adjusts fuel delivery, during closed loop operation, in attempts to optimize the air/fuel mix ratio (optimal ratio = 14.7:1).

Fulcrum – The support or point at which a lever pivots.

Generator – A device that creates electrical energy from mechanical energy.

Hall Effect – When a magnetic field is interjected perpendicular to a current flowing through a solid conductor, a measurable voltage is induced at right angle to the main current flow through the conductor.

HC – An acronym for Hydrocarbons. HCs are any number of carbon and hydrogen compounds used as fuel, such as gasoline.

HO2S – An abbreviation for Heated Oxygen Sensor.

Horsepower – A mechanical power measurement, or the rate at which work is done. One horsepower equals 33,000 pounds-feet of work per minute.

Hydraulic Lifter – A valve lifter that uses simple valving and oil pressure to slightly adjust its length, thereby maintaining zero clearance in the valvetrain.

Hydrocarbons - Any number of carbon and hydrogen compounds used as fuel, such as gasoline.

I/M – An abbreviation for Inspection and Maintenance. I/M usually refers to state emissions testing programs.

IAC – An acronym for Idle Air Control valve.

IAT – An acronym for Intake Air Temperature sensor.

Icing – The formation of ice on or around the throttle plate.

Ignition – The electrical system that provides the spark to ignite the air/fuel mixture during combustion.

Glossary (Continued)

Induction – The establishment of a magnetic field or electrical charge in a substance by the proximity of an electrified source, a magnet or magnetic field.

Intermittent – A repeatable condition/concern with specific criteria. The event must be active for diagnosis to occur. For example, temperature, speed, accessory, altitude, load, etc.

Intrusive Diagnostic Test – Any (on-board) test performed by the PCM which could have effects on the vehicle emissions or performance.

ISO 9141 – The International Standards Organization endorsed/recommended data communication network interface.

Isobutylene – A petrochemical that is reacted with methanol to form MTBE or ethanol to form ETBE.

Lash – The erratic movement of valvetrain components due to improper adjustment or lack of lubrication.

Leakdown, Hydraulic Lifter – The loss of oil pressure, during operation, from within a valve lifter.

Light Emitting Diode (LED) – A low voltage semiconductor that illuminates as current flows through it.

Lubricant – A substance or material, such as oil, that is placed between two moving parts to reduce friction.

Manifold Absolute Pressure (MAP) – The intake manifold pressure/vacuum.

Manifold Vacuum – A vacuum within the intake manifold developed from the cylinder intake strokes.

Mass Air Flow (MAF) – The volume of air passing into the engine.

Methanol (Wood Alcohol) – Usually manufactured from natural gas. Used, in combination with other co-solvent alcohols, as an octane enhancer.

Methyl Tertiary Butyl Ether (MTBE) - An octane enhancer for gasoline. A fuel oxygenate that is created by reacting isobutylene with methanol.

MIL – An acronym for Malfunction Indicator Lamp. Formerly known as, "Check Engine" or "Service Engine Soon" lamp.

Misfire - An incomplete or failed combustion in one or more cylinders. This is usually due to improper fuel, ignition, cylinder compression, or air.

Glossary (Continued)

Mode – A specific state of operation.

Non-Volatile Memory – Computer memory that is not lost when power is removed.

NO_x – An acronym for Oxides of Nitrogen. NOx is an emission produced when nitrogen and oxygen are combined, at high temperatures, in the combustion chamber.

OBD I – An acronym for On-Board Diagnostics Generation One. OBD I is a diagnostic system that is required by the California Air Resources Board since 1988. It monitors and controls various engine driveability functions by utilizing a microprocessor and sensors.

OBD II – An acronym for On-Board Diagnostics Generation Two. In addition to the OBD I functions, OBD II is expanded to include the monitoring of emissions system and sensor deterioration.

Octane – The measurement of a gasoline's ability to resist engine knock.

OHM – A measurement of electrical resistance.

Oxidation Catalysts – Platinum and palladium utilized in the catalytic converter to combine oxygen with hydrocarbons and carbon monoxide to create non-harmful emissions of water and carbon dioxide.

Oxides of Nitrogen (NOx) - An emission produced when nitrogen and oxygen are combined, at high temperatures, in the combustion chamber.

Oxygenate – An octane component that contains hydrogen, carbon, and oxygen in its molecular structure.

Passive Testing - Testing where the PCM monitors the system or component under normal operation.

PCM – An acronym for Powertrain Control Module. The PCM is an on-board control module that monitors engine and transaxle/transmission functions.

Pending Fault Code – A Type B DTC that has not matured.

Photocell – A semiconductor that controls, based on the presence of light, the current flow through a circuit.

Plenum – A chamber used to distribute the intake charge more evenly and efficiently. It is located between the throttle body and the runners of the intake manifold.

Polarity – The condition, in an electrical circuit or component, that determines the direction of current flow.

Glossary (Continued)

Ported Vacuum – A vacuum developed on the air cleaner side of the throttle plate as air moves past it.

Positive Crankcase Ventilation (PCV) – The system used to prevent blow-by gases from the crankcase from entering the atmosphere.

Post-Ignition - Occurs when the air/fuel mix self ignites during combustion, which results in a second flame front that collides with the first, causing an audible knock.

Potentiometer – A variable resistor that varies the voltage drop in a circuit.

Pounds Per Square Inch (PSI) – The unit of measure for the pressure of a gas or liquid.

Pounds-Feet (LB-FT) – The unit of measure for torque. One LB-FT torque equals the twisting force produced when one-pound force is applied to the end of a one-foot-long lever.

Powertrain – Combination of an engine and transmission.

Powertrain Control Module (PCM) – An on-board control module that monitors and controls engine and transaxle/transmission functions.

Pre-Ignition – The ignition of the air/fuel mixture prior to the timed ignition spark.

Pressure Regulator – A device that maintains/regulates a specified pressure within a system.

Programmable Read Only Memory (PROM) – A type of ROM (Read Only Memory) that can be programmed for different uses and applications.

Pulse Width Modulation (PWM) – The operation of device by a digital signal that is controlled by the time duration the device is turned ON and OFF.

Quad Driver – An integrated circuit that has the capability of four separate outputs.

Radio Frequency Interference Signal (RFI) – A high frequency type of EMI within the radio frequency band.

Random Access Memory (RAM) – A non-permanent type of memory that is used for information storage and retrieval. RAM is considered volatile as the memory is lost or "emptied" once power is removed.

Read Only Memory (ROM) – A permanent type of memory that is programmed by the computer manufacturer. It stores the parameters and operating instructions of the computer. ROM is considered non-volatile.

Glossary (Continued)

Refrigerant – The substance, utilized in A/C systems, that absorbs, carries, and releases heat.

Reid Vapor Pressure (RVP) – A method for determining the vapor pressures of gasoline and/or other petroleum based products.

Reserve Capacity – The amount of time (minutes) that a battery can deliver a 25-amp current while not dropping below 10.5 volts at 80 degrees F.

Resistance – The opposition to current flow in a circuit. (measured in ohms)

Revolutions Per Minute (RPM) – The measurement of how fast an object rotates around an axis.

Rheostat – *See Potentiometer.*

Scavenging – The process of drawing air/fuel into the cylinder, as a result of the movement of exhaust gases out.

Schrader Valve – A spring-loaded valve.

Society of Automotive Engineers (SAE) - An organization of automotive designers and engineers who establish standards and conduct tests on many automotive related functions.

Solenoid – An electrical device that, when energized, produces a mechanical motion.

Statistical Filtering – The process in which the PCM filters our information that could cause a false DTC to set. The PCM (over a period of time) internally creates charts based on the results of diagnostic testing, which in turn, are used to create a baseline for testing.

Stoichiometric Ratio – *See Air Fuel Ratio.*

Stroke – The distance a piston travels from BDC (bottom dead center) to TDC (top dead center).

Supercharger – A compressor that forces air (under pressure) into the cylinders to increase volumetric efficiency.

Suspend – An action the PCM may take with certain DTCs that will cease the running of some monitors when a fault exists in one system that could affect another system.

Synthetic Oil – A man-made oil that has improved resistance to thermal breakdowns.

Glossary (Continued)

System Status (I/M Ready) - An emission testing signal which states that all of the on-board diagnostics have been performed. The System Status (I/M Ready) is only concerned with whether or not the test was ran and not if it passed or failed.

TCC – An acronym for Torque Converter Clutch. The TCC is a clutch device, found in automatic transmissions, that creates a fluid coupling between the final drive output and the engine.

Thermistor – A resistor that varies resistance based on temperature changes.

Thermostat – A device that controls the flow within a system based on temperature, such as in the engine cooling system.

Throttle Body – A housing that contains a valve to regulate the airflow through the intake manifold, usually located between the air cleaner and the intake plenum.

Top Dead Center (TDC) – The highest point, in the cylinder, that a piston can travel.

Torque – A turning/twisting force measured in pounds-feet.

Torque Converter – A special form of fluid coupling where torque is increased.

TP – An acronym for Throttle Position sensor.

TRIP – A key cycle (Key ON, RUN, Key OFF) where the diagnostic's enable criteria is met and the diagnostic test occurs.

Turbocharger – An exhaust powered supercharger.

Turbulence – (As in an engine) The rapid swirling motion of the air and fuel mix entering the cylinder. Turbulence provides better fuel vaporization and cylinder fill.

TWC – An acronym for Three-Way Converter.

UART - An acronym for Universal Asynchronous Receive and Transmit. The UART is the data stream type used on non-OBD II systems. It toggles between 5 volts (passive) and 0 volts (active).

Vacuum – Negative pressure (less than atmospheric pressure), measured in inches of mercury.

Valve Overlap – The amount of time, measured in degrees of crank rotation, the intake and exhaust valves are both open.

Valvetrain – The group or collection of parts that allow the valves to operate. This includes the camshaft(s), related drive components, valves, and associated parts.

Glossary (Continued)

Vapor Lock – Vaporized fuel that is usually found in the fuel line, which prevents the necessary fuel delivery (to the cylinders).

Vehicle Control Module (VCM) - An on-board computer that controls the transmission, engine management, and other systems such as ABS.

Vehicle Identification Number (VIN) – An alphanumeric number on each vehicle that identifies the vehicle type, assembly plant, powertrain, etc.

Volatile Memory – Computer memory that is only retained while power is supplied.

Volatility – The measurement of the tendency of a liquid to change to vapor.

Volt – A unit of measurement for the force of pushing electrical current through a circuit.

Voltage – The number of volts required to pass current, against resistance, through a conductor.

Voltage Drop – A reduction or drop in voltage across a resistance within a circuit.

Volumetric Efficiency – The ratio, expressed in percent, between the actual and ideal amount of air/fuel mix entering the cylinder.

Warm-Up Cycle - A Warm-Up Cycle is attained when the ECT rises at least 40° F (22° C) from startup and reaches a minimum temperature of 160° F (71° C). The PCM utilizes Warm-Up Cycles rather than Key Cycles to clear DTCs.

Word – The number of bits needed to represent the largest data element processed by a computer, or the number of bits needed to represent a computer instruction. *Also See Byte.*