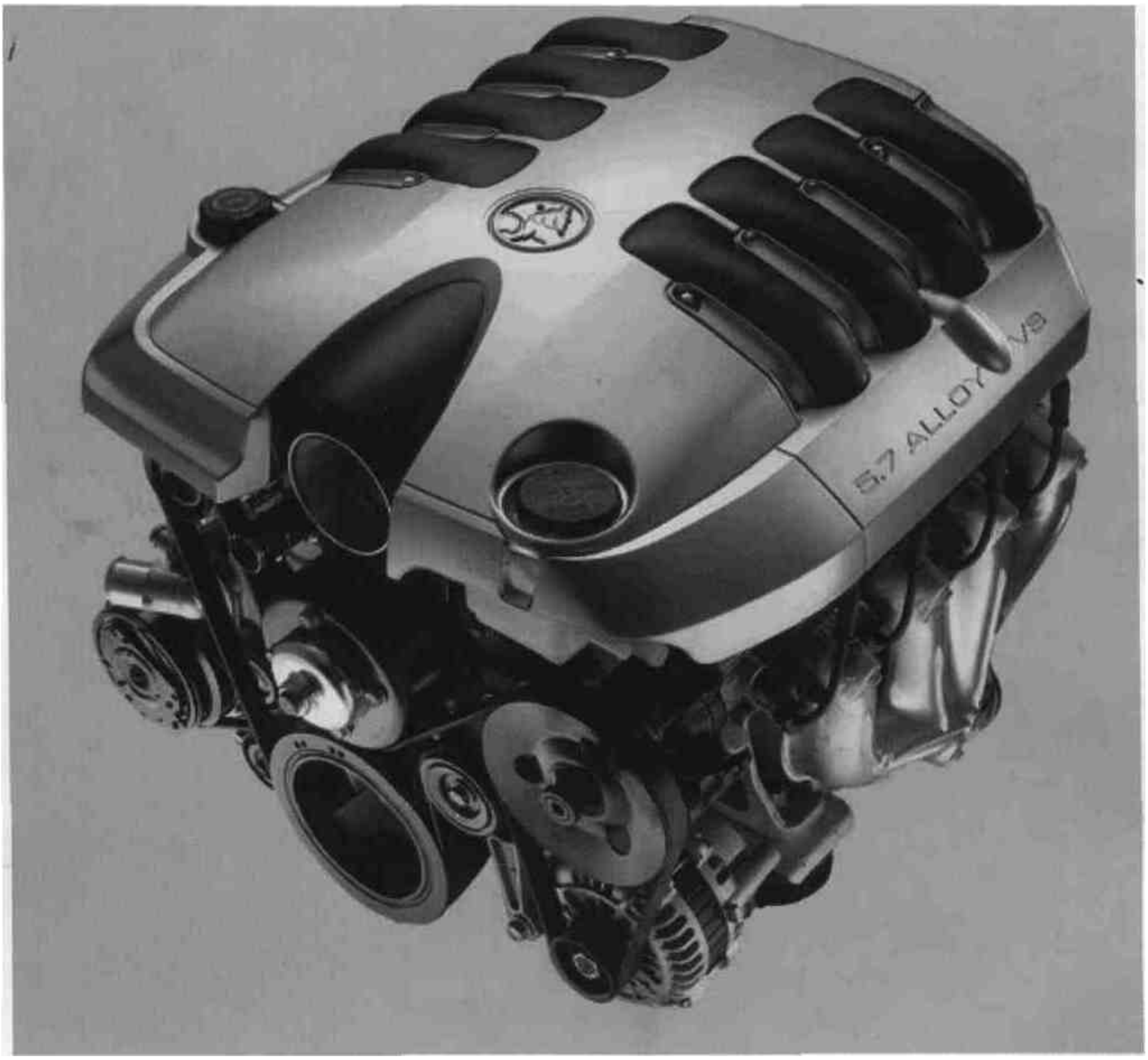
HOLDEN

SERVICE TRAINING

GEN III V8 ENGINE MANAGEMENT



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HOLDEN LTD A.C.N. 006 893 232

SERVICE TRAINING

February 2000

IMPORTANT SAFETY NOTICE

Proper service and repair is important to the safe, reliable operation of all motor vehicles The service procedures recommended by Holden Ltd A C N 006 893 232 and described in this publication are effective methods for performing service operations Some of these service operations require the use of tools specially designed for the purpose The special tools should be used when and as recommended

It is important to note that some warnings against the use of specific service methods that can damage the vehicle or render it unsafe are stated in this publication It is also important to understand these warnings are not exhaustive Holden Ltd could not possibly know, evaluate and advise the service trade of all conceivable ways in which service might be done or of all the possible hazardous consequences of each way Consequently, Holden Ltd has not undertaken any such broad evaluation Accordingly, anyone who uses a service procedure or tool which is not recommended by Holden Ltd must first be thoroughly satisfied that neither personal safety nor vehicle safety will be jeopardised by the service method selected

CONTENTS

NOTES

GENERAL INFORMATION

The GEN III V8 engine uses a Powertrain Control Module (PCM) to control exhaust emissions while maintaining excellent driveability and fuel economy. The PCM maintains a desired air/fuel ratio at precisely 14.7 to 1. To maintain a 14.7 to 1 air fuel ratio the PCM monitors the output signals from two oxygen sensors. The PCM will either add or subtract fuel pulses based on the oxygen sensors output signal. This method of feed back fuel control is called closed loop.

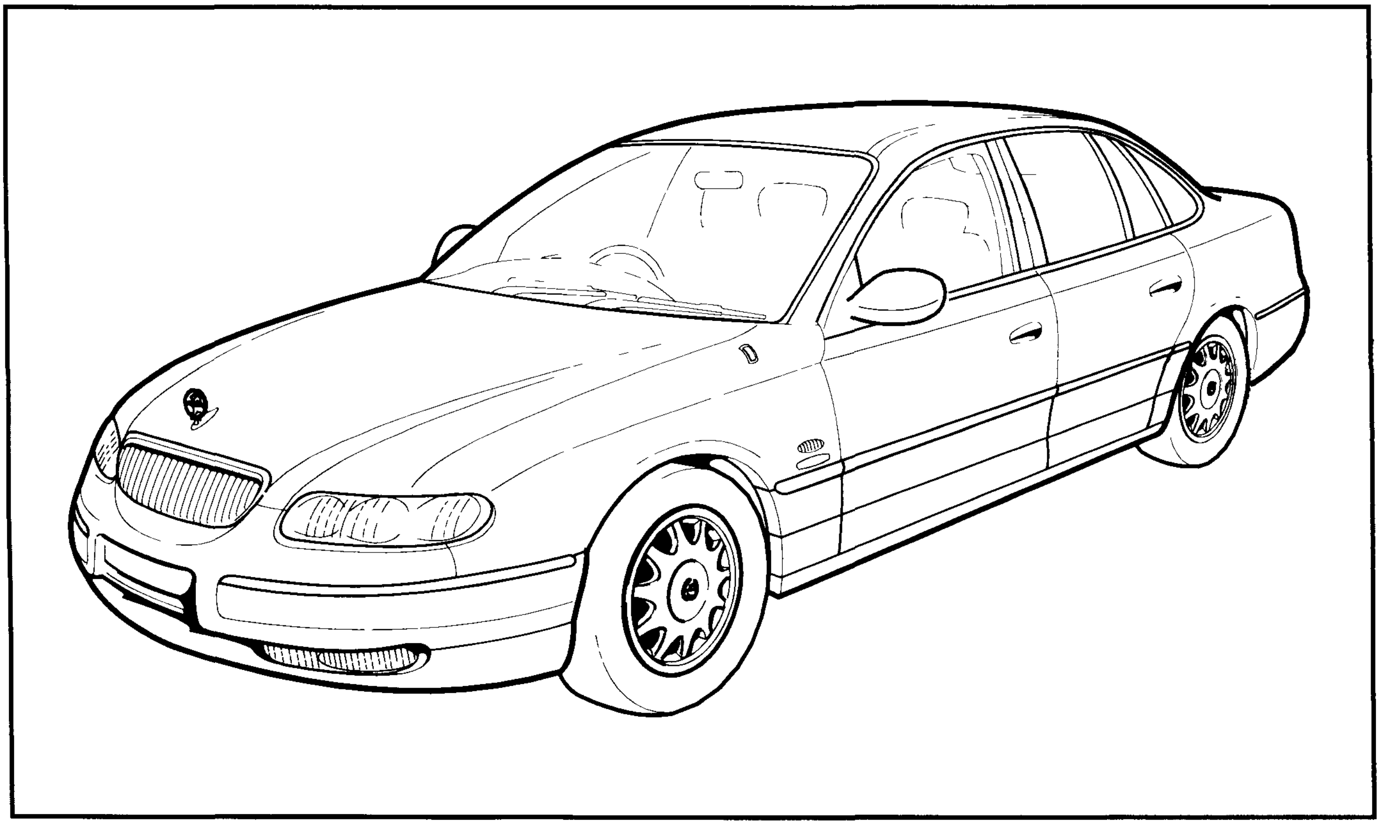
In addition to fuel control, the PCM also controls the following systems.

- The Ignition Dwell
- The Ignition Timing
- The Idle Speed
- The Engine Electric Cooling Fans
- The Electric Fuel Pump
- The Instrument Panel Check Powertrain lamp
- The A/C Compressor Clutch
- The Automatic Transmission Functions
- The Manual Transmission Reverse Lockout
- Theft Deterrent

The PCM also interfaces with other vehicle control modules, such as the Powertrain Interface Module (PIM), Instruments, and the Body Control Module (BCM). The illustration on the following page contains a list of the various operating conditions sensed by the PCM on the left, and the various systems controlled on the right.

The PCM has a built-in diagnostic system that identifies operational problems at which time it stores a Diagnostic Trouble Code (DTC) and on most occasions alerts the driver by illuminating the Check Powertrain Lamp (CPL) in the instrument. If the lamp comes on while driving, it does not mean that the engine should be stopped immediately, but the cause of the lamp coming on should be checked as soon as is reasonably possible. The PCM has built in backup systems that in all but the most severe faults will allow the vehicle to operate in a near normal manner until repairs can be made.

Below the instrument panel to the left of the steering column is a Data link Connector (DLC) which is used by the assembly plant for a computer "check-out" of the PCM system. The DLC is also used in service to help diagnose the system using Tech 2.



WH Caprice

ENGINE

OPERATING PARAMETERS SENSED

- A/C PRESSURE SENSOR
- A/C REQUEST ON OR OFF
- BATTERY VOLTAGE
- CAMSHAFT POSITION
- CRANKSHAFT POSITION
- SERIAL DATA
- ENGINE COOLANT LEVEL
- ENGINE COOLANT TEMPERATURE
- ENGINE COOLING FAN RESPONSE
- ENGINE KNOCK
- ENGINE SPEED
- EXHAUST GAS OXYGEN CONTENT
- INTAKE AIR TEMPERATURE
- MASS AIR FLOW
- MANIFOLD ABSOLUTE PRESSURE
- OIL PRESSURE
- SPARK RETARD SIGNAL
- THROTTLE POSITION
- TRANSMISSION SELECTOR POSITION
- THEFT DETERRENT SIGNAL
- VEHICLE SPEED

→ **POWERTRAIN CONTROL MODULE (PCM)** →

SYSTEMS CONTROLLED

- A/C COMPRESSOR CLUTCH
- CANISTER PURGE SOLENOID
- DIAGNOSTICS
- CHECK POWERTRAIN LAMP
- SERIAL DATA
- FIELD SERVICE MODE
- ELECTRIC ENGINE COOLING FANS
- ELECTRONIC SPARK CONTROL
- ELECTRONIC SPARK TIMING
- FUEL CONTROL
  - FUEL INJECTORS
  - ELECTRIC FUEL PUMP
- IDLE AIR CONTROL
- TORQUE MANAGEMENT

TRANSMISSION

OPERATING PARAMETERS SENSED

- BATTERY VOLTAGE
- ECONOMY/POWER SWITCH
- ENGINE SPEED
- ENGINE COOLANT TEMPERATURE
- STOP LAMP SWITCH
- THROTTLE POSITION
- TRANSMISSION FLUID TEMPERATURE
- TRANSMISSION GEAR POSITION
- VEHICLE SPEED

→ **POWERTRAIN CONTROL MODULE (PCM)** →

SYSTEMS CONTROLLED

- TRANSMISSION FLUID PRESSURE
- TORQUE CONVERTER CLUTCH
  - TCC ENABLE SOLENOID
  - TCC PWM SOLENOID
- 1-2 SHIFT SOLENOID
- 2-3 SHIFT SOLENOID
- 3-2 DOWNSHIFT SOLENOID
- DIAGNOSTICS
- CHECK POWERTRAIN LAMP
- SERIAL DATA

- MANUAL TRANSMISSION REVERSE LOCK-OUT

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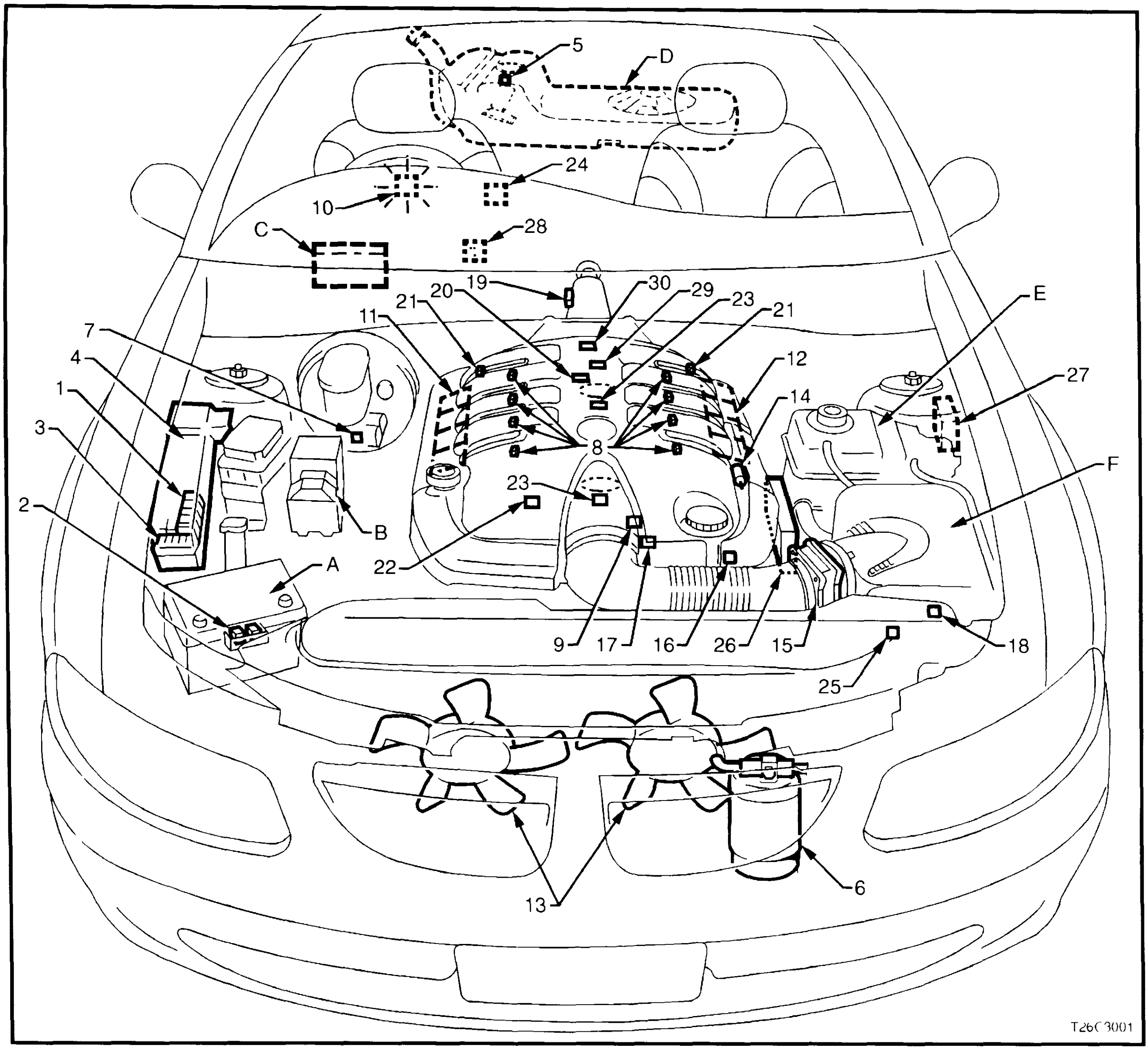
Gen III PCM Operating Parameters Sensed and Systems Controlled



Typical Component Locations

1	Engine Compartment Fusible Link Housing		
2	Battery Harness Cooling Fan Fusible Link Housing	**20**	Camshaft Position (CMP) Sensor
3	Engine Compartment Fuse Housing	**21**	Heated Oxygen (HO2S) Sensor (2)
4	Engine Compartment Relay Housing	**22**	Crankshaft Position (CKP) Sensor
5	Fuel Pressure Regulator (in fuel Tank)	**23**	Knock (KS) Sensors (2)
6	A/C Accumulator Tank	**24**	ECC In - Car Air Temperature Sensor
7	Brake Hydraulic Failure Switch	**25**	A/C Refrigerant Pressure Sensor
8	Fuel Injectors (8)	**26**	Powertrain Control Module (PCM)
9	Idle Air Control (IAC) Valve	**27**	Powertrain Interface Module (PIM) - Inside vehicle behind left kick panel
10	Check Powertrain Lamp (CPL)	**28**	Data link Connector (DLC)
11	Ignition Coil/Module Right Bank	**29**	Oil Pressure Sensor
12	Ignition Coil/Module Left Bank	**30**	Manifold Absolute Pressure (MAP) Sensor
13	Engine Cooling Fans (2)		
14	Canister Purge Solenoid	**A**	Battery
15	Mass Air Flow (MAF) Sensor	**B**	ABS
16	Engine Coolant Temperature (ECT) Sensor	**C**	BCM
17	Throttle Position (TP) Sensor	**D**	Fuel Tank
18	Intake Air Temperature (IAT) Sensor	**E**	Surge Tank (With Low Coolant Level Switch)
19	Vehicle Speed Sensor (VSS)	**F**	Air Cleaner

POWERTRAIN CONTROL MODULE

The Powertrain Control Module (PCM), is located in the engine compartment and constantly monitors the information from various sensors, and controls the engine and transmission operation, dependant on the information received from these sensors The PCM performs the diagnostic function of the system It can recognise operational problems, alert the driver through the Check Powertrain Lamp and store a Diagnostic Trouble Code(s) that will identify problem areas to aid the technician in making repairs The PCM supplies either a buffered 5 or 12 volts to power various sensors or switches This is done through resistance's in the PCM which are so high in value that a test light will not light when connected to the circuit In some cases, even an ordinary voltmeter will not give an accurate reading because the meter's internal resistance is too low

A 10 Meg Ohm input impedance digital voltmeter is required to assure accurate voltage readings.

The PCM controls output circuits such as the injectors, IAC, and various relays, etc by controlling the earth circuit through transistors or a device called a "Driver" in the PCM The two exceptions to this are the fuel pump relay control circuit and the automatic transmission pressure control solenoid (PCS) The fuel pump relay is the only PCM controlled circuit where the PCM controls the +12 volts sent to the coil of the relay The earth side of the fuel pump relay coil is connected to engine earth The PCM supplies current to the PCS and monitors how much current returns to the PCM on a separate terminal The PCM also receives and transmits serial data via the Powertrain Interface Module (PIM) and the serial data bus

The Gen III PCM does not contain a removable PROM, it uses an EEPROM (Flash Memory) which is non removable The PCM is programmed from the factory with the proper calibrations for vehicle operation In the event that the PCM is replaced, or an updated calibration is required to correct a vehicle's operating condition, the new PCM or the new calibration will have to be down loaded to the PCM EEPROM (Flash Memory) Down loading is accomplished through the vehicle DLC using the TECH 2 Service Programming System (SPS) and the Technical Information System (TIS)

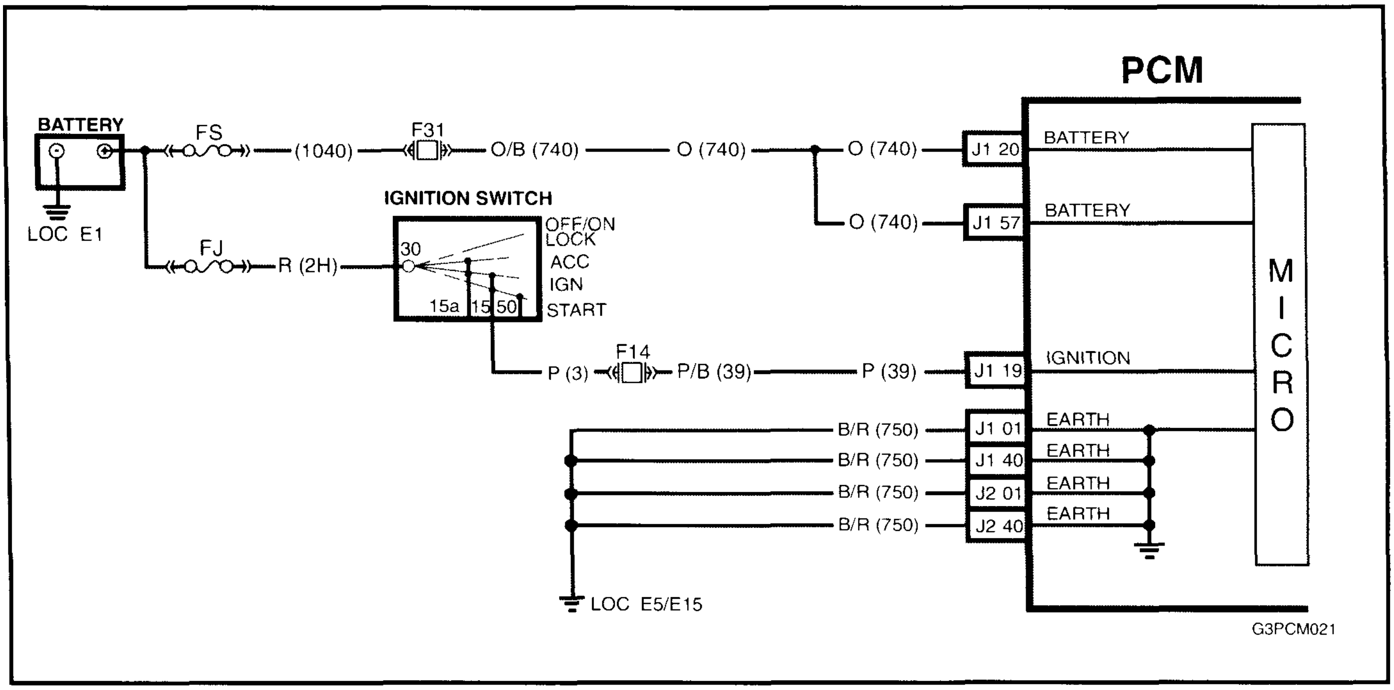
The service replacement PCM EEPROM (Flash Memory) will not be programmed DTC P0601 and P0602 indicates the Flash Memory is not programmed or has malfunctioned

PCM Security Link

Once the PCM, PIM and or BCM have been replaced, the new PCM, PIM and BCM must be security linked to each other using Tech 2 and TIS

PCM Power Supplies

Battery voltage is applied to PCM terminals J1-20 and J1-57 at all times via fuse F31 and ignition voltage is applied to PCM terminal J1-19 via fuse F14 whenever the ignition switch is in the ON or START positions The PCM is earthed from terminals J1-01, J1-40, J2-01 and J2-40 to earth points E5 and E15



PCM Battery, Ignition and Earth Circuits

PCM Five Volt Reference Circuits

The PCM has two five volt reference circuits The five volt reference circuit number one supplies five volts to the following sensors

- The Throttle Position Sensor (J1 -08)
- The Manifold Absolute Pressure Sensor (J1-48)
- Oil Pressure Sensor (J1-07)

The five volt reference circuit number two supplies five volts to the following sensor

- The A/C Pressure Sensor (J1-45)

The PCM monitors the voltage on the 5 0 volt reference circuit This DTC sets if the voltage is out of range

A failure in a Five Volt Reference Circuits will set one of the following DTCs:

DTC P1635 Five Volt Reference #1 Circuit

Conditions for running DTC P1635

- The ignition is on

Conditions for setting DTC P1635

- The five volt reference #1 circuit is out of range
- All of the above conditions are present for greater than 2 seconds

Action taken when DTC P1635 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P1635

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail
- A last test failed (Current DTC) clears when the diagnostic runs and does not fail

DTC P1639 Five Volt Reference #2 Circuit

Conditions for running DTC P1639

- The ignition is on

Conditions for setting DTC P1639

- The five volt reference #2 circuit is out of range
- All of the above conditions are present for greater than 2 seconds

Action taken when DTC P1639 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P1639

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail
- A last test failed (Current DTC) clears when the diagnostic runs and does not fail

DIAGNOSIS

The Rowel-train Management Section of the Service Manual is where to start all dnveability and emissions diagnosis Once you have read and understood the General Information Section which contains reference material wiring diagrams, PCM terminal end views and normal voltages, and component locations (Remember, this information is for reference, do not start diagnosis using these pages) Always start diagnosis on the page titled **On-Board Diagnostic System Check** This check first verifies that the diagnostic circuits are operating properly and then sends you to the correct service manual page for diagnosis

If the initial steps in the On-Board Diagnostic System Check reveal a problem, or if the engine does not start, you will be using one or more A charts for diagnosis Again, the On-Board Diagnostic System Check will send you to the correct chart These charts follow the On-Board Diagnostic System check and diagnose both fundamental PCM diagnostics and problems that prevent the engine from starting

If the On-Board Diagnostic System Check shows that Diagnostic Trouble Codes (DTC) have been stored, proceed to the appropriate Diagnostic Trouble Code diagnosis pages If more than one diagnostic trouble code has been stored, always start diagnosis with the lowest diagnostic trouble code number and work upward Diagnostic trouble code diagnosis pages start immediately after the A chart pages

Diagnostic Precautions

The following requirements must be observed when working on vehicles:

1. Before removing any PCM system component, disconnect the battery earth lead
2. Never start the engine without the battery being solidly connected
3. Never separate the battery from the on board electrical system while the engine is running
4. When charging the battery, disconnect it from the vehicle's electrical system
5. Never subject the PCM to temperatures above 80 degrees C i e paint oven Always remove control unit first if this temperature is to be exceeded
6. Ensure that all cable harness plugs are connected solidly and that battery terminals are thoroughly clean
7. The PCM harness connectors are designed to fit in only one way, there are indexing tabs and slots on both halves of the connector Forcing the connector into place is not necessary if it is being installed with the proper orientation Failure to take care to match the indexing tabs and slots to ensure the connector is being installed correctly can cause damage to the connector, the module, or other vehicle components or systems
8. Never connect or disconnect cable harness plug at the PCM when the ignition is switched on
9. Before attempting any electric arc welding on the vehicle, disconnect the battery leads and the PCM connectors
10. When steam cleaning engines, do not direct the steam cleaning nozzle at PCM system components If this happens, corrosion of the terminals can take place
11. Use only the test equipment specified in the diagnostic charts, since other test equipment may either give incorrect results or damage good components
12. All voltage measurements using a voltmeter must use a digital voltmeter with an internal impedance rating of at least 10 million ohms per volt (10 meg ohms)
13. When a test light is specified, a low-power test light must be used Do not use a high - wattage test light While a particular brand of test light is not suggested, a simple test on any test light will ensure it to be OK for PCM circuit testing Connect an accurate ammeter (such as the high-impedance digital multimeter) in series with the test light being tested, and power the test light-ammeter circuit with the vehicle battery

    If the ammeter indicates tess than 3/10 amp current flow (0 3 A or 300 mA), the test light is **OK** to use

    If the ammeter indicates ***more*** than 3/10 amp current flow (0 3 A or 300 mA), the test light is **NOT OK** to use

Blocking Drive Wheels

The vehicle drive wheels should always be blocked and parking brake firmly set while checking the system

Visual/Physical Inspection

A careful visual and physical inspection must be performed as part of any diagnostic procedure or in finding the cause of an emissions test failure. This can often lead to fixing a problem without further steps Inspect all electrical wires for correct routing, pinches, cuts, or disconnections Be sure to inspect wires that are difficult to see beneath the air cleaner, compressor, generator, etc Inspect all the wires in the engine compartment for proper connections, burned or chafed spots, pinched wires, or contact with sharp edges or hot exhaust manifolds This visual/physical inspection is very important It must be done carefully and thoroughly

Basic Knowledge and Tools Required

To use the VT Series Service Manual effectively, a general understanding of basic electrical circuits and circuit testing tools is required You should be familiar with wiring diagrams, the meaning of voltage, ohms, amps, the basic theories of electricity, and understand what happens in an open or shorted wire

To perform system diagnosis, the use of a Tech 2 is required A test light, digital volt-ohmmeter with 10 megohms impedance, vacuum gauge, and jumper wires are also required Please become acquainted with the tools and their use before attempting to diagnose a vehicle

Electrostatic Discharge Damage

Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage caused by electrostatic discharge It is possible for less than 100 volts of static electricity to cause damage to some electronic components By comparison, it takes as much as 4,000 volts for a person to even feel the zap of a static discharge

There are several ways for a person to become statically charged The most common methods of charging are by friction and by induction An example of charging by friction is a person sliding across a car seat, in which a charge of as much as 25,000 volts can build up

Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches earth Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity Static charges of either type can cause damage, therefore, it is important to use care when handling and testing electronic components

NOTE: To prevent possible Electrostatic Discharge damage

- Do Not touch the PCM connector pins

DIAGNOSTIC INFORMATION

The diagnostic charts and functional checks in the Service Manual are designed to locate a faulty circuit or component through logic based on the process of elimination The charts are prepared with the requirement that the vehicle

- Functioned correctly at the time of assembly
- There are no multiple faults
- The problem currently exists

The PCM performs a continual self-diagnosis on certain control functions This diagnostic capability is complemented by the diagnostic procedures contained in the Service Manual The PCM's language for communicating the source of a malfunction is a system of Diagnostic Trouble Codes (DTCs) The diagnostic trouble codes are four digit (POXXX or P1XXX) When a fault is detected by the PCM, a diagnostic trouble code is set and the Check Powertrain lamp may be illuminated

Self-Diagnostics

The PCM performs system self diagnostics, and can detect and often isolate system failures When a failure is detected, the PCM sets a DTC that represents that failure and may or may not turn on the Check Powertrain Lamp

Check Powertrain Lamp

The Check Powertrain Lamp is a Malfunction Indicator Lamp (MIL) and is located in the instrument panel and has the following functions

- It is used as a bulb check, it will come on for two seconds when the ignition is turned on
- It informs the driver that a problem has occurred and that the vehicle should be taken for service as soon as is reasonably possible

As a bulb and system check, the Check Powertrain lamp will come on for two seconds when the ignition is turned on If the Check Powertrain lamp remains illuminated, the self-diagnostic system has detected a problem If the problem goes away, the Check Powertrain lamp will go out in most cases after 10 seconds, but a Diagnostic Trouble Code will be stored in the PCM

When the Check Powertrain lamp remains on while the engine is running, or when a malfunction is suspected due to a dnveability or emissions problem, an **On-Board Diagnostic System Check must be performed.** The procedure for this check is given in the Service Manual These checks will expose malfunctions which may not be detected if other diagnostics are performed prematurely

Intermittent Check Powertrain Lamp

In the case of an intermittent problem, the Check Powertrain lamp may light for ten seconds and then will go out However, the corresponding Diagnostic Trouble Code (DTC) will be stored in the memory of the PCM The DTC will remain stored in the PCM memory until the Tech 2 erases it When unexpected DTCs appear during the diagnostic trouble code reading process, one can assume that these DTCs were set by an intermittent malfunction and could be helpful in diagnosing the system

An intermittent diagnostic trouble code may or may not re-set If it is an intermittent failure, a Diagnostic Trouble Code Chart is not used Consult the Diagnostic Aids on the page facing the diagnostic chart corresponding to the intermittent diagnostic trouble code The Symptoms section also covers the topic of intermittents A physical inspection of the applicable sub-system most often will resolve the problem The Tech 2 also has several features which can help with diagnosing intermittents, such as the Wiring Harness integrity test

STRATEGY BASED DIAGNOSTICS

The strategy based diagnostic is a uniform approach to repair all Electrical/Electronic systems The diagnostic flow can always be used to resolve an Electrical/Electronic system problem and is a starting point when repairs are necessary The steps below are defined to instruct the technician how to proceed with a diagnostic process Steps below also refer to step numbers found on the Strategy Based Diagnostic table

1. **Verify the Driver Concern:** To verify the driver concern, the technician should know the normal operation of the system
2. **Preliminary Check:** Conduct a thorough visual and operational inspection, review the service history, detect unusual sounds or odours, and gather diagnostic trouble code information to achieve effective repair
3. **Service information (Manual) System Check(s):** System checks verify proper operation of the system This will lead the technician in an organised approach to diagnostics
4. **Check Bulletins and Other Service Information:** This should include, Techlines, All Dealer letters, and Service Training Publications
5. **Service Diagnostics** (Paper/Electronic)

   5.1 DTC Stored: Follow the designed DTC table exactly to make an effective repair

   5.2 Symptom, No DTC: Select the symptom from the symptom tables and follow the diagnostic paths or suggestions to complete the repair, or refer to the applicable component/system checks in Section 6C3-2C in the Service Manual

   5.3 No Published Diagnostics: Analyse the complaint and develop a plan for diagnostics Utilise the wiring diagrams and theory of operation

   Call Technical Assistance for similar cases where repair history may be available Combine technician knowledge with efficient use of the available service information

   5.4 Intermittent faults: Conditions that are not always present are intermittent To resolve intermittents, perform the following steps

   5.4.1 Observe history DTCs, DTC modes and Freeze Frame data

   5.4.2 Evaluate the symptoms and conditions described by the driver

   5.4.3 Use a check sheet or other method to identify the circuit or electrical system component

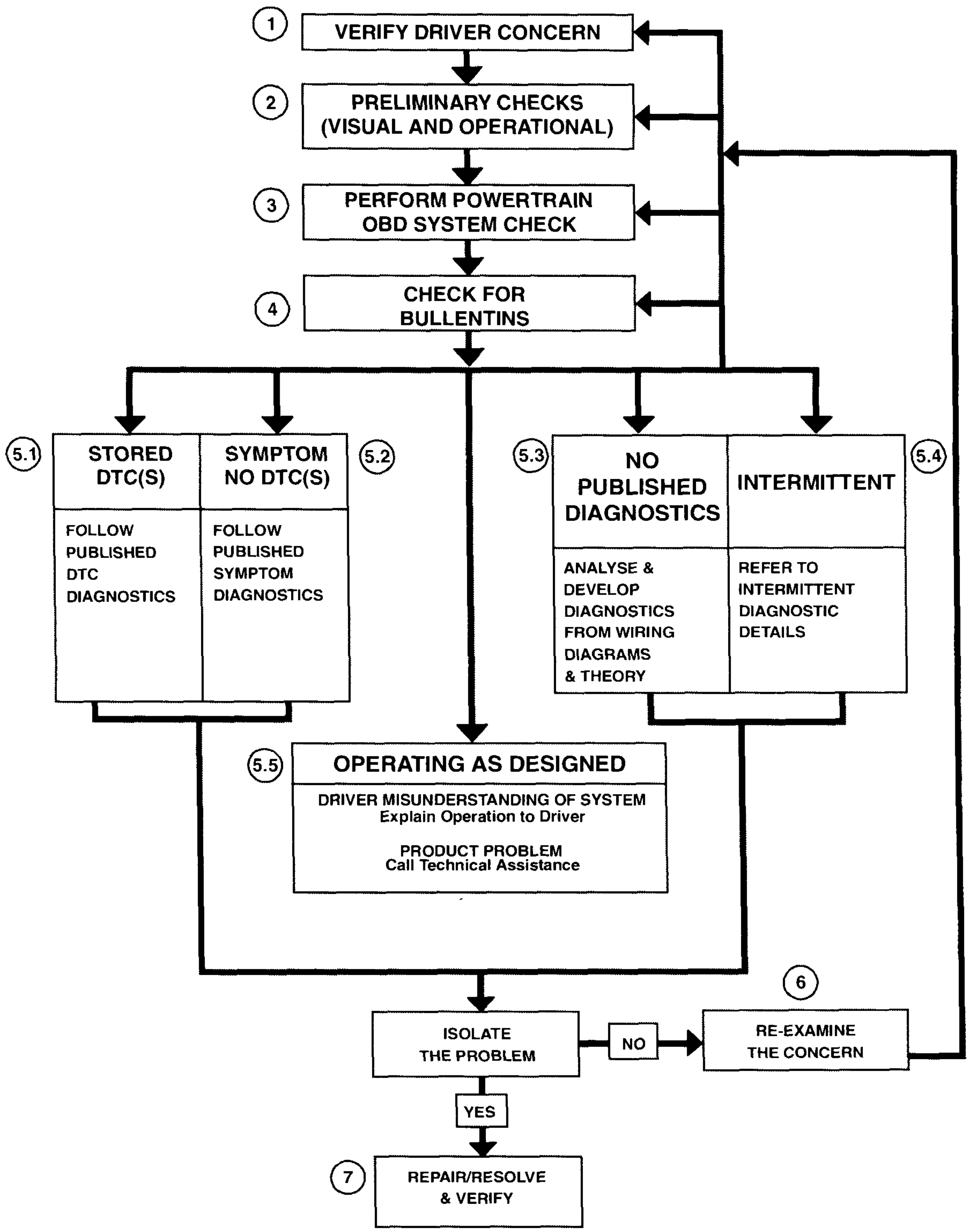
   5.4.4 Follow the suggestions for intermittent diagnosis found in the service documentation

   The Tech 2 and DMM have data capturing capabilities that can assist in detection of intermittents

   5.5 Vehicle Operates As Designed/No Trouble Found: This condition exists when the vehicle is found to be operating normally The condition described by the driver may be normal Verify against another vehicle that is operating normally The condition may be intermittent Contact Technical Assistance if the concern is common Verify the complaint under the conditions described by the driver before releasing the vehicle

6. **Re-examine the Concern:** When the complaint cannot be successfully found or isolated, a re-evaluation is necessary The complaint should be re-verified and could be intermittent or normal as per step 5 3 or 5 5
7. **Repair and Verification Tests:** After isolating the cause, the repair should be made Then validate for proper operation and verify that the symptom has been corrected This may involve road testing or other methods to verify the complaint has been resolved under the following conditions
   - Conditions noted by the driver
   - If a DTC was diagnosed, verify a repair by duplicating conditions present when a DTC was set as noted in the Freeze Frame/Failure Records data

STRATEGY BASED DIAGNOSTICS



DIAGNOSTIC CHART

Strategy Based Diagnostic

POWERTRAIN ON-BOARD DIAGNOSTIC SYSTEM CHECK

After the visual/physical underhood inspection, the On-Board Diagnostic System Check is the starting point for all diagnostic procedures or finding the cause of an emissions failure

All Diagnostic procedures must always begin with the On-board Diagnostic System Check

Diagnostic procedures must begin with the On-Board Diagnostic System Check, which represents an organised approach for identifying system problems

The ON-BOARD DIAGNOSTIC SYSTEM CHECK makes an initial check of the system, then will direct the technician to other charts in the Service Manual It must be used as a starting point for all procedures The entire diagnostic section in the VT Series Service Manual is set up in a specific order, that is, the ON-BOARD DIAGNOSTIC SYSTEM CHECK will lead the technician to other charts, and those charts may lead to still other charts **THE SEQUENCE MUST BE FOLLOWED.** The engine/transmission control system uses many input signals and controls many output functions If the correct diagnostic sequence is not followed, incorrect diagnosis and replacement of good parts may happen

Diagnostic charts incorporate diagnosis procedures using a Tech 2 where possible This Tech 2 is a small hand-held computer in itself Its job is to give information to a technician about what is happening in the engine/transmission management system

The Data Link Connector (DLC) is used by the assembly plant to perform end of line tests This connector can also be used by technicians to monitor certain inputs and outputs as seen by the Powertrain Control Module The Tech 2 reads and displays the information (serial data) supplied to the data link connector from the Powertrain Control Module (PCM)

The correct procedure to diagnose a problem is to follow three basic steps

1. Are the On-Board Diagnostics working? This is determined by performing the On-Board Diagnostic System Check Since this is the starting point for the diagnostic procedures or finding the cause of a failure, always begin here

   If the On-Board Diagnostics are not working, the On-Board Diagnostic System Check will lead to a diagnostic chart to correct the problem If the On-Board Diagnostics are working correctly, the next step is

2. Is there a Diagnostic Trouble Code stored[7] If a diagnostic trouble code is stored, go directly to the numbered diagnostic trouble code chart This will determine if the fault is still present If no diagnostic trouble code is stored, then

3. Observe Serial Data transmitted by the PCM This involves reading the information available on the Serial Data Stream with a Tech 2 Information on this tool and the meaning of the various displays can be found in the succeeding paragraphs Typical data readings under a particular operating condition can be found on the Tech 2 Data page

POWERTRAIN OBD SYSTEM CHECK: EXAMPLE

Step	Action	Value(s)	Yes	No
1	Ignition ON engine OFF Is the Check Powertrain Lamp (CPL) Malfunction Indicator Lamp (MIL) ON for 2 seconds, then OFF?		Go to Step 2	Go to *Check Powertrain MIL Table*
2	**IMPORTANT: Check for applicable service bulletins before proceeding with diagnosis.** **Do not turn the ignition OFF when performing this Diagnostic table.** 1 Connect a Tech 2 scan tool to the Data Link Connector (DLC) 2 Turn ON the ignition leaving the engine OFF Does the Tech 2 scan tool power-up?		Go to Step 3	Go to *Data Link Connector Diagnosis*
3	Does the Tech 2 scan tool display PCM serial data?		Go to Step 4	Go to *Data Link Connector Diagnosis*
4	Does the engine crank?		Go to Step 10	Go to Step 5
5	Does the Tech 2 scan tool display BCM serial data?		Go to Step 7	Go to Step 6
6	Does the Tech 2 scan tool display PIM serial data?		Go to *Starter Cranking Circuit* Table	Go to Step 8
7	Are any BCM DTC(s) stored?		Go to applicable *BCM DTC* Tables	Go to Step 9
8	Repair open or short in UART serial data circuit between the BCM, PIM, and the DLC Is action complete?		Go to Step 15	
9	Does the Tech 2 scan tool display the PCM Theft Status as START?		Go to *Starter Cranking Circuit* Table	Go to *Theft Deterrent* System in Section12J-1 or 12J-2
10	Does the engine start?		Go to Step 11	Go to *Engine Cranks but Does Not Run* Table
11	With the engine running, observe the Check Powertrain Malfunction Indicator Lamp (MIL) Is the Lamp ON?		Go to Step 12	Go to Step 13
12	Observe the PCM DTC information using a Tech 2 scan tool Are any PCM DTCs displayed?		Go to the applicable *DTC* table	Go to *Check Powertrain MIL Lamp Table*
13	Compare the Tech 2 scan tool data with the values shown in the Engine Data Stream Are the values normal or within typical ranges?		Go to Step 14	Go to *Diagnostic Aids and Test Descriptions*
14	Does the Tech 2 scan tool display BCM, and PIM serial data?		Go to *Symptoms*	Go to Step 8
15	Check and clear all DTCs from PCM, BCM, and PIM Retest vehicle, is vehicle OK?		System OK	Go to Step 1

SYSTEM DIAGNOSTICS

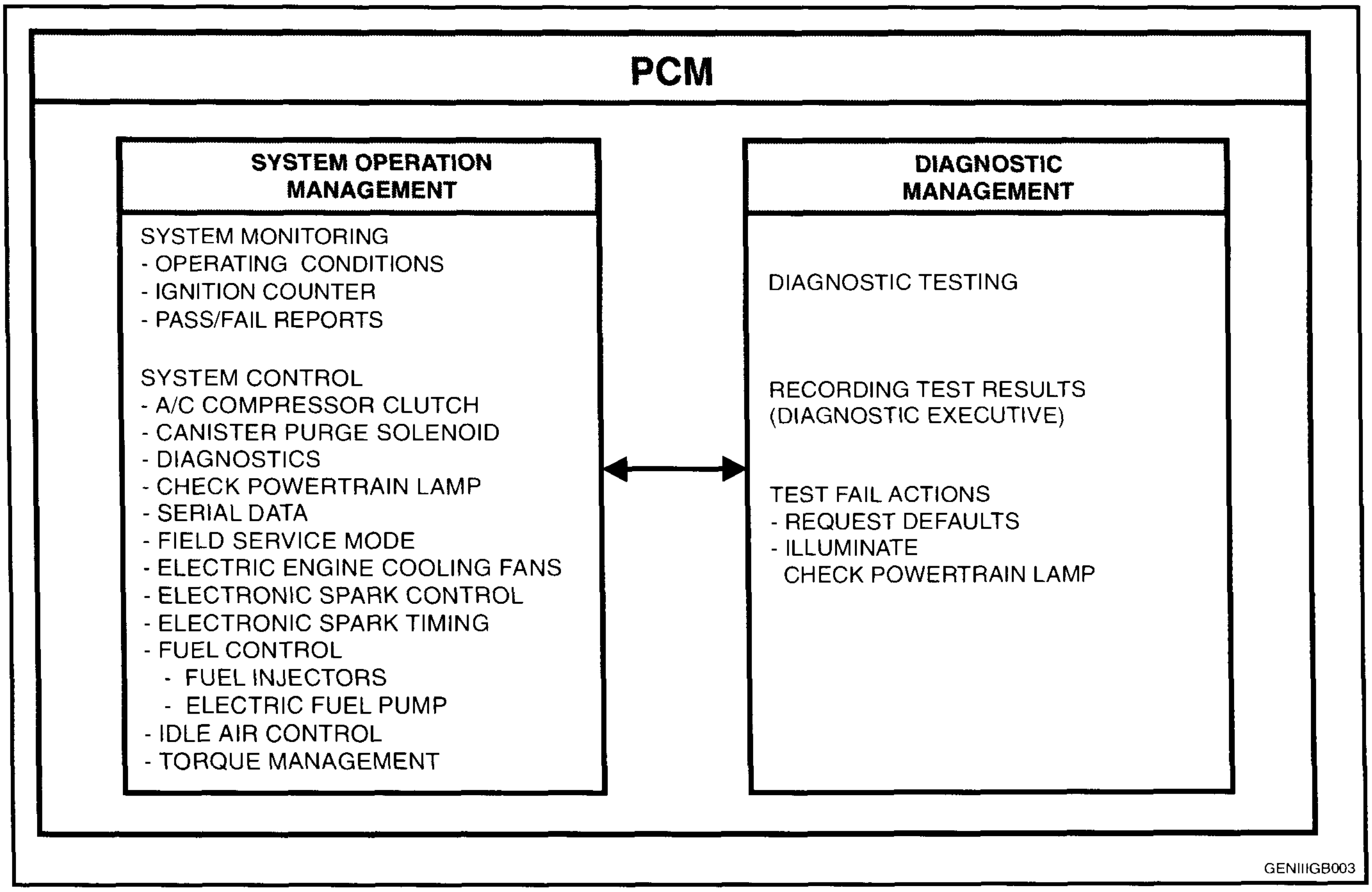
The PCM has two functions to perform

1. It must be able to control the vehicle systems using sensor inputs and internal software
2. It must also be able to perform system diagnostics

Both management systems have the ability to share information and communicate

The PCM diagnostics are controlled by the diagnostic management system The diagnostic management system must be able to

- Perform diagnostic testing
- Record the results of diagnostic testing
- Request test fail actions



System Diagnostics

Diagnostic Testing

One of the primary functions of the diagnostic management system is to perform diagnostic testing of system operation The **Diagnostic** is the test or tests run on a system or component to determine if it is operating according to specifications The different types of diagnostic tests include

- **Passive**
- **Active**
- **Intrusive**

Passive testing simply monitors the system or components during operation During **Active** testing, the PCM controls the system or component in a specific action while monitoring takes place The PCM may perform active tests as a result of failed passive tests The **intrusive** test is a special type of active test that involves an action by the PCM that may affect vehicle performance or emissions

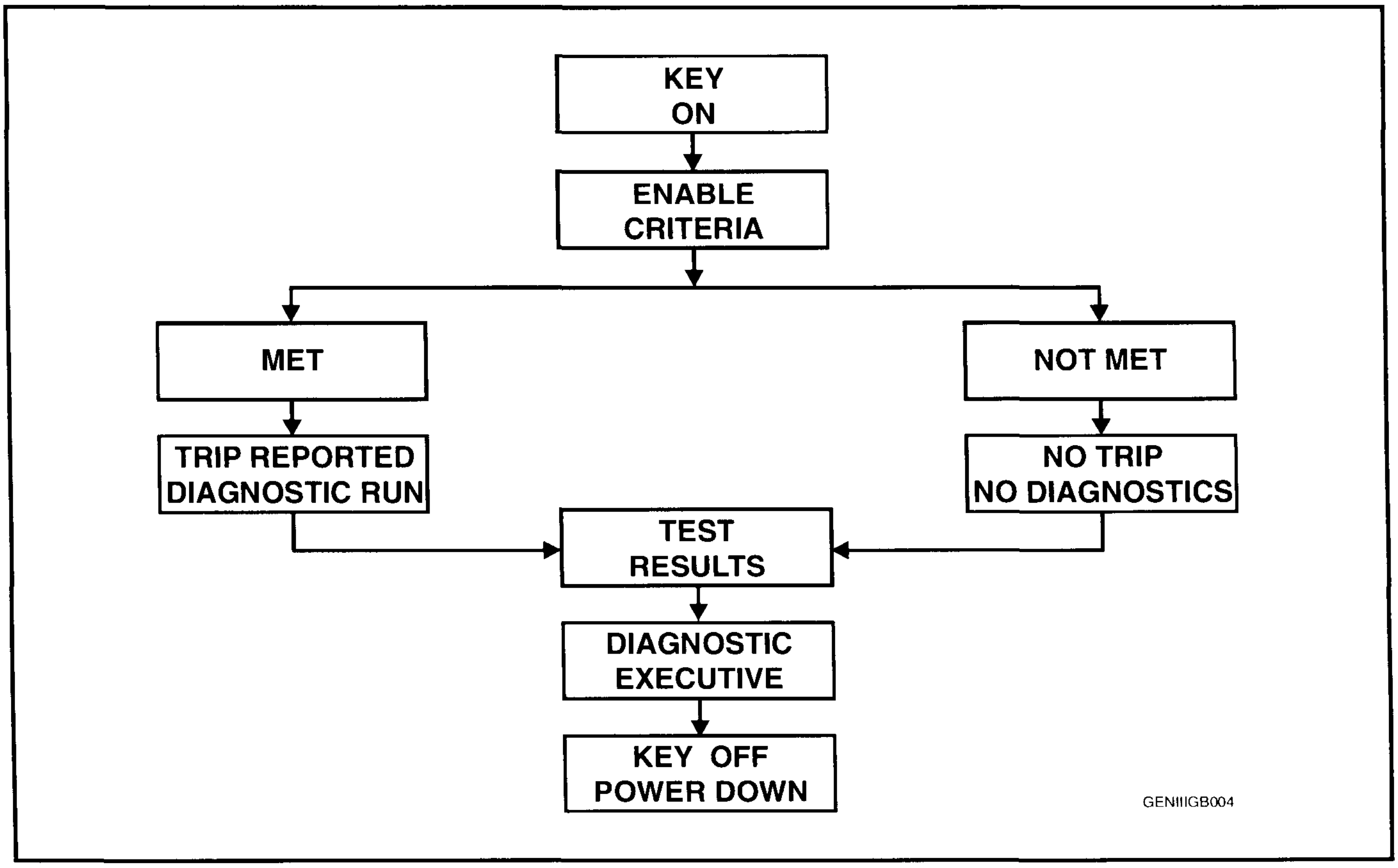
The **Enable Criteria** are the exact conditions required for a diagnostic to be run The enable criteria for any DTC are listed under **Conditions to Set** as part of the diagnostic information in the Service Manual

Diagnostic testing occurs during a trip A **Trip** is a key-on cycle in which all the enable criteria for a given diagnostic test are met, followed by a key-off / power-down Since the enable criteria for each DTC is different, a trip for each DTC is different

The PCM counts warm-up cycles instead of key cycles to clear DTCs A **warm-Up Cycle** is achieved when the engine coolant temperature rises at least 22°C from start-up and achieves a minimum temperature of 71 °C

The PCM also has the ability to learn from the results of its diagnostic testing The PCM internally charts the results of diagnostic testing over a period of time and creates a baseline - the normal results of a test This is called **Statistical Filtering** By using this learning capability, the PCM is able to filter out information that could cause a false DTC to set

NOTE: The loss of battery power to the PCM will result in the loss of "learned" information. The PCM will perform an aggressive testing schedule to relearn information. This mode of testing is called Quick Learn and is not noticeable in most cases.



Diagnostic Testing

Diagnostic Information

The diagnostic tables and functional checks in the Service Manual are designed to locate a faulty circuit or component through logic based on the process of elimination. The tables in the Service Manual are prepared with the understanding that the vehicle:

- Functioned correctly at the time of assembly.
- There are no multiple faults.
- The problem currently exists.

The PCM performs a continual self-diagnosis on certain control functions. The PCM indicates the source of a fault through the use of Diagnostic Trouble Codes (DTCs). The DTCs are four digit codes (POXXX or P1XXX). When a fault is detected by the PCM, a DTC will be set and stored in the memory of the PCM and the Check Powertrain Lamp may illuminate.

Recording Test Results (Diagnostic Executive)

The Diagnostic Executive is a unique segment of the PCM software which is designed to co-ordinate and prioritise the diagnostic procedures as well as define the protocol for recording and displaying their results. The main responsibilities of the Diagnostic Executive are:

- **DTC Information**

  DTC Information indicates the status of the diagnostic testing for a specific DTC. It contains information on pass / fail status of the test, when the diagnostic test failed and if the DTC is requesting the illumination of the Check Powertrain Lamp.

- **Freeze Frame / Failure Records**

  Freeze frame / failure records are stored any time a diagnostic test fails. The PCM has the ability to store up to six freeze frame / failure records. When a diagnostic test fails, records are stored in the first fail position. If a different diagnostic test fails, a second fail record position. Additional failed diagnostic tests for different DTCs also store fail records until the fail record memory is full. The PCM has the ability to store six freeze frame / failure records, if more than six DTC freeze frame failure records are stored, the fail records are replaced on a first in, first out basis.

  The freeze frame / failure records data list has 32 parameters for data capture. When a DTC is set, the PCM will capture all 32 parameters at the time the DTC is logged.

  In addition to the regular data list parameters found in the freeze frame / failure records data list, there is additional information available about the DTC diagnostics:

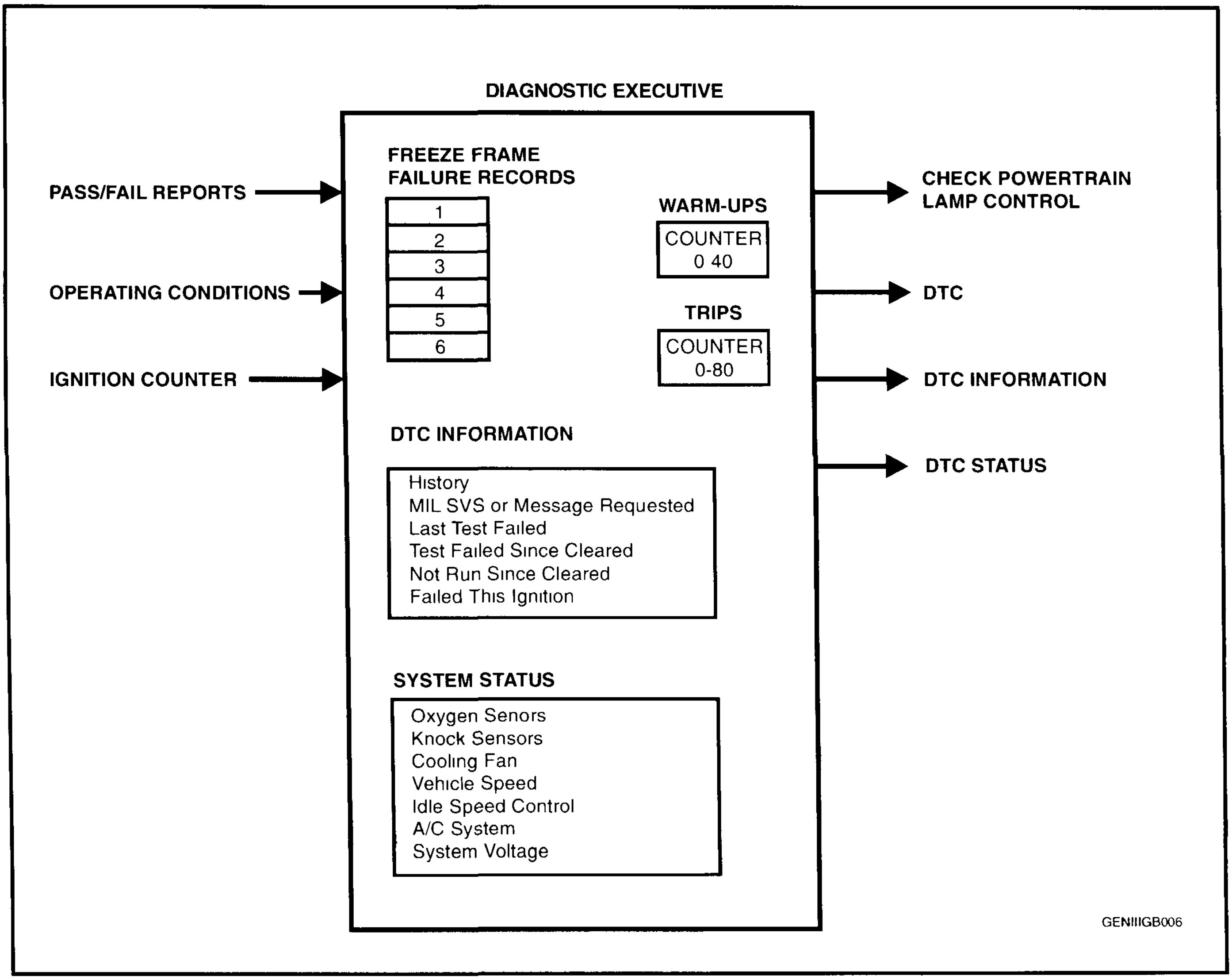
  - First Odometer - Vehicle kilometre value when the DTC failure first recorded.
  - Last Odometer - Vehicle kilometre value when the DTC fail is recorded.
  - Fail Counter - Number of ignition cycles with failure (DTC was set).
  - Pass Counter - Number of ignition cycles with diagnostic passes (DTC was not set again).
  - Not Run Counter - Number of ignition cycles without diagnostic run (DTC conditions were not tested).

- **System Status**

  The System Status (I/M Flag) stores information on which diagnostics have run. If a system diagnostic has run, the system status flag (yes/no) will be set.

- **Warm-up Cycles**

  Records the number of warm-up cycles that have been achieved since the DTC was set.



Diagnostic Executive

DTC Information

The status of the diagnostic test and the related DTC messages can be viewed by using Tech 2 The combination of messages is dependent on the status of the diagnostic test The following is a list of the DTC information messages

- **History:** This messages indicates that the DTC has been stored in memory as a valid fault
- **MIL SVS or Message Requested:** This message indicates the DTC has requested the illumination of the Check Powertrain lamp (MIL)
- **Last Test Failed:** This message indicates that the last diagnostic test failed during the current ignition cycle This message remains until the diagnostic test passes, the DTCs are cleared or the ignition is turned off
- **Test Failed Since Code Cleared:** This message indicates that the diagnostic test failed at least once since the DTC was cleared
- **Not Run Since Code Cleared:** This message indicates the diagnostic test related to this DTC has not been run since the DTCs have been cleared The status of the system cannot be determined since a trip for the DTC diagnostic test has not occurred
- **Failed This Ignition:** This message indicates that the diagnostic test related to the DTC has failed this ignition cycle

Conditions to Set DTCs

A DTC sets when the enable criteria are met, the diagnostic test is run and the results of the test are outside the PCM parameters

Conditions to Clear DTCs

There are three methods for clearing DTCs from the PCM memory

Method 1 :

Tech 2 can be used to clear DTC information This also clears freeze frame / failure record data, and statistical PCM filters This is the preferred method to clear DTCs

Method 2:

If the battery positive or earth to the PCM is interrupted, all current information concerning the DTC, including freeze frame / failure records, statistical filters and system status information may be lost

NOTE: The PCM retains memory for an extended period of time with the battery disconnected. This is not the preferred method for clearing DTCs.

Method 3:

If the fault that caused the DTC to be stored in the PCM memory has been corrected, the Diagnostic Executive begins to count the warm-up cycles Once it has counted forty consecutive warm up cycles with no further faults detected, the DTC is automatically cleared from the PCM memory

PCM Sleep Test

After the ignition switch is turned OFF, the PCM will continue to operate for several seconds During this shut down, the PCM will set the IAC valve to a position to be used on the next start-up, de-energise all the solenoids and relays etc and go to sleep The Tech 2 scan tool will display updated data until the sleep mode is activated then the PCM will no longer send out serial data and the Tech 2 scan tool will display DLC Data Lost

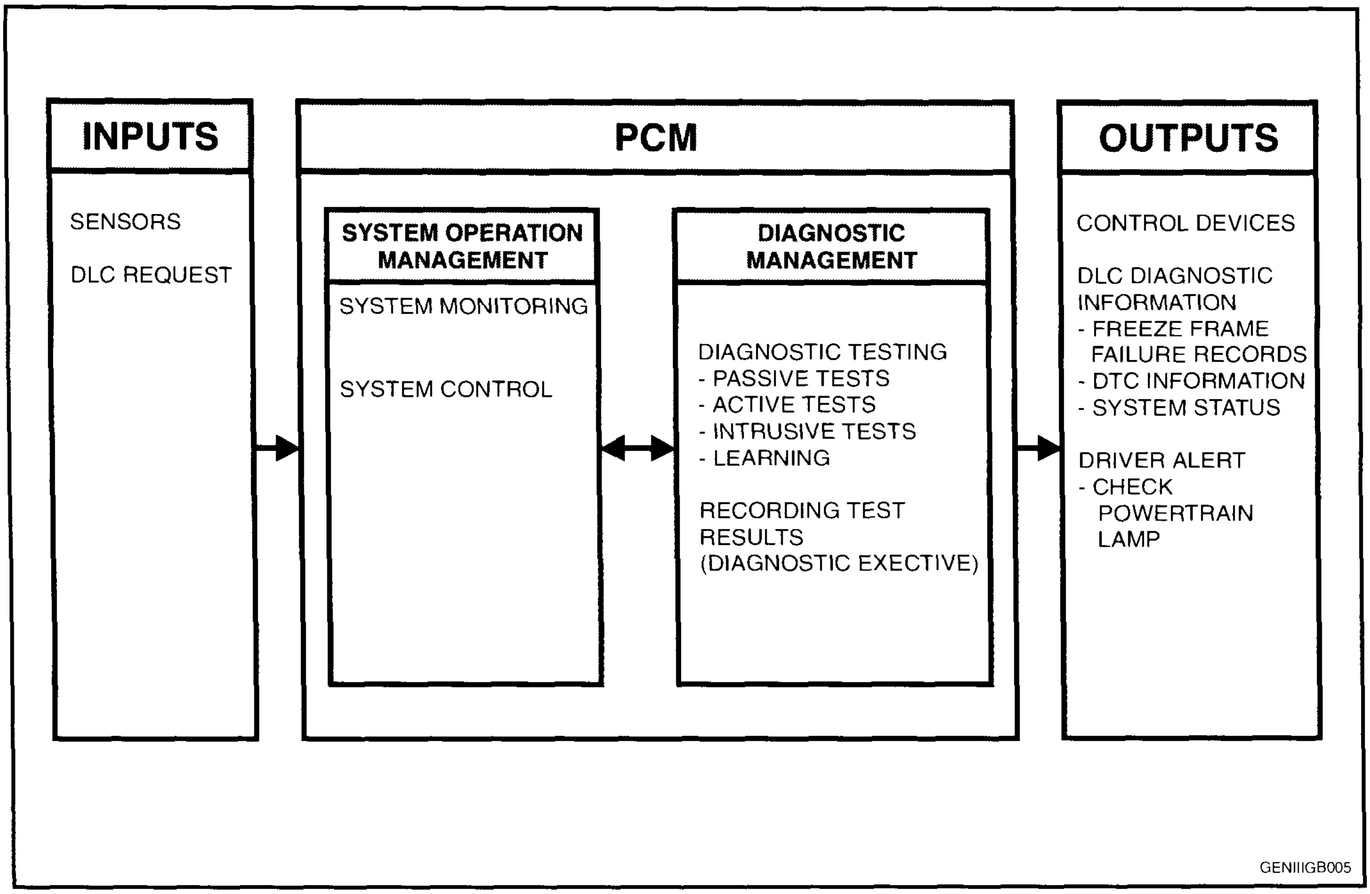
PCM Learning Ability

The PCM has a learning ability which allows the PCM to make corrections for minor variations in the engine or the transmission system to improve dnveability

Test Fail Actions

When a diagnostic fails and a DTC is set, the Diagnostic Management System performs test fail actions. The test fail actions are dependent on the DTC. The Diagnostic Management System may perform the following once a DTC is set.

- Illuminate the Check Power-train Lamp (controlled by the Diagnostic Executive).
- Substitute default values
- Request PCM default operations
- Store or update freeze frame / failure records



Test Fail Actions

PCM GEN III V8 ENGINE DIAGNOSTIC TROUBLE CODES (DTC)

DTC	DESCRIPTION	ILLUMINATE CHECK POWERTRAIN LAMP
P0101	MAF Sensor Performance	Yes
P0102	MAF Sensor Circuit Low Frequency	Yes
P0103	MAF Sensor Circuit High Frequency	Yes
P0107	MAP Sensor Circuit Low Voltage	Yes
P0108	MAP Sensor Circuit High Voltage	Yes
P0112	IAT Sensor Circuit Low Voltage	No
P0113	IAT Sensor Circuit High Voltage	No
P0117	ECT Sensor Circuit Low Voltage	Yes
P0118	ECT Sensor Circuit High Voltage	Yes
P0121	TP Sensor Circuit Insufficient Activity	Yes
P0122	TP Sensor Circuit Low Voltage	Yes
P0123	TP Sensor Circuit High Voltage	Yes
P0125	ECT Excessive Time to Closed Loop	No
P0131	HO2S Circuit Low Voltage Bank 1 Sensor 1	Yes
P0132	HO2S Circuit High Voltage Bank 1 Sensor 1	Yes
P0133	HO2S Slow Response Bank 1 Sensor 1	Yes
P0134	HO2S Insufficient Activity Bank 1 Sensor 1	Yes
P0135	HO2S Heater Circuit Bank 1 Sensor 1	Yes
P0151	HO2S Circuit Low Voltage Bank 2 Sensor 1	Yes
P0152	HO2S Circuit High Voltage Bank 2 Sensor 1	Yes
P0153	HO2S Slow Response Bank 2 Sensor 1	Yes
P0154	HO2S Insufficient Activity Bank 2 Sensor 1	Yes
P0155	HO2S Heater Circuit Bank 2 Sensor 1	Yes
P0171	Fuel Trim System Lean Bank 1	Yes
P0172	Fuel Trim System Rich Bank 1	Yes
P0174	Fuel Trim System Lean Bank 2	Yes
P0175	Fuel Trim System Rich Bank 2	Yes
P0230	Fuel Pump Control Circuit	Yes
P0325	Knock Sensor System	Yes
P0327	Knock Sensor Circuit Front	Yes
P0332	Knock Sensor Circuit Rear	Yes
P0335	CKP Sensor Circuit	Yes
P0336	CKP Sensor Circuit Performance	Yes
P0341	CMP Sensor Circuit Performance	Yes
P0342	CMP Sensor Circuit Low Voltage	Yes
P0343	CMP Sensor Circuit High Voltage	Yes
P0351	Ignition Control #1 Circuit	Yes
P0352	Ignition Control #2 Circuit	Yes
P0353	Ignition Control #3 Circuit	Yes
P0354	Ignition Control #4 Circuit	Yes

PCM GEN III V8 ENGINE DIAGNOSTIC TROUBLE CODES (DTC) (Continued)

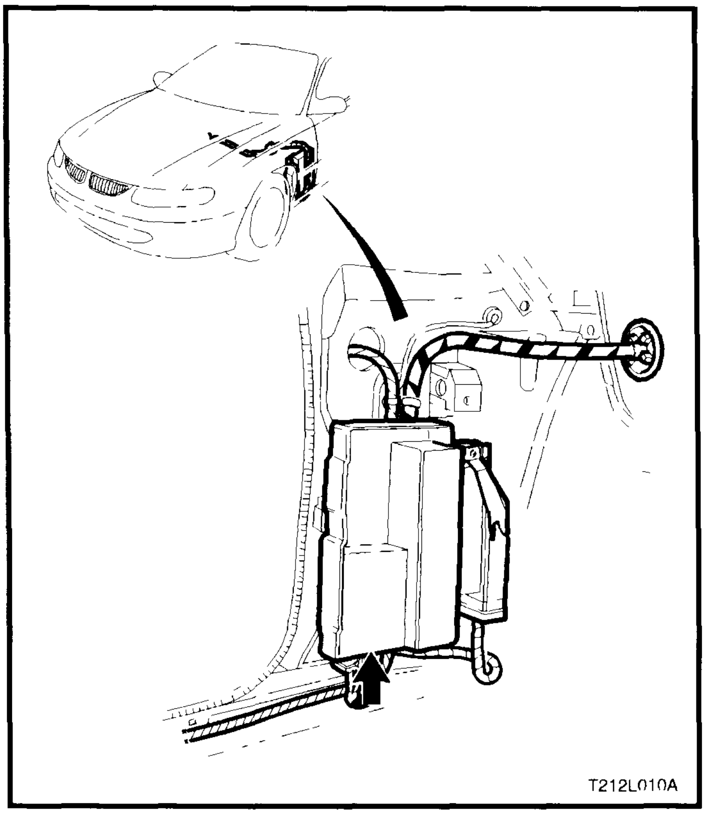
DTC	DESCRIPTION	ILLUMINATE CHECK POWERTRAIN LAMP
P0355	Ignition Control #5 Circuit	Yes
P0356	Ignition Control #6 Circuit	Yes
P0357	Ignition Control #7 Circuit	Yes
P0358	Ignition Control #8 Circuit	Yes
P0443	EVAP Purge Solenoid Control Circuit	Yes
P0481	High Speed Cooling Fan Relay Driver Circuit	Yes
P0502	Vehicle Speed Sensor Circuit Low Input	
P0503	Vehicle Speed Sensor Circuit Intermittent	
P0506	Idle Speed Low	Yes
P0507	Idle Speed High	Yes
P0522	Engine Oil Pressure Sensor Low Input	Yes
P0523	Engine Oil Pressure Sensor High Input	Yes
P0530	A/C Refrigerant Pressure Sensor Circuit	No
P0562	System Voltage Low	No
P0563	System Voltage High	No
P0601	PCM Memory	Yes
P0602	PCM Not Programmed	Yes
P0608	Vehicle Speed Sensor Output Circuit	No
P0654	Engine Speed Output Circuit	No
P1111	IAT Sensor Intermittent High Voltage	No
P1112	IAT Sensor Intermittent Low Voltage	No
P1114	ECT Sensor Intermittent Low Voltage	No
P1115	ECT Sensor Intermittent High Voltage	No
P1121	TP Sensor Intermittent High Voltage	No
P1122	TP Sensor Intermittent Low Voltage	No
P1133	HO2S Insufficient Switching Bank 1 Sensor 1	No
P1134	HO2S Transition Time Ratio Bank 1 Sensor 1	No
P1153	HO2S Insufficient Switching Bank 2 Sensor 1	No
P1154	HO2S Transition Time Ratio Bank 2 Sensor 1	No
P1258	Engine Coolant Over Temp Fuel Disable	Yes
P1539	A/C Clutch Status Circuit High Voltage	No
P1546	A/C Clutch Status Circuit Low Voltage	No
P1626	Theft Deterrent System Fuel Enable Circuit	Yes
P1630	PCM In Learn Mode	Yes
P1631	Theft Deterrent Password Incorrect	Yes
P1635	5 Volt Reference #1 Circuit	Yes
P1639	5 Volt Reference #2 Circuit	Yes

NOTES

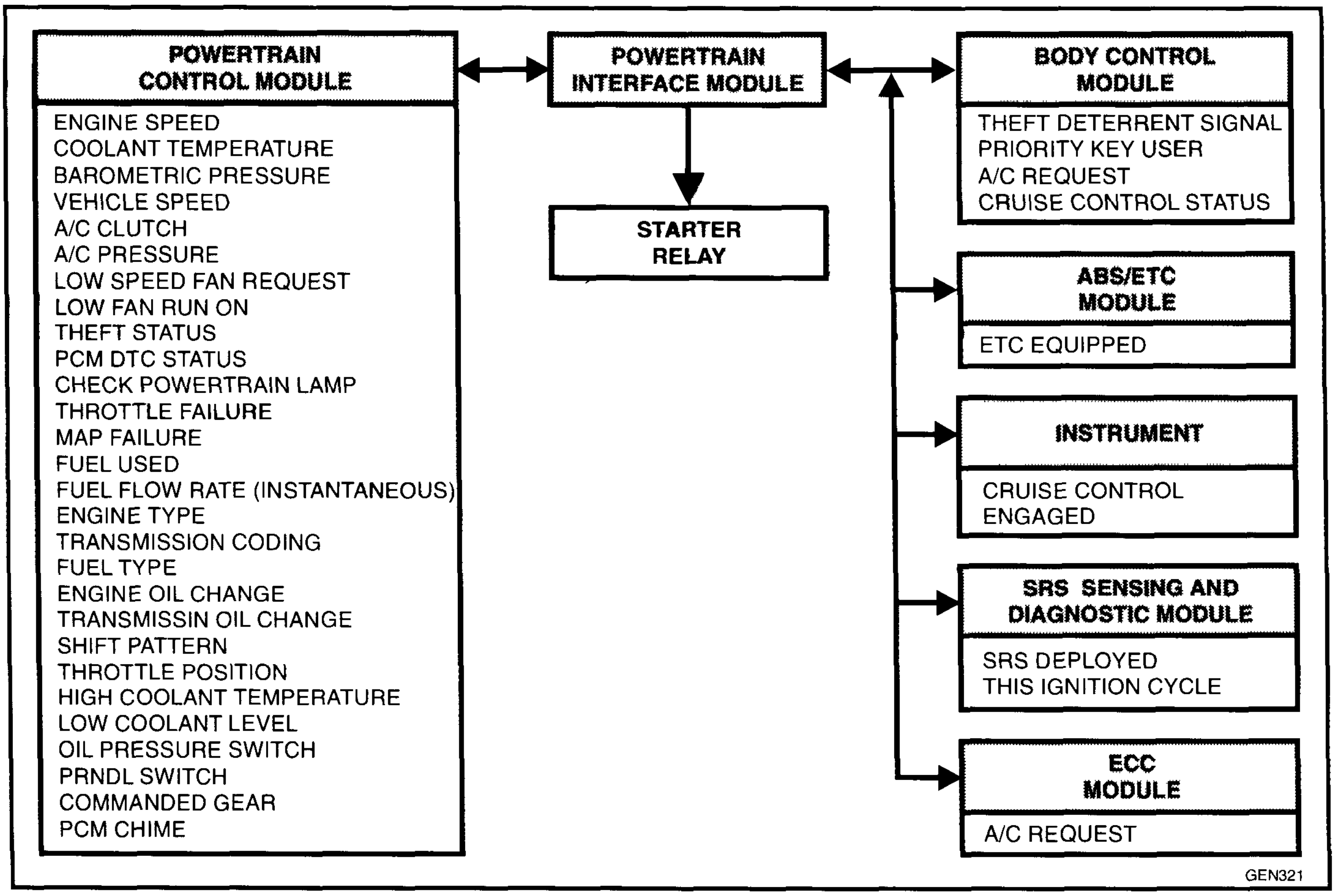
POWERTRAIN INTERFACE MODULE

The Powertrain Interface Module (PIM), is located in the passenger compartment behind the left kick panel. The PIM acts as a communication translator between the PCM and other control modules that use a different serial data protocol. The GEN III V8 PCM uses Class II serial data to communicate, while other control modules in the vehicle are designed to transmit serial data via the conventional Universal Asynchronous Receive and Transmit (UART) protocol. Since these two types of serial data are not compatible, the PIM is required to transmit data in either direction between the PCM and other control modules. The PIM will interpret the serial data information and translate UART to Class II or Class II to UART to support the appropriate vehicle control module operation. The PIM is also used to control the operation of the starter relay.

A PIM malfunction may affect vehicle operation and may interrupt starter motor operation.



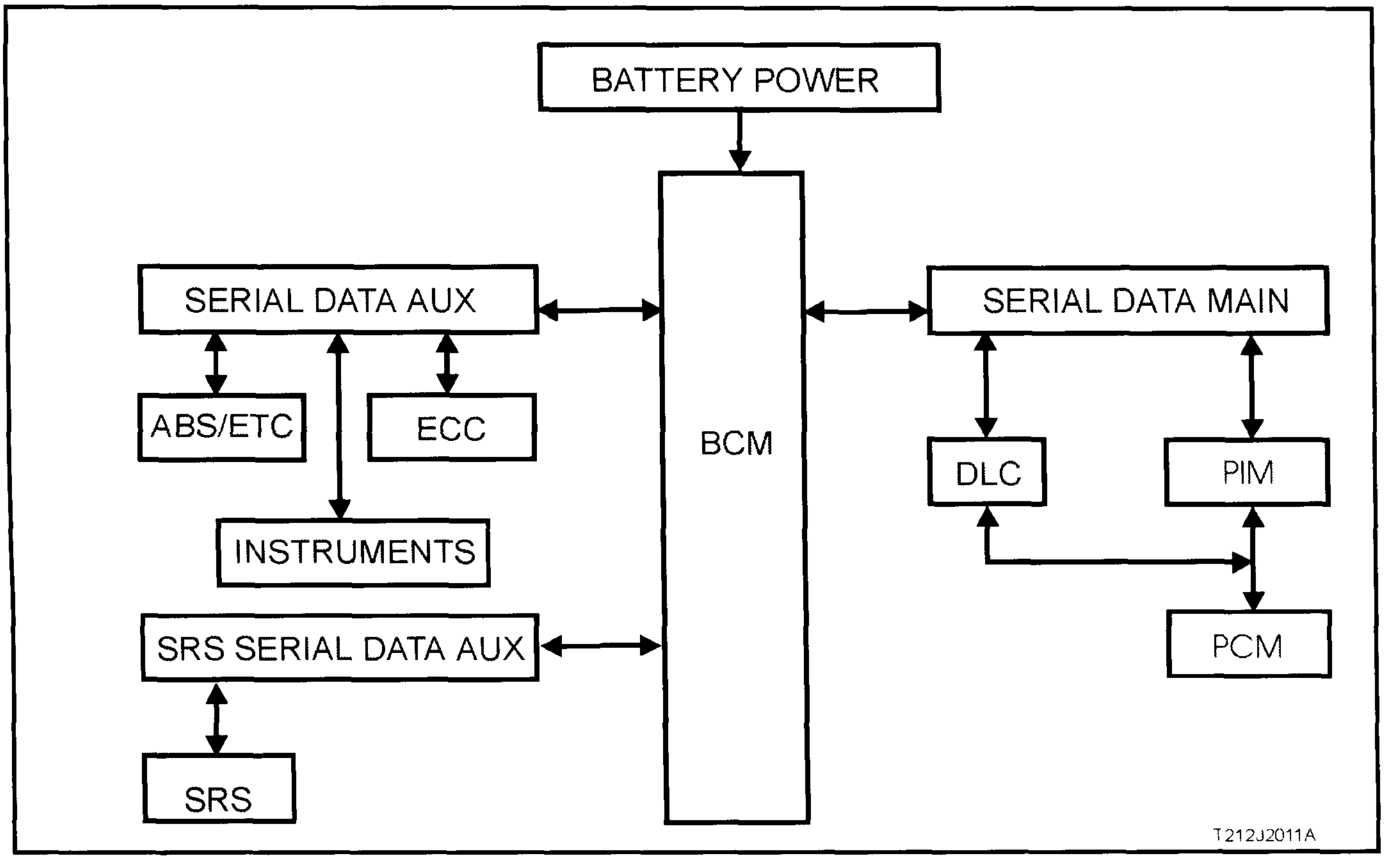
PIM location



PIM Communication

SERIAL DATA COMMUNICATION (BUS MASTER)

Various devices; system control modules of the vehicle, as well as TECH 2 communicate with each other. The communication between control modules and communication with the TECH 2 diagnostic scan tool is achieved on the serial communication lines using serial data. Serial data transfers information in a linear fashion - over a single line, one bit at a time. The serial data line is referred to as the 'data bus'. Excluding the GEN III V8 PCM, all control modules communicating on the data bus communicate using UART communication.



System Overview - Serial Communication

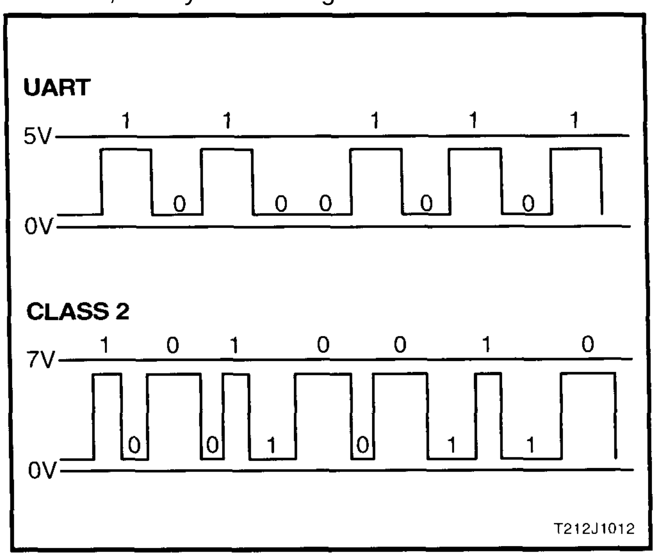
DART is a 5 volt data line that toggles the voltage to earth (0 volts) at a fixed bit pulse width during communication. UART transmits data at the rate of 8.2 kilobits per second (8192 bits/sec). With UART communication, when there is no communication on the data line, the system voltage will be 5 volts.

The GEN III V8 PCM uses Class 2 communication. This type of communication toggles the data line from 0 volts to 7 volts at either a short or long pulse width at a rate of 10.4 kilobits per second (average). With Class 2 communication, when there is no communication on the data line, the system voltage will be 0 volts.

As the 'Class 2' communication is different to UART (different languages), communication between the modules is incompatible, and as such, requires a Powertrain Interface Module (PIM) to convert Class 2 communication into UART, and UART into Class 2 (a translator).

TECH 2 is able to communicate with both UART and Class 2 control modules.

On all VT and WH Models, the BCM is the Bus Master of the serial data communication system. The BCM periodically polls (surveys) each device on the data bus and requests status data.



Serial Data Digital Wave Form

On vehicles fitted with a GEN III V8, the devices (control modules) the BCM polls are

- Power-train Interface Module (PIM)
- Instrument cluster (INS)
- Antilock Brake/Electronic Traction Control System (ABS/ETC) Module
- Supplemental Restraint System (SRS) Sensing and Diagnostic Module (SDM)
- Electronic Climate Control (ECC) Module
- TECH2

The data provided by each device may be utilised by any device connected to the bus

Each device has a unique response Message Identifier Word (MIW) for ease of identification

The bus master (BCM) polls each device with a serial data message which includes that devices MIW The device responds by putting a serial data message onto the bus which includes its MIW and data, of which is retrieved and utilised by any device requiring it

The BCM polls each device for a status update, once every 300 milliseconds The exception to this being the PIM (GEN III V8) which is polled twice every 300 milliseconds The PIM will construct a serial data message from information requested from the PCM via the Class 2 communication This constructed serial data message is then placed on the serial data bus

When the ignition switch is turned from the OFF position to the ON position, the BCM will communicate with the PCM via the PIM for theft deterrent purposes If the BCM does not receive an OK TO START message from the PIM within 0 5 seconds of ignition on, the auxiliary data bus is isolated via switching from the BCM

The isolation of the auxiliary data bus during this period eliminates the possibility of a device failure other than the BCM, or PIM, causing a problem on the serial data bus and inhibiting theft deterrent communications

This period (short loop time) continues until the PIM responds with an acknowledgment or for a maximum of five seconds after which the BCM will switch to the standard polling sequence and a no start condition will occur

Following successful theft deterrent communications, the BCM begins sequential polling of devices on the bus and normal system operation is established

When the ignition switch is in the OFF position, the BCM continues to poll, allowing for TECH 2 communications and external control of the bus prior to the ignition being switched on

Starter Relay

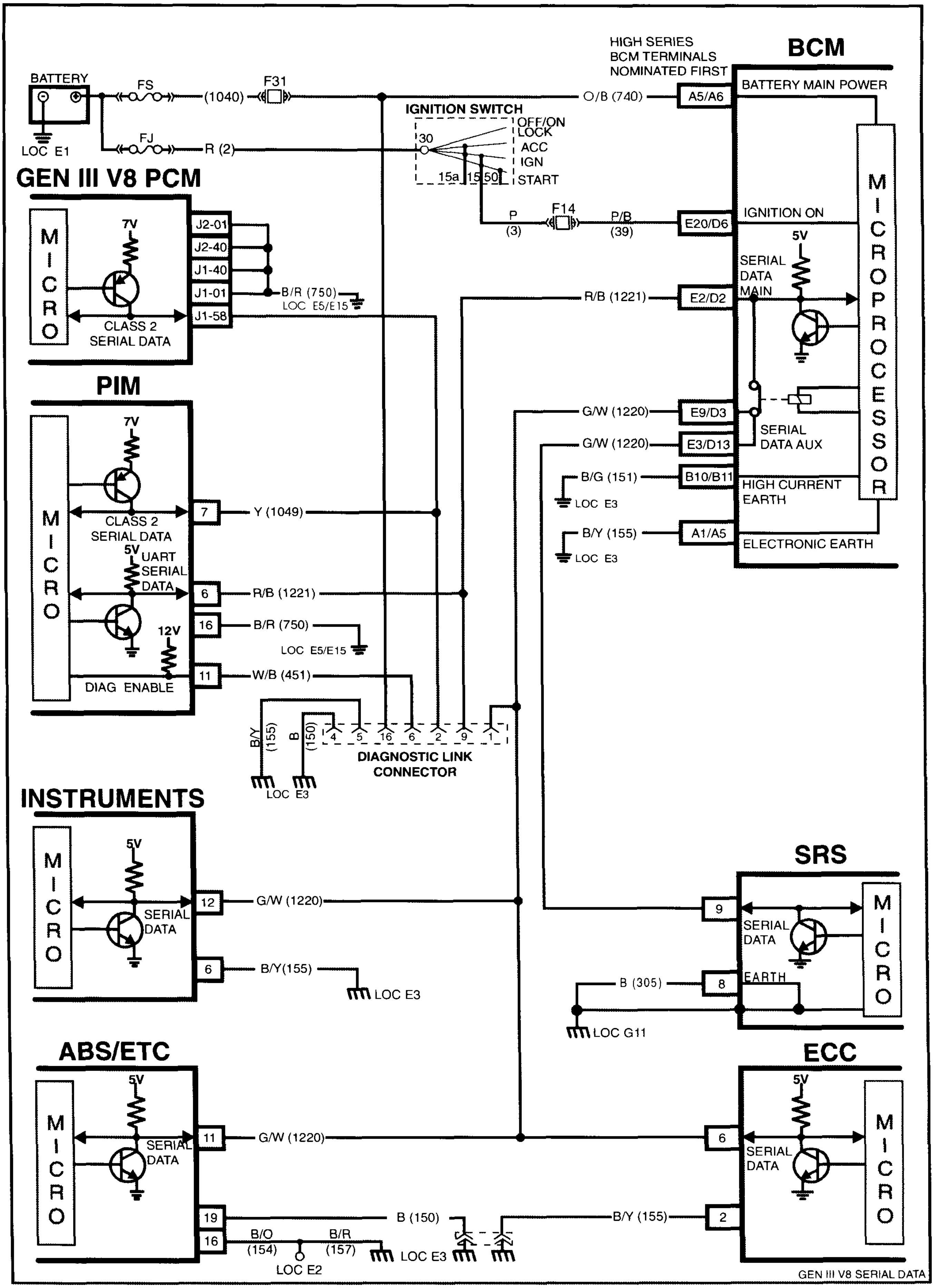
The PIM also controls the operation of the starter relay When the ignition switch is turned to on, the PIM will enable the starter relay for one second, if the PIM does not receive the correct security code it will disable the starter relay If the PIM receives the correct security code from the BCM, the PIM will continue to enable the start relay Once the engine has started and the engine speed is above 500 RPM the PIM will disable the starter relay, preventing starter engagement while the engine is running

If the serial data bus between the BCM and the PIM should fail (no polling from the BCM for more than 10 minutes) after successful theft deterrent communications, the PIM will allow subsequent starts, however there will be a crank delay of one second If the PIM receives valid communication, normal operation will resume

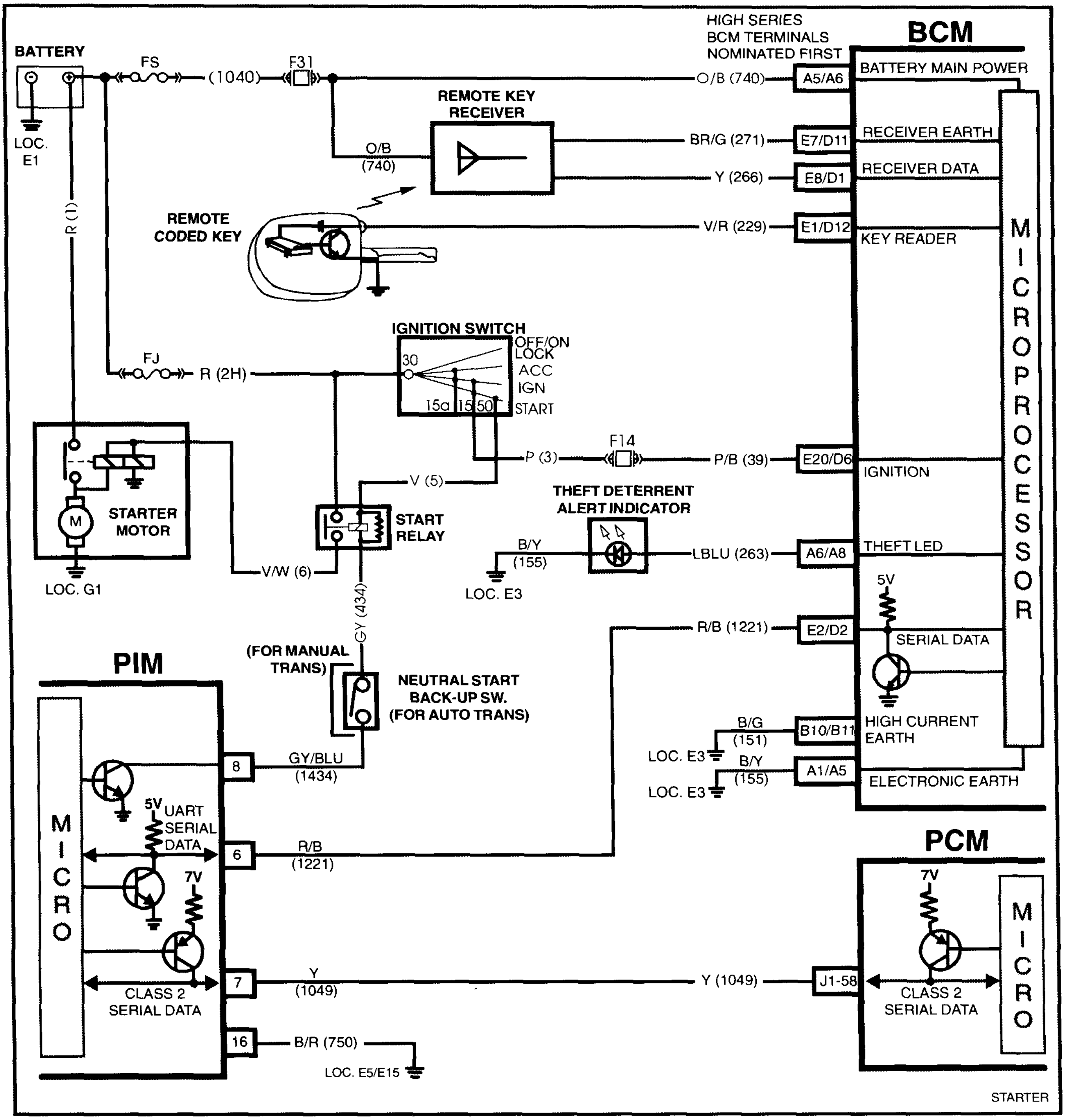
If the Class II serial data bus between the PIM and the PCM should fail (no communications for 20 seconds) after successful theft deterrent communications, the PCM will allow subsequent starts, however there will be a crank delay of one second If communications between the PCM and the PIM are re-established, normal operation will resume

GEN III V8 TECH 2 NORMAL MODE

INFORMATION TRANSMITTED	INFORMATION RECEIVED					
TECH 2 STRING	PCM	ABS / ETC	BCM	ECC	INST	SRS
POWERTRAIN CONTROL MODULE						
Engine Speed				✔		
Coolant Temperature				✔	✔	
Barometric Pressure		✔				
Vehicle Speed			✔	✔	✔	
A/C Clutch (Air Conditioning)						
A/C Pressure (Air Conditioning)				✔		
Low Speed Fan Request			✔			
Low Fan Run On			✔			
Theft Status			✔			
PCM DTC Status					✔	
Check Powertrain Lamp					✔	
Throttle Failure		✔				
Map Failure		✔				
Fuel Used					✔	
Fuel Flow Rate (Instantaneous)					✔	
Engine Type		✔				
Transmission Coding						
Fuel Type					✔	
Engine Oil Change						
Transmission Oil Change						
Shift Pattern					✔	
Throttle Position		✔				
High Coolant Temperature						
Low Coolant Level					✔	
Oil Pressure Switch					✔	
PRNDL Switch					✔	
Commanded Gear			✔			
PCM Chime (Powertrain Control Module)					✔	
ABS ETC						
Stop Lamp Switch			✔			
ABS Warning Lamp						
TCS Warning Lamp					✔	
ETC Equipped	✔					
Low Traction						
ABS Chime					✔	
DTC Status					✔	
BODY CONTROL MODULE						
Ignition Status						
Ignition Off Time				✔		
Instrument Lamps					✔	
Lights On						
Ambient Light Level				✔		
Boot Status						
Rear Lamp Status						
Front Wiper Status						
Front Autowiper Status						
Cruise Control Input Signal					✔	
A/C Request (Air Conditioning)	✔					
BCM Low Fan Drive	✔					
BCM Chime (Body Control Module)					✔	
Key User	✔			✔	✔	
BCM DTC Status					✔	
ELECTRONIC CLIMATE CONTROL						
DTC Status					✔	
Rear Window Demist Status						
Day/Night Status					✔	
A/C Request (Air Conditioning)	✔					
INSTRUMENTS						
Engine Oil Life Reset						
Transmission Fluid Life Reset						
Cruise Control Engaged	✔					
SRS Configuration						✔
Fuel Level - Petrol	✔					
Fuel Level - LPG						
DTC Status						
SUPPLEMENTARY RESTRAINT SYSTEM						
SRS Warning Lamp					✔	
SRS Deployed This Ignition Cycle	✔		✔			
SRS DTC Status					✔	
SRS Module						



Serial Data Circuit



Starter Circuit

TECH 2 TEST MODES AND DISPLAYS FOR PIM DIAGNOSIS

As a prerequisite to any PIM diagnostics the user must be familiar with the proper use of TECH 2. The following pages list the TECH 2 functions and provide a brief explanation of their operation for diagnosing the PIM.

FO: Normal Mode

In the FO: Normal Mode, information that the PIM is communicating to other control modules, via the serial data line, is displayed.

DATA STREAM / SCREEN DISPLAY	DESCRIPTION	UNITS DISPLAYED
Engine Speed	Displays current engine speed.	RPM
Coolant Temperature	Displays the current engine coolant temperature.	°C
Barometric Pressure	Displays the current barometric pressure.	kPa
Vehicle Speed	Displays current vehicle speed.	km/h
A/C Clutch	Displays current status of A/C Clutch.	on / off
A/C Pressure	Displays current A/C Pressure.	kPa
Low Speed Fan Request	Displays if the PCM is requesting the BCM to turn on the low speed cooling fan.	Off / On
Low Fan Run On	Displays if the PCM is requesting the BCM to turn on the low speed cooling fan in run on mode.	No / Yes
Theft Status	Displays the current PCM Theft Status.	Start / No Start
PCM DTC Status	Displays PCM DTC status.	NO DTC / DTCs Set
Check Power-train Lamp	Displays the current Status of the Check Powertrain Lamp.	On / Off
Throttle Failure	Displays if the PCM has detected a throttle failure.	No / Yes
MAP Failure	Displays if the PCM has detected a MAP failure.	No / Yes
Fuel Used	Displays the amount of fuel used for the current ignition cycle.	Litres
Fuel Flow Rate	Displays the current amount of fuel being used.	L/hour
Engine Type	Displays the engine type.	V8GEN III,
Transmission Coding	Displays transmission type.	Automatic Trans. Manual Trans.
Fuel Type	Displays the type of fuel the PCM is currently operating on.	Petrol / LPG
Engine Oil Change	NOT USED (Displays if the PCM has calculated that an engine oil change is required).	Okay / Service Request
Transmission Oil Change	NOT USED (Displays if the PCM has calculated that a transmission oil change is required).	Okay / Service Request
Shift Pattern	Displays the shift pattern the PCM is currently operating in.	Power / Economy
Throttle Position	Displays the current throttle position.	0 - 100 %
High Coolant Temperature	Displays if the PCM has detected High Coolant Temperature	No / Yes
Oil Pressure Switch	Displays if the PCM is commanding the oil pressure lamp On or Off.	On / Off
PRNDL Switch	Displays the status of the PRNDL Switch (Selector Lever Position).	P, R, N, D, 3, 2, 1
Commanded Gear	Displays the transmission commanded gear	P/N, 1, 2, 3, 4
PCM Chime	Displays the PCM Chime request to the instruments	No / Yes

F1: Diagnostic Trouble Codes

The following functions will be available in this mode:

FO: Read Current DTC Information - a listing of all (if any) current DTCs that have been set by the PIM will be displayed. A short description of what the DTC is, is also displayed in this mode.

Diagnostic Trouble Codes

There are four (4) PIM DTCs that will set. Each of these DTCs have corresponding diagnostic tables. The four (4) DTCs that will set are:

DTC	DTC DESCRIPTION
B2002	Low Speed Fan No BCM Response
B2006	No Serial Data From PCM
B2007	Starter Relay Voltage High
B2009	EEPROM Checksum Error

There are twenty (20) other PIM DTCs that will also set whenever DTC B2006 sets. These DTCs indicate the loss of part of the Class II serial data. If there is a problem with the Class II serial data circuit, and the PIM does not receive any of this information a DTC B2006 will set. The Power-train On Board Diagnostic (OBD) System Check will identify a problem with the serial data circuit or other circuits, and direct the technician in the proper direction for diagnosis. There are no PIM DTC tables associated with these twenty (20) PIM DTCs, so always diagnose the PCM first.

DTC	DTC DESCRIPTION
B2017	No Throttle Position Sensor (TPS) Information
B2018	No A/C Clutch Information
B2019	No Engine Speed Information
B2020	No Vehicle Speed Information
B2021	No Commanded Gear Information
B2022	No Transmission Type
B2023	No Low Speed Fan Run On Information
B2024	No Low Speed Fan Request Information
B2025	No Engine Coolant Temp (ECT) Information
B2026	No Fuel Flow Rate Information
B2027	No Fuel Used Counter Information
B2028	No A/C Pressure Information
B2029	No PRNDL Information
B2030	No Engine Oil Information
B2031	No Oil Pressure Information
B2032	No Shift Information
B2033	No Check Power-train Lamp Information
B2034	No Low Coolant Level Information
B2035	No Barometric Pressure Information
B2036	No PCM Information

F1: Clear DTC Information - simply select Clear Codes, and TECH 2 will command the PIM to clear all DTCs. TECH 2 will then display if the DTCs have been cleared successfully or not.

F2: Data Display

In this test mode, TECH 2 displays the information the PIM is actually receiving and the status of the PIM outputs, such as the starter relay An explanation for each data parameter displayed on the Tech 2 is listed below

DATA STREAM / SCREEN DISPLAY	DESCRIPTION	UNITS DISPLAYED
Start Relay	Displays On when the Start Relay is enabled	On / Off
Fuel Continue	Displays Yes if the PCM has received the correct theft deterrent signal from the PIM The PCM will continue to enable fuel	Yes / No
Fuel Disable Time Out	Displays Off when the PCM sends a message back to the PIM indicating that the PCM is satisfied with theft deterrent signal from the PIM and is allowing fuel injection	On / Off
Fuel Disable Cycle Ign	Displays On when the PCM security has failed Engine will not be fuelled until the ignition has been cycled from On to Off to On	On / Off
Auto Learn Active	Tech 2 displays Yes if the PCM is in automatic password learning mode	Yes / No
PIM Theft Deterrent Communication Lost	Displays Yes if there is a loss of theft deterrent communication between the PIM and PCM	Yes / No
Password Learning	Displays Yes if the PIM is in a current Password Learn mode PCM will learn CLASS 1 1 security code from PIM on the next ignition cycle	Yes / No
PIM DTC Status	Indicates if a PIM DTC is set This does not indicate what DTC is set, just informs that DTC (s) are or are not set	NO DTCs / DTCs Set
Software Version	PIM software version number, will vary with PIM software updates	PIM Software ID Number
PIM Communication Disable	Will display Off when the diagnostic enable line is grounded	On / Off
A/C Clutch	Represents the commanded state of the A/C clutch control relay Clutch should be engaged when On is displayed	On / Off
Check Powertrain Lamp	This is an indication that the PCM is commanding the Check Powertrain Lamp to be illuminated	On / Off
Low Coolant Level	This is an indication from the PCM that the coolant level is low, and the PCM is commanding the Low Coolant lamp to be illuminated	Yes / No
Oil Pressure Switch	This is an indication from the PCM that the oil pressure is low and the PCM is commanding the Low Oil Warning Lamp to be illuminated	Off / On
Engine Oil Change	This is not used by VT or WH Series Vehicles	Okay/ Service Request
Engine Oil Life Reset	This is not used by VT or WH Series Vehicles	Off / On
Shift Pattern	This display shows the state of the PCM shift pattern Economy/Power	Economy / Power
Low Speed Fan Request	Indicates if the PCM is commanding the engine cooling fan low speed relay On or Off	On / Off
Low Fan Run On	The scan tool will indicate On if the PCM is commanding the BCM to enable the Low Fan Relay when the key is turned Off	Yes / No

F3: Snapshot

In this mode, TECH 2 captures data before and after a forced manual trigger

The purpose of the SNAPSHOT test mode is to help isolate an intermittent or transient problem by storing BCM data parameters just before and just after a problem occurs

F4: Miscellaneous Tests

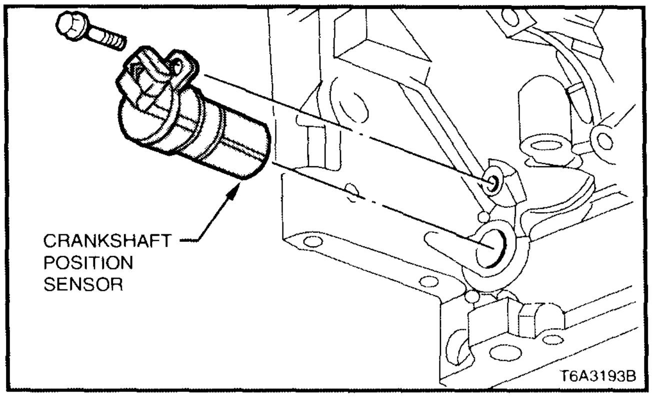
FO: Starter Relay: In this mode, TECH 2 commands the PIM to turn the Starter Relay On or Off With the Starter Relay commanded On the engine should crank when the ignition switch is turned to start With the Starter Relay commanded Off the engine should not crank when the ignition switch is turned to start

CRANKSHAFT POSITION SENSOR

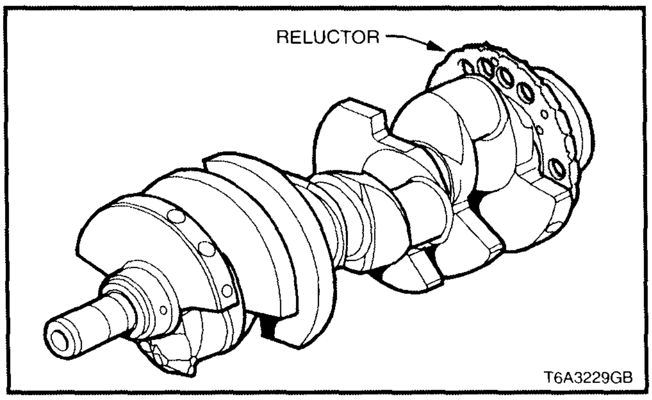
The Crankshaft Position Sensor (CKP) is mounted in the right rear of the engine block behind the starter. The CKP sensor works in conjunction with a 24X reluctor wheel mounted on the rear of the crankshaft. The CKP sensor has a battery power supply, an earth, and a signal circuit.

As the crankshaft rotates, the reluctor wheel teeth interrupt a magnetic field produced by a magnet within the sensor. The sensor's internal circuitry detects this and produces a signal which the PCM reads. The PCM uses this signal to accurately measure crankshaft position and engine speed.

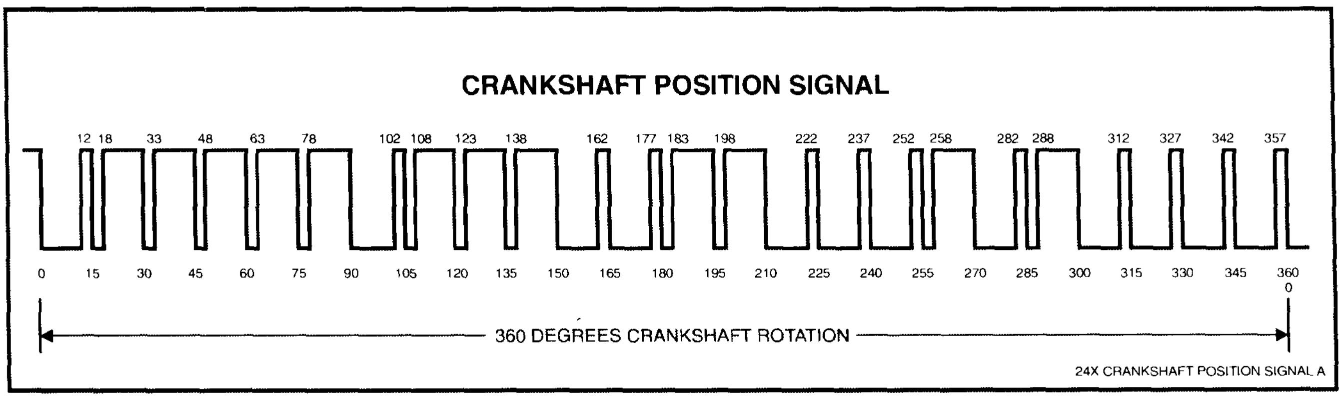
The reluctor wheel is mounted on the rear of the crankshaft. The 24X reluctor wheel use two different width notches (12° and 3°) that are 15° apart. This pulse width encoded pattern allows cylinder position identification within 90 degrees of crankshaft rotation. In some cases, cylinder identification can be located in 45 degrees of crankshaft rotation. This reluctor wheel also has dual track notches that are out of phase. The dual track design allows for quicker starts and accuracy.



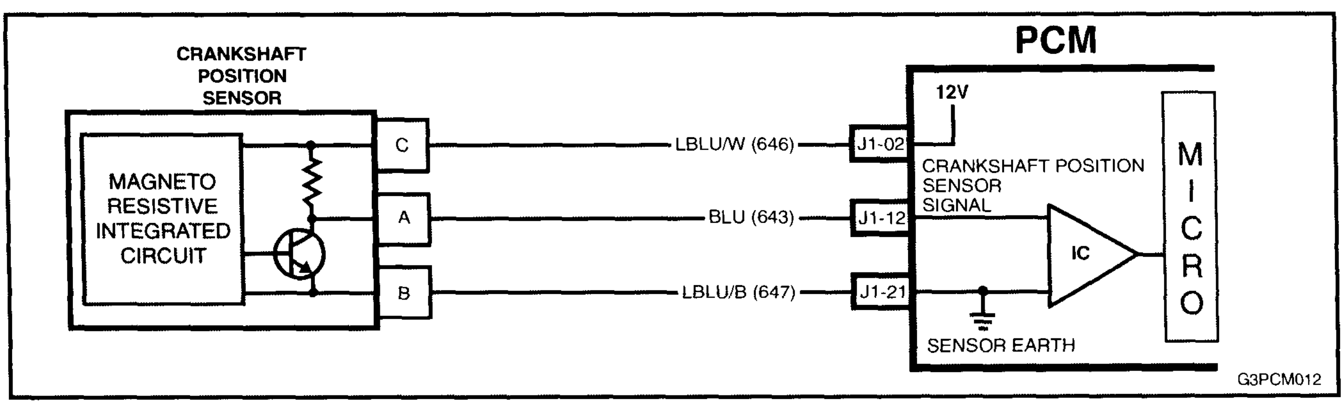
Crankshaft Position Sensor



Crankshaft Position Sensor Reluctor



Crankshaft Position Sensor Signal



Crankshaft Position Sensor Circuit

NOTE: The engine will not run if the PCM does not receive a CKP signal. With no CKP signal, the PCM will not issue any injector pulses.

A failure in the Crankshaft Position Sensor or circuit will set one of the following DTCs:

DTC P0335 Crankshaft Position Sensor Circuit

Conditions for running the DTC P0335

- DTCs P0101, P0102, P0103, P0341, P0342, P0343 are not set.
- The CMP sensor is transitioning.
- The ignition voltage is between 5 and 17.0 volts.
- The MAF is greater than 3 g/s.

Conditions for setting DTC P0335

- The PCM determines no signal from the CKP sensor for at least three seconds.

Action taken when DTC P0335 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0335

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0336 Crankshaft Position Sensor Circuit Performance

Conditions for running DTC P0336

- The ignition voltage is between 5.0 and 17.0 volts.
- The engine speed is greater than 400 RPM.

Conditions for setting DTC P0336

- The PCM determines no signal from the CKP sensor or the signal is out of range for at least one second.

Action taken when DTC P0336 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0336

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

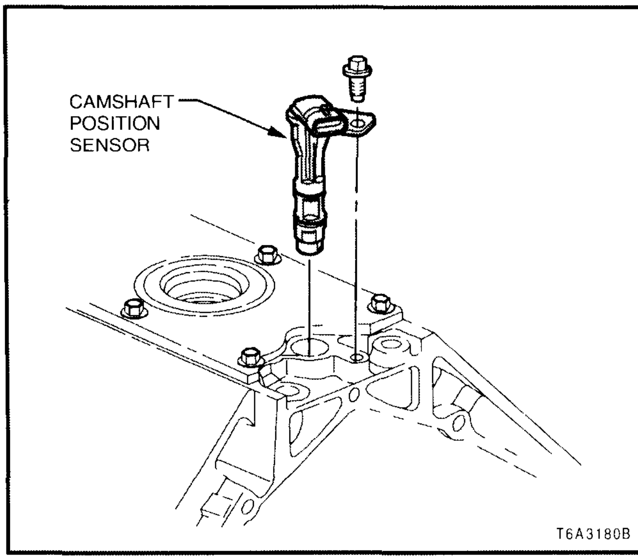
CAMSHAFT POSITION SENSOR

The Camshaft Position (CMP) sensor is mounted through the top of the engine block at the rear of the valley cover The CMP sensor works in conjunction with a "IX reluctor wheel on the camshaft The reluctor wheel is inside the engine immediately in front of the rear cam bearing The PCM provides a 12 volt power supply to the CMP sensor as well as an earth and a signal circuit

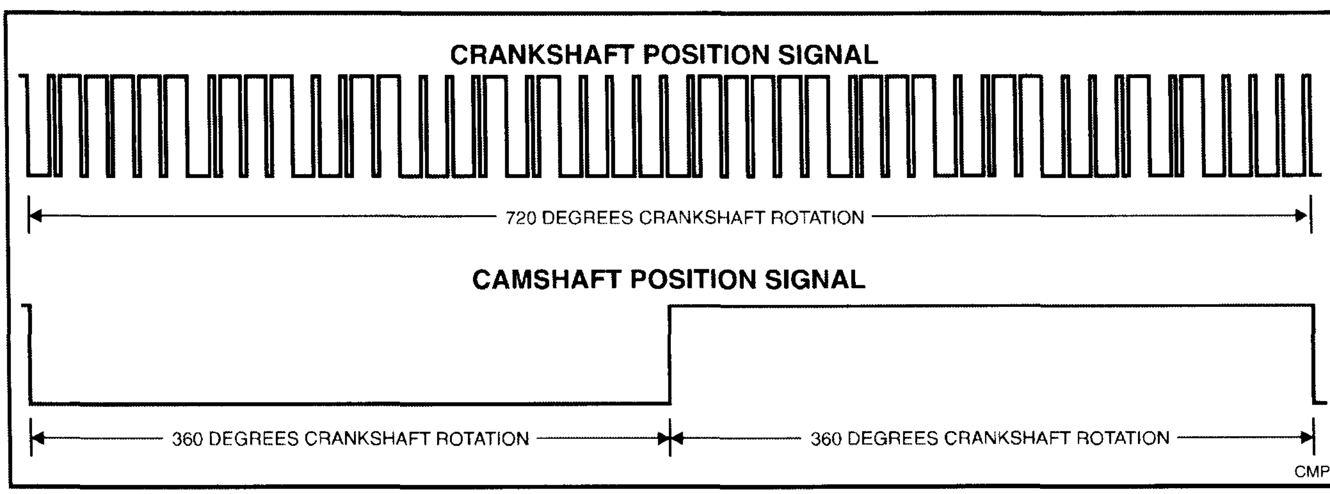
The PCM uses the CMP signal to determine if a cylinder is on a firing stroke or on an exhaust stroke As the camshaft rotates, the reluctor wheel interrupts a magnetic field produced by a magnet within the sensor The sensors internal circuitry detects this and produces a signal which the PCM reads The PCM uses this "IX signal in combination with the Crankshaft Position sensor 24X signal in order to determine crankshaft position and stroke

If the PCM is receiving a 24X Crankshaft Position sensor signal, the engine will start even if there is no CMP sensor signal The PCM cannot determine when a particular cylinder is on either a firing or exhaust stroke by the 24X signal alone, the PCM requires the cam signal in order to determine if the cylinder is on either the firing or exhaust stroke

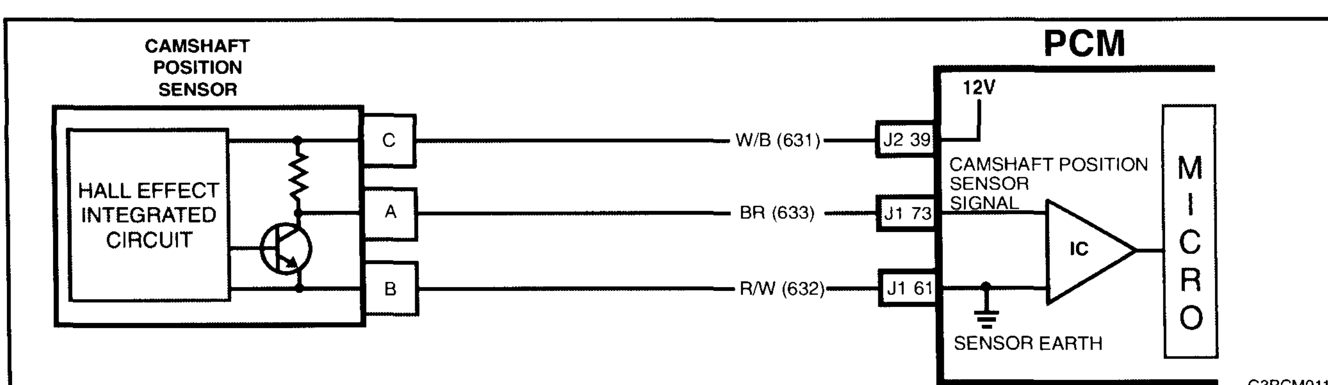
If there is no CMP signal present the system attempts synchronisation and looks for an increase in MAP signal indicating the engine started If the PCM does not detect a MAF increase, the PCM assumes it incorrectly synchronised to the exhaust stroke and re-synchs to the opposite cam position A slightly longer cranking time may be a symptom of this condition



Camshaft Position Sensor



Crankshaft and Camshaft Position Sensor Signal



Camshaft Position Sensor Circuit

A failure in the Camshaft Position Sensor or circuit will set one the of following DTCs:

DTC P0341 Camshaft Position Sensor Circuit Performance

Conditions for running the DTC P0341

- The ignition voltage is between 5.0 and 17.0 volts.
- The engine speed is greater than 400 RPM.

Conditions for setting the DTC P0341

- The PCM detects that a CMP to CKP mismatch has occurred for at least 10 seconds.

Action taken when the DTC P0341 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0341

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0342 Camshaft Position Sensor Circuit Low Voltage

Conditions for running DTC P0342

- The ignition voltage is between 5.0 and 17.0 volts.
- The engine speed is greater than 400 RPM.

Conditions for setting the DTC P0342

- The PCM detects the Camshaft Position Sensor signal is low when the signal should be high for at least one second.

Action taken when the DTC P0342 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0342

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0343 Camshaft Position Sensor Circuit High Voltage

Conditions for running DTC P0343

- The ignition voltage is between 5.0 and 17.0 volts.
- The engine speed is greater than 400 RPM.

Conditions for setting DTC P0343

- The PCM detects the Camshaft Position Sensor signal is stuck high when the signal should be low for at least one second.

Action taken when DTC P0343 Sets

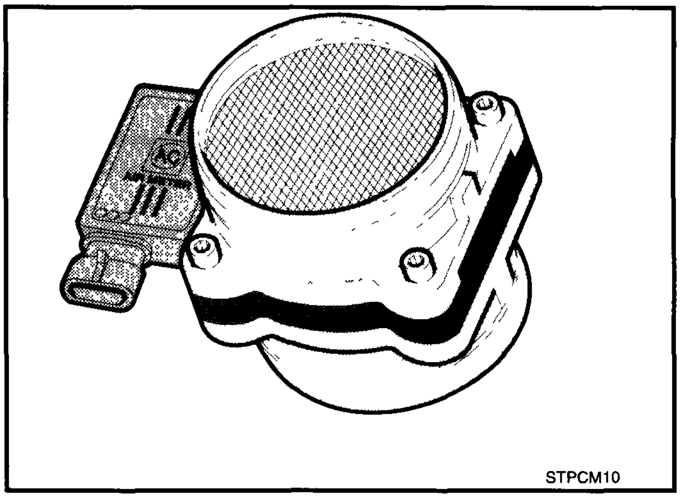
- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

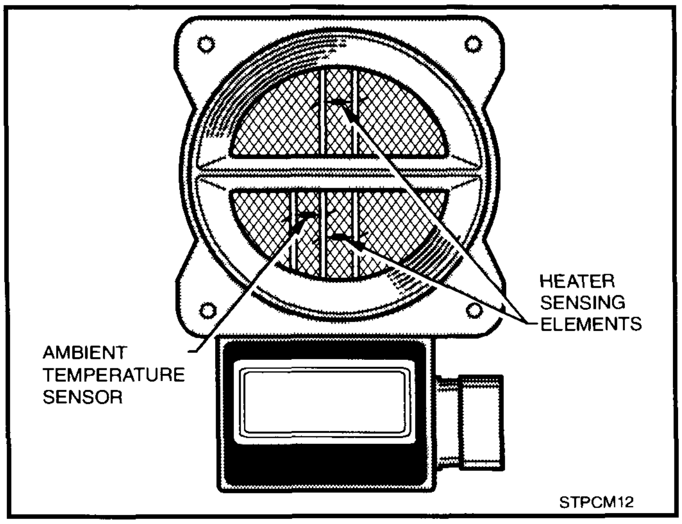
MASS AIR FLOW SENSOR

The Mass Air Flow (MAF) sensor utilises a heated element type of operation. A heated element in the MAF is placed in the air flow stream of the engine intake system. The heating element is maintained at a constant temperature differential above the air temperature. The amount of electrical power required to maintain the heated element at the proper temperature is a direct function of the mass flow rate of the air past the heated element.



Mass Air Flow Sensor

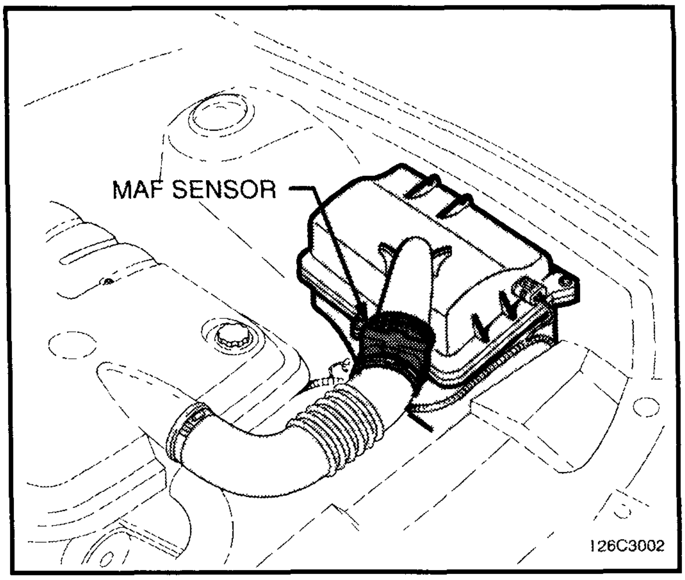
Three sensing elements are used in this system. One senses ambient air temperature and uses two calibrated resistors to establish a voltage that is always a function of ambient temperature. This ambient sensor is mounted in the lower half of the sensor housing. The other two sensing elements are heated to a predetermined temperature that is significantly above ambient air temperature. The two heated elements are connected electrically in parallel and mounted directly in the air flow stream of the sensor housing. One sensor is in the top and the other sensor is in the bottom of the sensor housing. This is done so that the air meter is less sensitive to upstream dueling configurations that could skew the flow of air through the housing.



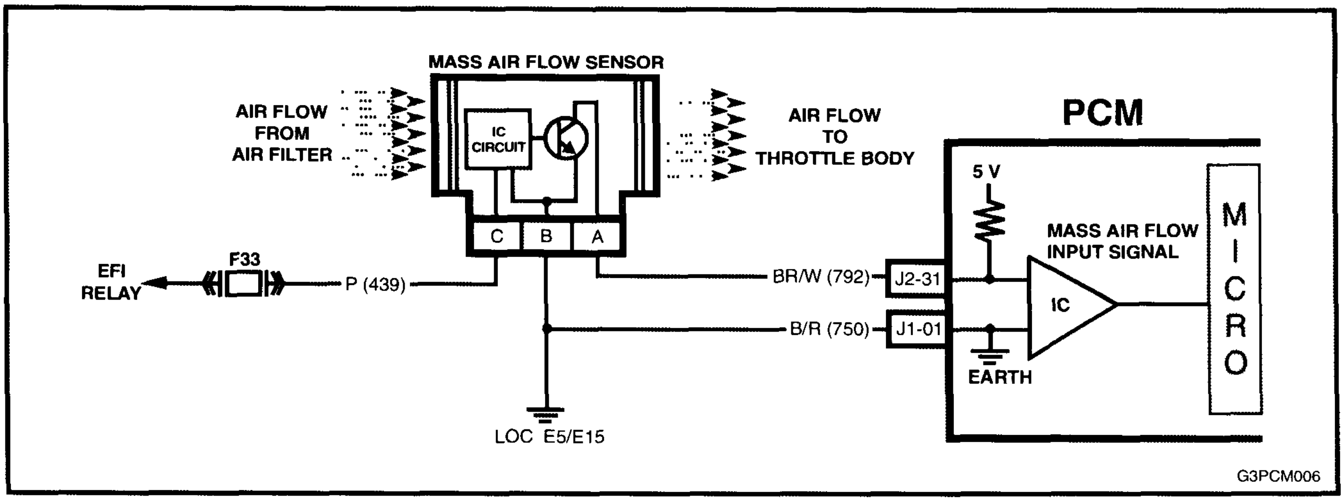
MAF Sensing Elements

As air passes over the heated elements during engine operation they begin to cool. By measuring the amount of electrical power required to maintain the heated elements at the predetermined temperature above ambient temperature the mass air flow rate can be determined.

Once the mass air flow sensor has developed an internal signal related to the mass air flow rate, it must send this information to the PCM. In order to preserve the accuracy and resolution of the small voltage signal in the mass air flow sensor, it is converted to a frequency signal by a voltage oscillator and sent to the PCM.



MAF Sensor Location

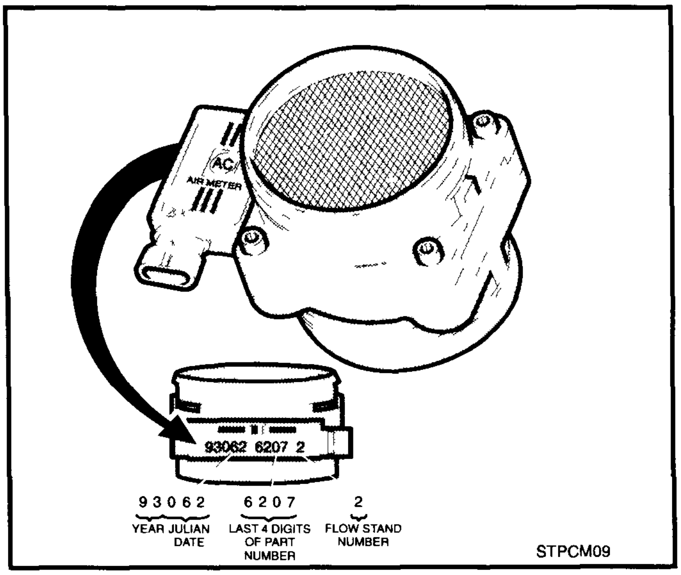


MAF Sensor Circuit

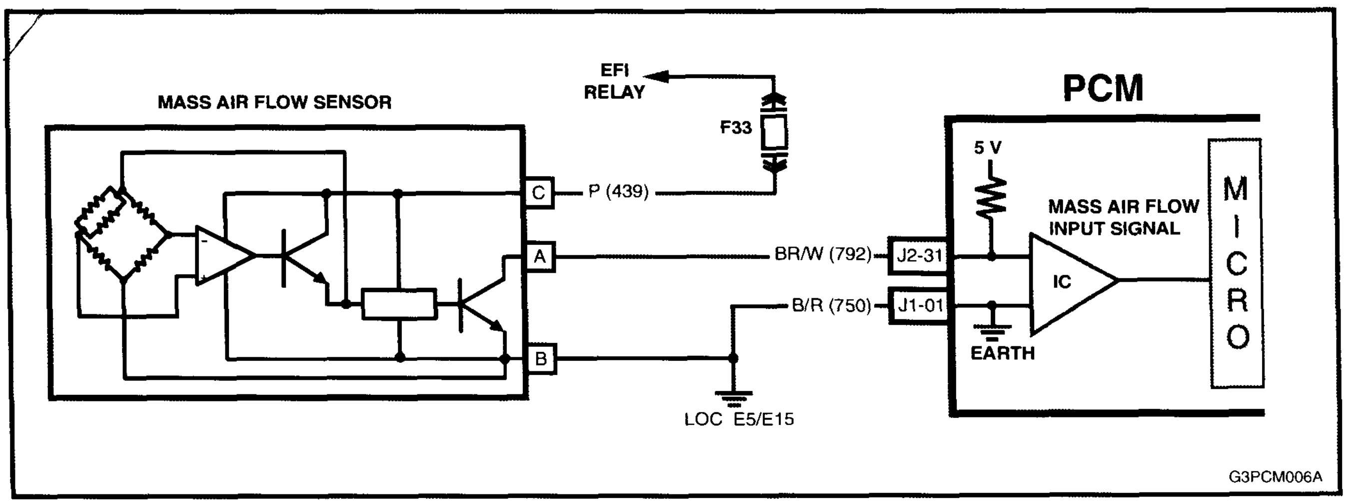
The signal that is sent from the MAF sensor is sent in the form of a frequency output. A large quantity of air passing through the sensor (such as when accelerating) will be indicated as a high frequency output. A small quantity of air passing through the sensor will be indicated as a low frequency output (such as when decelerating or at idle). The Tech 2 scan tool displays MAF sensor information in frequency, and in grams per second. At idle the readings should be low and increase with engine RPM.

If a problem occurs in the MAF sensor circuit, the PCM will store a DTC in its memory. The PCM will turn on the Check Powertrain Lamp, indicating there is a problem. If this occurs, the PCM will calculate a substitute mass air flow signal based on speed density RPM, MAP and IAT.

No field service adjustment is necessary or possible with this MAF sensor.



MAF Sensor Identification



MAF Sensor Simplified Schematic Circuit

A failure in the Mass Air Flow sensor or circuit will set one of the following DTCs:

DTC P0101 Mass Air Flow System Performance

Conditions for running the DTC P0101

- DTCsPO-102, P0103, P0107, P0108, P0121, P0122, P0123 are not set
- The engine is running
- The throttle position angle is less than 50% and the engine vacuum (BARO-MAP) is greater than 65 kPa
- The system voltage is greater than 11 volts but less than 16 volts
- The change in throttle position is less than 3%
- All above conditions stable for two seconds

Conditions for setting DTC P0101

- The MAF frequency is 50% different from the speed density calculation
- All conditions met for at least five seconds

Action taken when DTC P0101 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records
- The PCM utilises speed density (RPM, MAP, IAT) for fuel management

Conditions for clearing the Check Powertrain Lamp and DTC P0101

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail
- A last test failed (current DTC) clears when the diagnostic runs and does not fail

DTC P0102 Mass Air Flow Sensor Circuit Low Frequency

Conditions for running DTC P0102

- The engine speed is greater 300 RPM
- The system voltage is at least 1 1 0 volts

Conditions for setting DTC P0102

- The MAF frequency is less than 10 Hz
- All conditions met for at least one second

Action taken when DTC P0102Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails
- The PCM utilises speed density (RPM, MAP, IAT) for fuel management
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P0102

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail
- A last test failed (current DTC) clears when the diagnostic runs and does not fail

DTC P0103 Mass Air Flow Sensor Circuit High Frequency

Conditions for running DTC P0103

- The engine speed is greater than 300 RPM
- The system voltage is greater than 1 1 0 volts

Conditions for setting DTC P0103

- The MAP frequency is greater than 11,250 Hz
- All conditions met for at least one second

Action taken when DTC P0103Sets

- The PCM illuminates the Check Power-train Lamp when the diagnostic runs and fails
- The PCM utilises speed density (RPM, MAP, IAT) for fuel management
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P0103

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail
- A last test failed (current DTC) clears when the diagnostic runs and does not fail

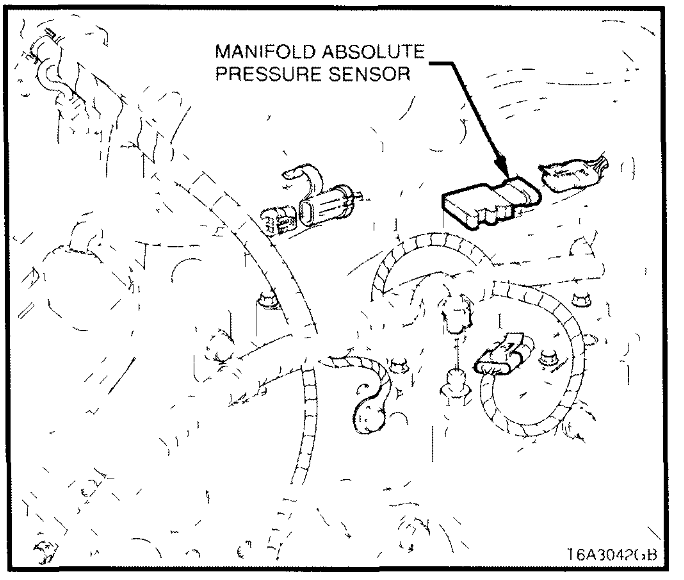
MANIFOLD ABSOLUTE PRESSURE SENSOR

The Manifold Absolute Pressure (MAP) sensor measures the changes in the intake manifold pressure which result from engine load (intake manifold vacuum) and RPM changes and converts these into a voltage output.

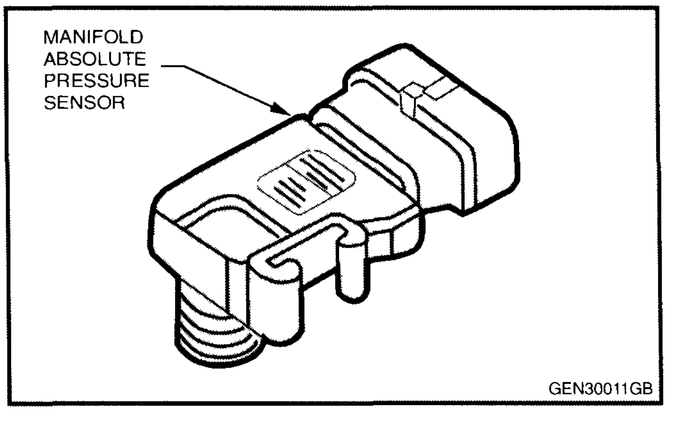
The control module sends a 5-volt supply voltage to the MAP sensor. As the manifold pressure changes, the output voltage of the sensor also changes. By monitoring the sensor output voltage, the control module knows the manifold pressure.

A closed throttle during engine coast down would produce a relatively low MAP output, while a wide open throttle would produce a high output. This high output is produced because the pressure inside the manifold is the same as outside the manifold during wide open throttle, so it measures 100% of outside air pressure (atmospheric pressure). The MAP sensor is also used, to measure barometric pressure, allowing the control module to make adjustments for different operating altitudes.

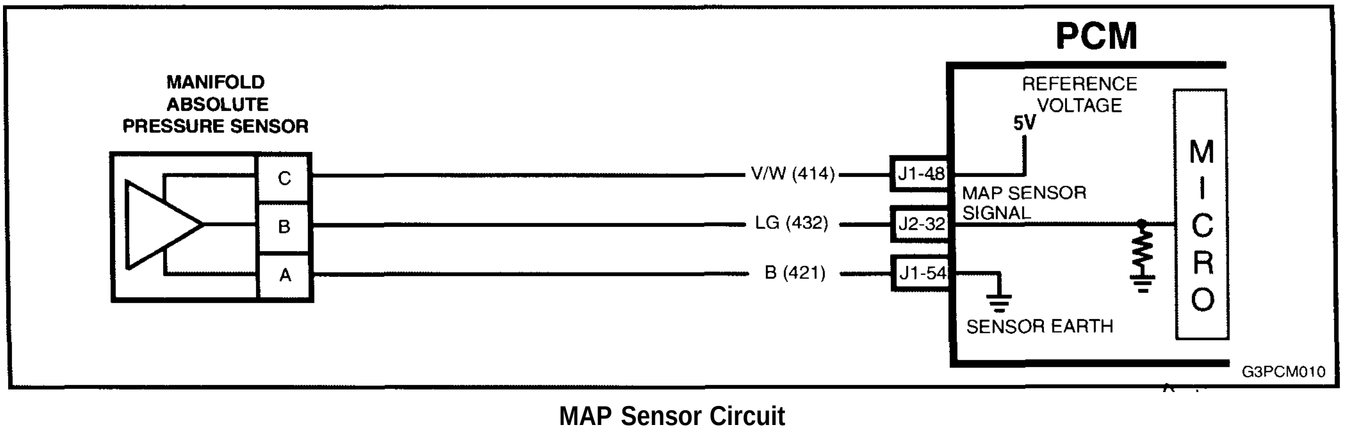
With the engine running, the MAP output voltage signal should vary from about 1.0 to 1.5 volts at idle, to about 4.0 to 4.5 volts at wide open throttle. This MAP output voltage signal is sent to the control module MAP sensor input signal terminal. With ignition on and engine stopped, the manifold pressure is equal to atmospheric (or barometric) pressure and the signal voltage output will be high, close to 5 volts at sea level. This voltage is used by the PCM as an indication of engine load and atmospheric pressure, altitude and is referred to as BARO.



Manifold Absolute Pressure Sensor Location



Manifold Absolute Pressure Sensor



MAP Sensor Circuit

DTC P0107 Manifold Absolute Pressure Sensor Circuit Low Voltage

Conditions for running DTC P0107

- No TP or ECT sensor DTCs set.
- The engine is running.
- The TP angle is above 20% when the engine speed is greater than 1200 RPM.

OR

- The TP angle is below 18% when the engine speed is below 1000 RPM.

Conditions for setting DTC P0107

- The MAP sensor voltage is less than 0.10 volts.
- All conditions met for at least two seconds

Action taken when DTC P0107 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P0107

- The PCM turns the check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0108 Manifold Absolute Pressure Sensor Circuit High Voltage

Conditions for running DTC P0108

- No TP or ECT sensor DTCs set.
- The engine is running.
- The TP angle is above 20% when the engine speed is greater than 1000 RPM.

OR

- The TP angle is below 18% when the engine speed is below 1200 RPM.

Conditions for setting DTC P0108

- The MAP sensor voltage is greater than 4.3 volts.
- All conditions met for at least four seconds

Action taken when DTC P0108 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/ Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P0108

- The PCM turns the Check Powertrain lamp OFF when the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

ENGINE COOLANT TEMPERATURE SENSOR

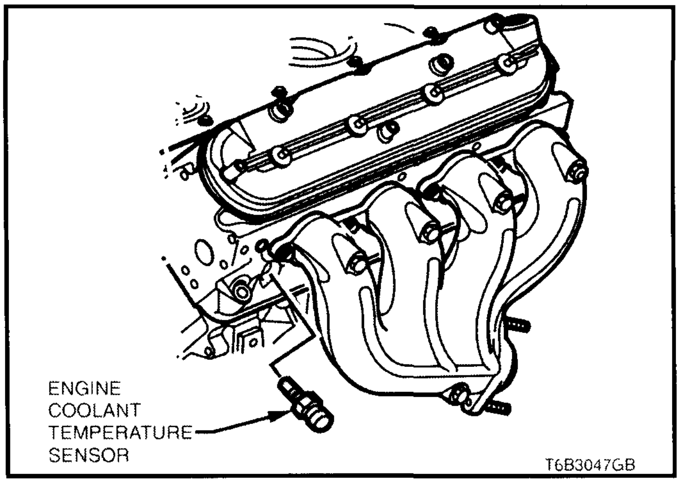
The Engine Coolant Temperature (ECT) sensor is a thermistor, (a resistor that changes value based on temperature) mounted in the engine coolant stream. Low engine coolant temperature produces a high sensor resistance (29k ohms at -20°C) while high engine coolant temperature causes low sensor resistance (180 ohms at 100°C).

The PCM supplies a 5 volt signal voltage to the sensor through a resistor network in the PCM, and monitors the circuit voltage, which will change when connected to the sensor.

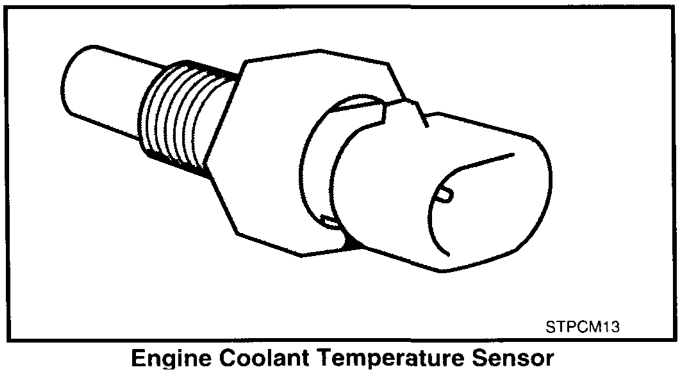
The circuit voltage will vary depending on the resistance of the coolant temperature sensor. The circuit voltage will be close to the 5 volt level when the sensor is cold, and will decrease as the sensor warms. Engine coolant temperature affects most systems controlled by the PCM.

The PCM uses a dual pull up resistor network to increase the resolution through the entire operating range of engine coolant temperature. When the coolant temperature is less than 51 °C both the 4K and 348 ohm resistors are used. When the coolant temperature reaches 51 °C. The PCM switches a short across the 4K resistor and only the 348 ohm resistor is used.

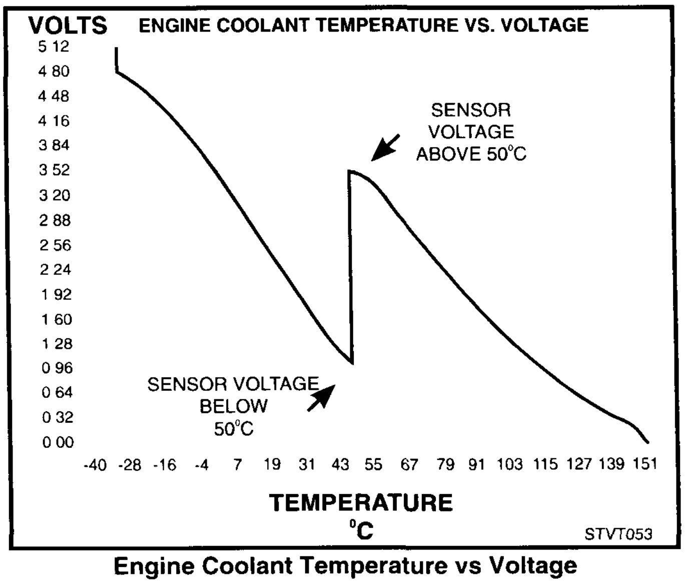
As the engine warms, the sensor resistance becomes less and the voltage at the PCM coolant temperature sensor signal terminal should decrease from approximately 4.5 volts when cold to 0.9 volts at 51 °C. At this temperature the PCM switches the short across the 4k resistor, the voltage will then rise to 3.5 volts. The voltage will again decrease as the coolant temperature increases until at normal engine operating temperature (95°C), the voltage should be less than 2.0 volts.



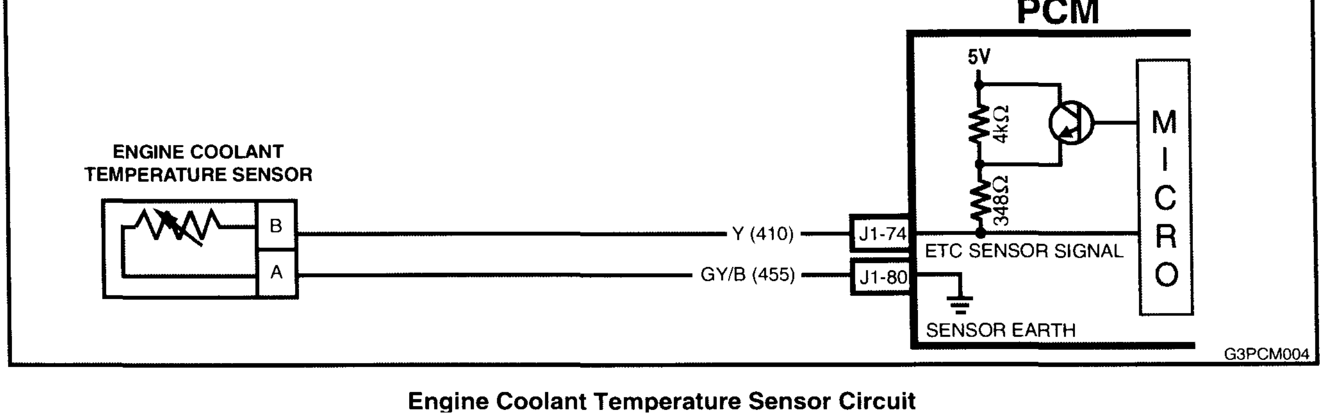
Engine Coolant Temperature Sensor Location



Engine Coolant Temperature Sensor



Engine Coolant Temperature vs Voltage



Engine Coolant Temperature Sensor Circuit

A failure in the Engine Coolant Temperature Sensor or circuit will set one of the following DTCs:

DTC P0117 Engine Coolant Temperature Sensor Circuit Low Voltage

Conditions for running DTC P0117

- The engine run time is greater than 10 seconds

Conditions for setting DTC P0117

- The engine coolant temperature is greater than 139°C
- All conditions met for at least 45 seconds

Action taken when DTC P0117 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails
- The PCM will substitute a coolant temperature default value

  The PCM arrives at this default value, by using current intake air temperature, then counting upward to 116°C at a rate of approximately 7 degrees per minute
- PCM will turn on the electric engine cooling fans This is a FAIL-SAFE action by the PCM to prevent a possible engine overheat condition, since the DTC indicates an unknown actual coolant temperature
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P0117

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail
- A last test failed (current DTC) clears when the diagnostic runs and does not fail

DTC P0118 Engine Coolant Temperature Sensor Circuit High Voltage

Conditions for running DTC P0118

- The engine run time is greater than 10 seconds

Conditions for setting DTC P0118

- The engine coolant temperature is at or below -38 9°C
- All conditions met for at least 45 seconds

Action taken when DTC P0118 Sets

- The PCM illuminates the Check Powertrain Lamp when diagnostic runs and fails
- The PCM will substitute a coolant temperature default value

  The PCM arrives at this default value, by using current intake air temperature, then counting upward to 116°C at a rate of approximately 7 degrees per minute
- PCM will turn on the electric engine cooling fans This is a FAIL-SAFE action by the PCM to prevent a possible engine overheat condition, since the DTC indicates an unknown actual coolant temperature
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P0118

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail
- A last test failed (current DTC) clears when the diagnostic runs and does not fail

DTC P 1 1 1 4 Engine Coolant Temperature Sensor Circuit Intermittent Low Voltage

Conditions for running DTC P 1 1 1 4

- The engine run time is greater than 10 seconds.

Conditions for setting DTC P 1 1 1 4

- The Engine Coolant Temperature is greater than 139°C for at least one second.

Action taken when DTC P 1 1 1 4 Sets

- The PCM stores the DTC information into memory when the diagnostic runs and fails.
- The Check Powertrain Lamp will not be illuminated.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P 1 1 1 4

- A last test failed (Current DTC) will clear when the diagnostic runs and does not fail.

DTC P 1 1 1 5 Engine Coolant Temperature Sensor Circuit Intermittent High Voltage

Conditions for running DTC P 1 1 1 5

- The engine run time is greater than 60 seconds.

Conditions for setting DTC P 1 1 1 5

- The Engine Coolant Temperature is less than -35°C for at least one second.

Action taken when DTC P 1 1 1 5 Sets

- The PCM stores the DTC information into memory when the diagnostic runs and fails.
- The Check Powertrain Lamp will not be illuminated.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P1115

- A last test failed (Current DTC) will clear when the diagnostic runs and does not fail.

DTC P1258 Engine Coolant Over Temp Fuel Disabled

Conditions for running DTC P1258

- DTCsPO-117, P0118, are not set.
- The engine is running.

Conditions for setting DTC P1258

- The engine coolant temperature is greater than 132°C.
- The above conditions present for greater than 10 seconds.

Action taken when DTC P1258 Sets

- The PCM will randomly disable several injectors.
- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P1258

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail.
- A last test failed (Current DTC) will clear when the diagnostic runs and does not fail.

INTAKE AIR TEMPERATURE SENSOR

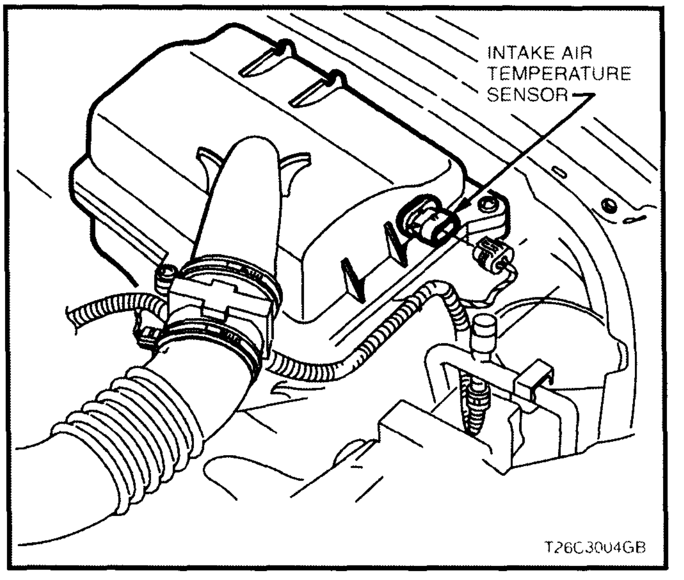
The Intake Air Temperature (IAT) sensor is a thermistor, (a resistor that changes resistance with changes in temperature) mounted in the air cleaner housing Of the intake system. Low intake air temperature produces high resistance in the sensor, approximately 101k ohms at -40°C, while high intake air temperature causes low sensor resistance, approximately 80 ohms at 130°C.

The PCM:

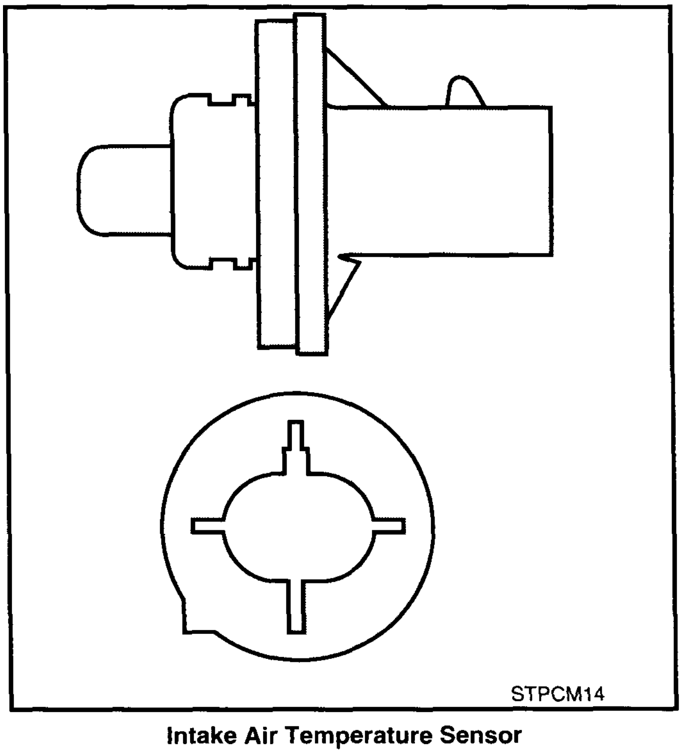
1. Supplies a 5 volt signal voltage to the sensor through a resistor in the PCM, and
2. Monitors the intake air temperature circuit voltage, which will change when connected to the intake air temperature sensor.

The circuit voltage will vary depending on the resistance of the IAT sensor. The voltage will be close to the 5 volt level when the sensor is cold, and will decrease as the sensor warms.

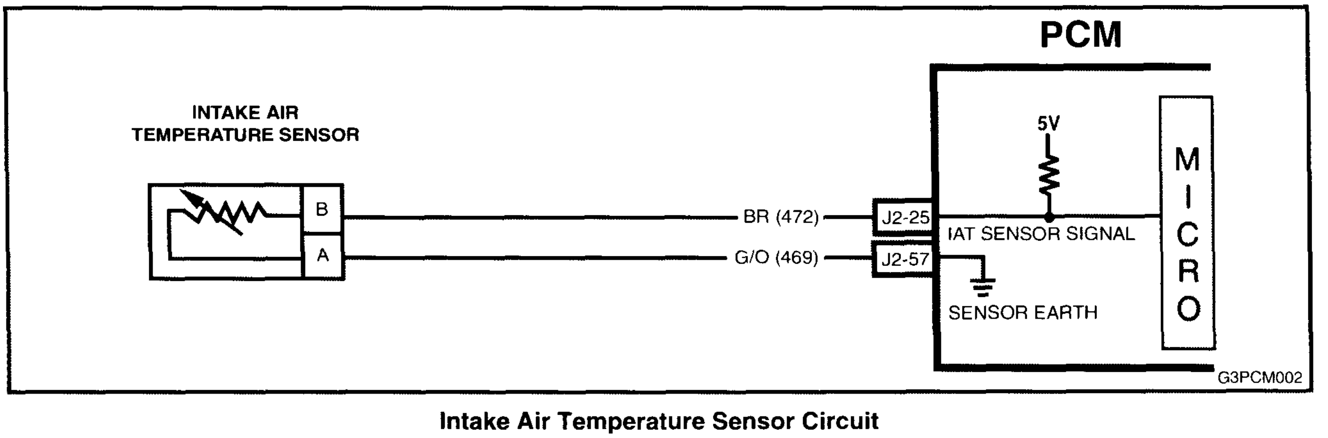
The IAT sensor signal voltage is used by the PCM to assist in calculating the fuel injector pulse width, idle speed, canister purge and electronic spark timing.



Intake Air Temperature Sensor Location



Intake Air Temperature Sensor



Intake Air Temperature Sensor Circuit

A failure in the Intake Air Temperature Sensor or circuit will set one of the following DTCs:

DTC P0112 Intake Air Temperature Sensor Circuit Low Voltage

Conditions for running DTC P0112

- DTC(s) P0101, P0102, P0103, P0117, P0118, are not set
- The engine run time is greater than 30 seconds
- The vehicle speed is less than 40 km/h

Conditions for setting DTC P0112

- The Intake Air Temperature is greater than 139°C
- All conditions met for at least 20 seconds

Action taken when DTC P0112 Sets

- The PCM stores the DTC information into memory when the diagnostic runs and fails
- The Check Powertrain Lamp will not be illuminated
- The PCM will substitute a default Intake Air Temperature value of 25°C
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P0112

- A last test failed (current DTC) clears when the diagnostic runs and does not fail

DTC P0113 Intake Air Temperature Sensor Circuit High Voltage

Conditions for running DTC P0113

- DTCs P0101, P0102, P103, P0117, P0118 are not set
- The engine run time is greater than 100 seconds
- The engine coolant temperature is greater than 0°C
- The vehicle speed is less than 11 km/h

Conditions for setting DTC P0113

- The Intake Air Temperature is at or below -35°C
- All conditions met for at least 20 seconds

Action taken when DTC P0113 Sets

- The PCM stores the DTC information into memory when the diagnostic runs and fails
- The Check Powertrain Lamp will not be illuminated
- The PCM will substitute a default Intake Air Temperature value of 25°C
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P0113

- A last test failed (current DTC) clears when the diagnostic runs and does not fail

DTC P 1 1 1 1 Intake Air Temperature Sensor Circuit Intermittent High Voltage

Conditions for running DTC P1111

- DTCs P0101, P0102, P103, P0117, P0118 are not set
- The engine run time is greater than 100 seconds
- The engine coolant temperature is greater than 0°C
- The vehicle speed is less than 1 1 km/h
- The mass air flow is less than 15 g/s

Conditions for setting DTC P1111

- The intake air temperature is less than -35°C
- All conditions are present for 0 3 seconds

Action taken when DTC P 1 1 1 1 Sets

- The PCM stores the DTC information into memory when the diagnostic runs and fails
- The Check Power-train Lamp will not be illuminated
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Power-train Lamp and DTC P 1 1 1 1

- A last test failed (Current DTC) will clear when the diagnostic runs and does not fail

DTC P 1 1 1 2 Intake Air Temperature Sensor Circuit Intermittent Low Voltage

Conditions for running DTC P 1 1 1 2

- DTCs P0101, P0102, P103, P0117, P0118 are not set
- The engine run time is greater than 30 seconds
- The vehicle speed is less than 40 km/h

Conditions for setting DTC P 1 1 1 2

- The intake air temperature is less than 139°C
- All conditions are present for 0 3 seconds

Action taken when DTC P 1 1 1 2 Sets

- The PCM stores the DTC information into memory when the diagnostic runs and fails
- The Check Powertrain Lamp will not be illuminated.
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P 1 1 1 2

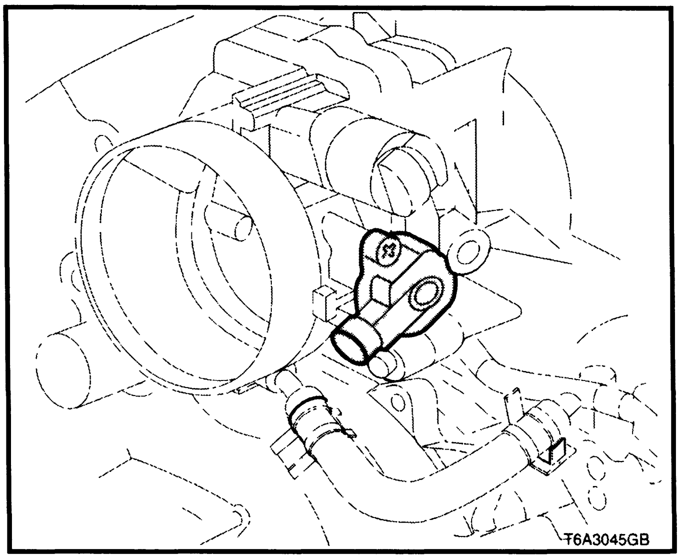
- A last test failed (Current DTC) will clear when the diagnostic runs and does not fail

THROTTLE POSITION SENSOR

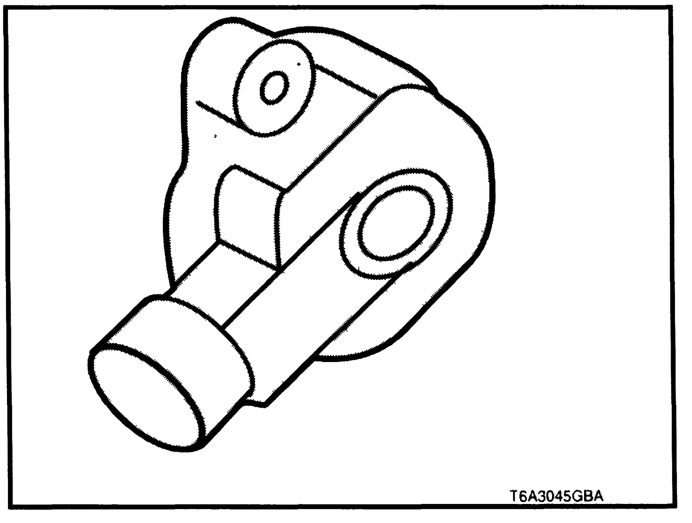
The Throttle Position (TP) sensor is connected to the throttle shaft on the throttle body unit. It is a potentiometer with one end connected to 5 volts from the PCM and the other end to PCM earth. A third wire connects from a sliding contact in the TP sensor to the PCM allowing the PCM to measure the voltage from the TP sensor. As the throttle is moved (accelerator pedal moved), the output of the TP sensor changes. At a closed throttle position, the output of the TP sensor is below 1.25V. As the throttle valve opens, the output increases so that, at wide-open throttle (WOT), the output voltage should be about 4 volts.

By monitoring the output voltage from the TP sensor, the PCM can determine fuel delivery based on throttle valve angle (driver demand). A broken or loose TP sensor can cause intermittent bursts of fuel from the injectors, and an unstable idle, because the PCM interprets the throttle is moving.

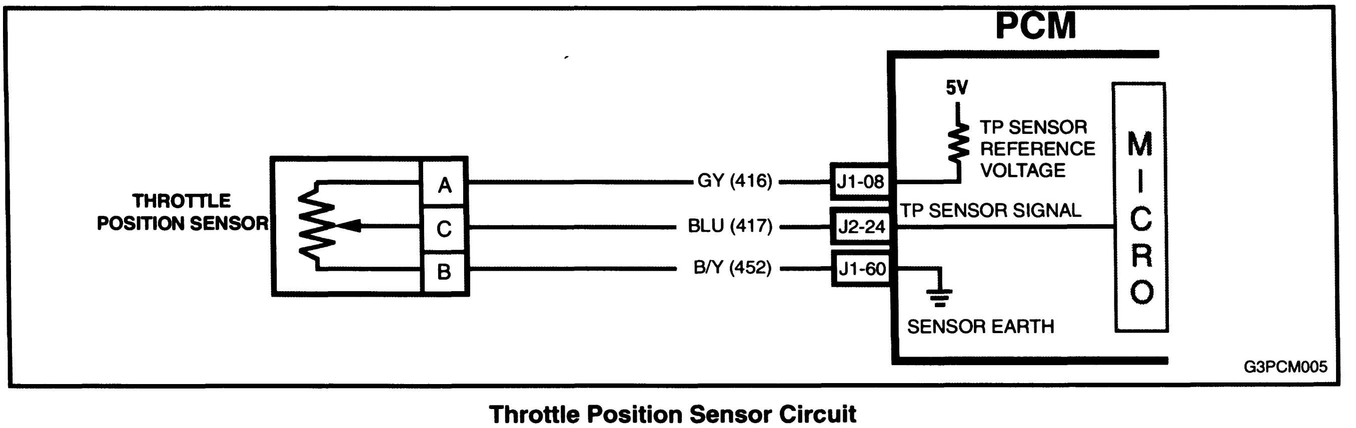
The TP sensor is not adjustable and there is no set value for voltage at closed throttle because the actual voltage at closed throttle can vary from vehicle to vehicle due to tolerances. The PCM has a special program built into it that can adjust for the tolerances in the TP sensor voltage reading at idle. The PCM uses the reading at closed throttle idle for the zero reading (0% throttle) so no adjustment is necessary. Even if the TP sensor voltage reading was to be changed by: tampering, throttle body coking, sticking cable or any other reason, the TP sensor will still be 0%. The PCM will learn what the closed throttle value is every time the throttle comes back to closed throttle.



Throttle Position Sensor Location



Throttle Position sensor



Throttle Position Sensor Circuit

A failure in the Throttle Position Sensor or circuit will set one of the following DTCs:

DTC P0121 Throttle Position Sensor Circuit Insufficient Activity

Conditions for running DTC P0121

- No MAP sensor or TP sensor DTCs set
- The engine run time is greater than 10 seconds
- The engine coolant temperature is greater than 0°C
- The IAC is between 0 and 255 counts
- The MAP is less than 55 kPa
- OR
- The MAP is greater than 65 kPa
- MAP is steady

Conditions for setting DTC P0121

- The predicted throttle angle does not match the actual throttle angle
- All conditions are met for at least 20 seconds

Action taken when DTC P0121 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P0121

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail
- A last test failed (current DTC) clears when the diagnostic runs and does not fail

DTC P0122 Throttle Position Sensor Circuit Low Voltage

Conditions for running DTC P0122

- The ignition switch is ON or the engine is running

Conditions for setting DTC P0122

- The TP sensor signal voltage is less than 0 2 volts

Action taken when DTC P0122 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records
- The PCM uses a default TP sensor value
- The Transmission TCC will not apply
- High transmission line pressure
- Fixed transmission shift points, hard shifts and no fourth gear in hot mode

Conditions for clearing the Check Powertrain Lamp and DTC P0122

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail
- A last test failed (current DTC) clears when the diagnostic runs and does not fail

DTC P0123 Throttle Position Sensor Circuit High Voltage

DTC P0123 Sensor Circuit

Conditions for running DTC P0123

- The ignition is ON or the engine is running.

Conditions for setting DTC P0123

- The TP sensor signal voltage is greater than 4.8 volts.
- Conditions present for at least ten seconds.

Action taken when DTC P0123 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.
- The PCM uses a default TP sensor value.
- The Transmission TCC will not apply.
- High transmission line pressure.
- Fixed transmission shift points, hard shifts and no fourth gear in hot mode.

Conditions for clearing the Check Powertrain Lamp and DTC P0123

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P1121 Throttle Position Sensor Circuit Intermittent High Voltage

Conditions for running DTC P1121

- The ignition is on.

Conditions for setting DTC P1121

- The TP sensor voltage is greater than 4.8 volts.

Action taken when DTC P1121 Sets

- The PCM stores the DTC information into memory when the diagnostic runs and fails.
- The Check Powertrain Lamp will not be illuminated.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing DTC P1121

- A last test failed (Current DTC) will clear when the diagnostic runs and does not fail.

DTC P1122 Throttle Position Sensor Circuit Intermittent Low Voltage

Conditions for running DTC P1122

- The ignition switch is ON or the engine is running.

Conditions for setting DTC P1122

- The TP sensor voltage is less than 0.2 volts.

Action taken when DTC 1122 Sets

- The PCM stores the DTC information into memory when the diagnostic runs and fails.
- The Check Powertrain Lamp will not be illuminate.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing DTC P1122

- A last test failed (Current DTC) will clear when the diagnostic runs and does not fail.

EXHAUST GAS OXYGEN SENSORS

The GEN III V8 engine incorporates the use of Heated Exhaust Gas Oxygen Sensors (H02S). The oxygen sensors are the key to closed-loop fuel control. The PCM uses information from the oxygen sensors to precisely fine tune its fuel injector pulse width calculations, based on the unused, left-over oxygen content in the exhaust. The system uses, two four wire heated oxygen sensors. The oxygen sensors have a Zirconia element that, when heated to temperatures above 360°C, produces voltages based on the amount of oxygen content surrounding the tip, as compared to oxygen in the atmosphere.

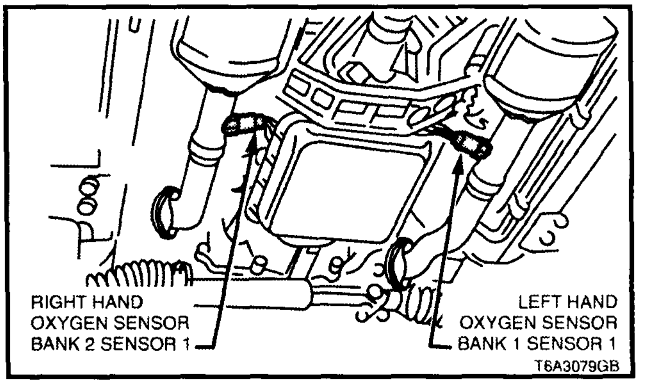
The sensors are mounted in the exhaust pipe with the sensing portion exposed to the exhaust gas stream. When the sensor has reached an operating temperature of more than 360°C, it acts as a voltage generator, producing a rapidly changing voltage of between 10 - 1000 millivolts. This voltage output is dependent upon the oxygen content in the exhaust gas, as compared to the sensor's atmospheric oxygen reference cavity. The reference cavity of an un-heated oxygen sensor is exposed to the atmosphere through the body of the oxygen sensor. The oxygen sensors have an internal heating element that is used to heat the Zirconia element faster inside the sensors, thereby decreasing the amount of time before the fuel control system can begin running in closed loop.

The heated oxygen sensors have four wires, with two for the internal Positive Temperature Co-efficient (PTC) thermistor type heater circuit. One of these wires has 12 volts continually applied to the heater element whenever the ignition is on. The other wire is for the heater element earth. When the sensor is cold, maximum current (approximately 4 amps) flows through the heater circuit and gradually reduces to approximately 0.5 amps as the sensor reaches full operating temperature. The other two sensor wires are for the sensor's signal to the PCM, and the sensor earth.

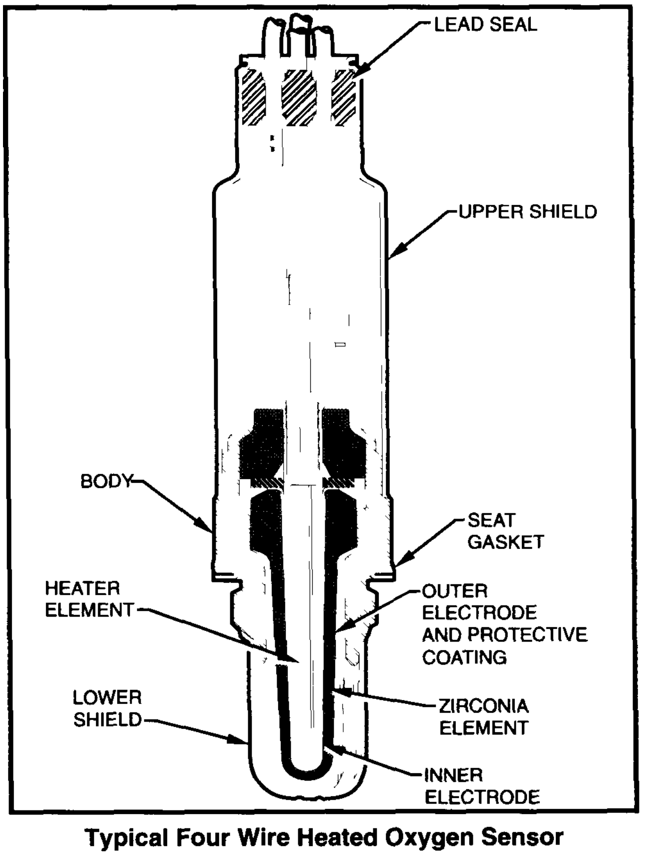
The reference cavity of a heated oxygen sensor is exposed to the atmosphere by the air that passes between the wire strands and insulation of the oxygen sensor leads. The signal and heater leads used on the oxygen sensor are of the stranded type. Stranded leads have small spaces between the wire strands and the insulation. These spaces allow a satisfactory amount of air to pass through the lead to maintain an adequate air reference.

When the sensor is cold, it produces either no voltage, or an unusable, slowly changing one. Also when cold, its internal electrical resistance is extremely high - many million ohms. The PCM always supplies a steady 450 millivolt, very low current bias voltage to the oxygen sensor circuit. When the sensor is cold and not producing any voltage, the PCM detects only this steady bias voltage. As the sensor begins heating, its internal resistance decreases and it begins producing a rapidly changing voltage that will overshadow the PCM's supplied steady bias voltage. When the PCM detects the changing voltage, it knows the oxygen sensor is hot and its output voltage can be used for fine-tuning the fuel injector pulse width. The PCM monitors the oxygen sensor's changing voltage for going above and below a mid-range voltage band (approximately 300 - 600 millivolts), to help decide when to operate in the closed-loop mode.

When the fuel system is correctly operating in the closed-loop mode, the oxygen sensor voltage output is rapidly changing several times per second, fluctuating from approximately 100mV (high oxygen content - lean mixture) to 900mV (low oxygen content - rich mixture). The PCM monitors the changing voltage, and decides the needed fuel mixture correction.



Oxygen Sensor Locations



Typical Four Wire Heated Oxygen Sensor

The oxygen sensors are mounted in the exhaust pipes and are referred to as Bank 1 Sensor 1 (left exhaust pipe) Bank 2 Sensor 1 (right exhaust pipe)

The following DTCs set when the PCM detects a H02S signal circuit that is low

DTC P0131 Bank 1 Sensor 1 H02S

DTC P0151 Bank 2 Sensor 1 H02S

The following DTCs set when the PCM detects a H02S signal circuit that is high

DTC P0132 Bank 1 Sensor 1 H02S

DTC P0152 Bank 2 Sensor 1 H02S

The following DTCs set when the PCM detects no H02S activity

DTC P0134 Bank 1 Sensor 1 H02S

DTC P0154 Bank 2 Sensor 1 H02S

A fault in the oxygen sensor heater element or its ignition feed or earth results in an increase in time to Closed Loop fuel control This may cause increased emissions, especially at start-up The following DTCs set when the PCM detects a malfunction in the H02S heater circuits

- DTC P0135 Bank 1 Sensor 1 H02S heater
- DTC P0155 Bank 2 Sensor 1 H02S heater

Response Time

Not only is it necessary for the oxygen sensors to produce voltage signals for rich or lean exhaust, it is also important to respond quickly to changes If the oxygen sensors respond slowly, the customer may complain of poor fuel economy, rough idle, surging or lack of performance The PCM will set a DTC that indicates degraded H02S performance if a H02S response switching, transition time, or ratio problem is detected

DTC P1133 Insufficient Switching Bank 1 Sensor 1

DTC P1134 Transition Time Ratio Bank 1 Sensor 1

DTC P1153 Insufficient Switching Bank 2 Sensor 1

DTC P1154 Transition Time Ratio Bank 2 Sensor 1

Oxygen Sensor Contaminants

Carbon

Black carbon or soot deposits result from over-rich air-fuel mixtures However, carbon does not harm an oxygen sensor Deposits can be burned off in the vehicle by running the engine at part throttle for at least two minutes

Silica

Certain RTV silicon gasket materials give off vapour as they cure that may contaminate the oxygen sensor This contamination is usually caused by the vapours being pulled from the PCV system, into the combustion chamber and passed on to the exhaust system The sand like particles from the RTV silica embed in the molecules of the oxygen sensor element and plug up the surface With the outside of the oxygen sensor element not able to sense all of the oxygen in the exhaust system it results in lazy oxygen sensor response and engine control The oxygen sensor will have a whitish appearance on the outside if it has been contaminated

There is also a possibility of silica contamination caused by silicon in the fuel Some oil companies have used silicone to raise the octane rating of their fuel Careless fuel handling practices with transport containers can result in unacceptable concentrations of silicone in the fuel at the pump

Silica contamination can be caused by silicon in lubricants used to install vacuum hoses on fittings Do not use silicon sealers on gaskets or exhaust joints

Lead

Lead glazing of the sensors can be introduced when regular, or leaded fuel is burned It is difficult to detect lead contamination by visual inspection

Other Substances

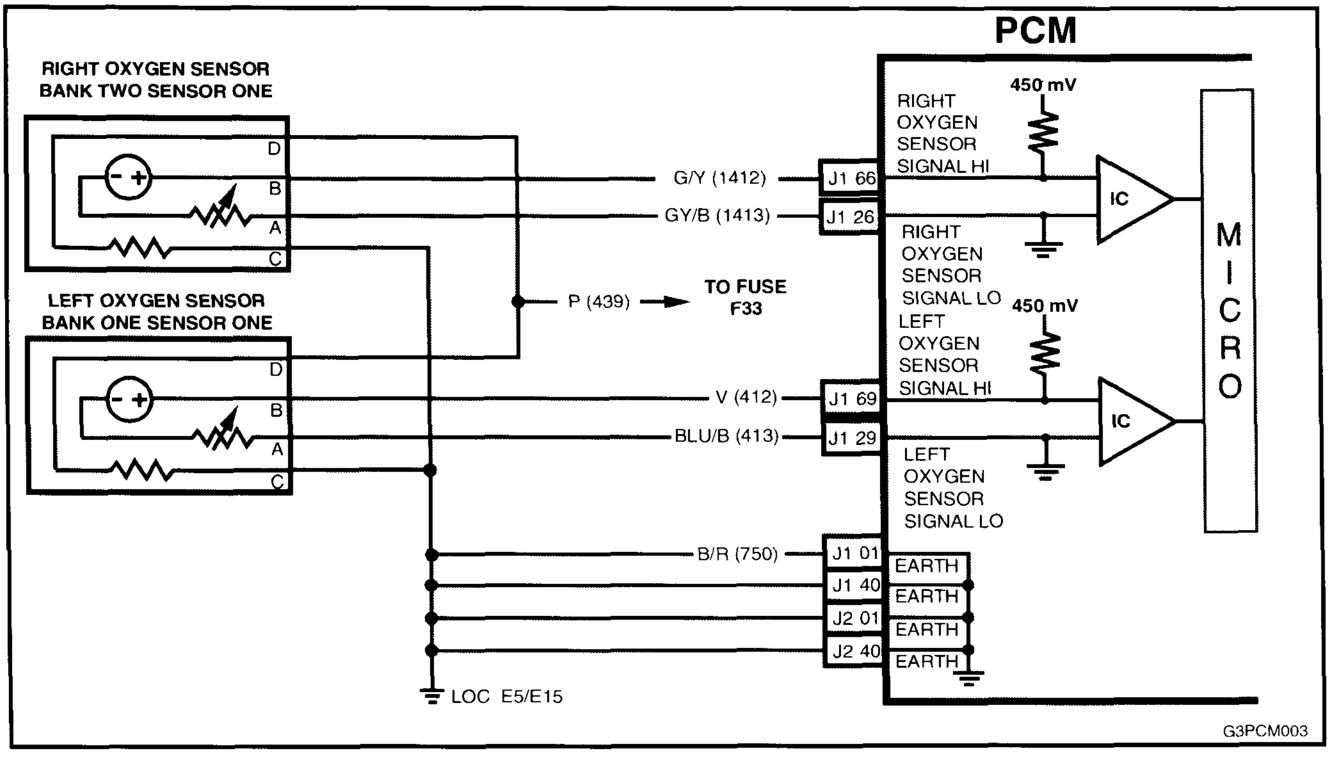
Oil deposits will ultimately prevent oxygen sensor operation The sensor will have a dark brown appearance Causes of high oil consumption should be checked

The additives in ethylene glycol can also affect oxygen sensor performance This produces a whitish appearance If antifreeze enters the exhaust system, you will likely encounter other, more obvious, symptoms of cooling system trouble If for example the engine had a head gasket failure where coolant did enter the combustion chamber it would be a good idea to check the oxygen sensor operation after the head gasket was repaired

Multiple Failures

If you encounter multiple or repeated oxygen sensor failures on the same vehicle, consider contamination

Leaded fuel, silica contamination from uncured, low-grade (unapproved) RTV sealant, and high oil consumption are possible causes



Four Wire Heated Oxygen Sensor Circuit

A failure in the Heated Oxygen Sensors or circuits will set one of the following DTCs:

DTC P0131 Heated Oxygen Sensor Circuit Low Voltage Bank 1 Sensor 1

Conditions for running DTC P0131

Criteria 1

- DTCs P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351, P0358, P1258 are not set
- The engine coolant temperature is greater than 48°C
- The ignition voltage is greater than 9 0 volts
- The fuel system is operating in Closed Loop
- The fuel trim learn is enabled
- The air/fuel ratio is between 14 5 and 14 7 1
- The TP angle is between 0% and 70%

Criteria 2

- DTCs P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351, P0358, P1258 are not set
- The ignition voltage is greater than 9 0 volts
- The Power Enrichment mode is enabled for at least 0 5 seconds

Conditions for setting DTC P0131

Criteria 1

- The H02S signal voltage remains below 200 mV
- The Criteria 1 conditions are present for at least 33 seconds

Criteria 2

- The H02S signal voltage remains below 360 mV
- The Criteria 2 conditions are present for at least five seconds

Action taken when DTC P0131 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records
- Open Loop Fueling

Conditions for clearing the Check Powertrain Lamp and DTC P0131

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fails
- A last test failed (current DTC) clears when the diagnostic runs and does not fail

DTC P0132 Heated Oxygen Sensor Circuit High Voltage Bank 1 Sensor 1

Conditions for running DTC P0132

Criteria 1

- DTCs P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351-P0358, P1258, are not set.
- The ignition voltage is greater than 9.0 volts.
- The fuel system is operating in Closed Loop.
- The fuel trim learn is enabled.
- The air/fuel ratio is between 14.5:1 and 14.7:1.

Criteria 2

- DTCs P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351-P0358, P1258 are not set.
- The ignition voltage is greater than 9.0 volts.
- Deceleration Fuel Cut-off mode is enabled for greater than one second.

Conditions for setting DTC P0132

Criteria 1

- The H02S signal voltage remains above 775 mV.
- The Criteria 1 conditions are present for at least 33 seconds.

Criteria 2

- The H02S signal voltage remains above 540 mV.
- The Criteria 2 conditions are present for at least five seconds.

Action taken when DTC P0132 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.
- Open Loop Fueling.

Conditions for clearing the Check Powertrain Lamp and DTC P0132

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0133 Heated Oxygen Sensor Slow Response Bank 1 Sensor 1

Conditions for running DTC P0133

- DTCs P0101, P0102, P0103. P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336. P0351, P0358, P1258, are not set.
- The engine coolant temperature is greater than 65°C.
- The ignition voltage is greater than 9.0 volts.
- The fuel system is operating in Closed Loop.
- The engine speed between 1000 RPM and 2300 RPM.
- The engine air flow is between 20 g/s and 50 g/s.
- The EVAP canister purge duty cycle is greater than 0%.
- The engine run time is greater than 120 seconds.

Conditions for setting DTC P0133

- The lean to rich response (below 300 mV to above 600 mV) average time is greater than 100 milliseconds.
- The rich to lean response (above 600 mV to below 300 mV) average time is greater than 100 milliseconds.
- The above conditions are met for at least 100 seconds.

Action taken when DTC P0133 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.
- Open Loop Fueling.

Conditions for clearing the Check Powertrain Lamp and DTC P0133

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fails.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0134 Heated Oxygen Sensor Insufficient Activity Bank 1 Sensor 1

Conditions for running DTC P0134

- DTCs P0101,P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351, P0358, P1258,are not set.
- The ignition voltage is greater than 9.0 volts.
- The fuel system is operating in Closed Loop.
- The engine run time is greater than 70 seconds.
- The engine coolant temperature is greater than 48°C.

Conditions for setting DTC P0134

- The H02S signal voltage is steady between 350 mV and 550 mV.
- The conditions are present for at least 70 seconds.

Action taken when DTC P0134 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.
- Open Loop Fueling.

Conditions for clearing the Check Powertrain Lamp and DTC P0134

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0135 Heated Oxygen Sensor Heater Circuit Bank 1 Sensor 1

Conditions for running DTC P0135

- DTCs P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351, P0158, P1258 are not set.
- The intake air temperature and the engine coolant temperature are less than 50° C and are within 8°C of each other at engine start-up.
- The ignition voltage is between 10.0 volts and 18.0 volts.
- The engine air flow is less than 18g/s.

Conditions for setting DTC P0135

- The H02S voltage remains between 300 mV and 700 mV for a predetermined amount of time (depends on engine coolant temperature and air flow).

Action taken when DTC P0135 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0135

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0151 Heated Oxygen Sensor Circuit Low Voltage Bank 2 Sensor 1

Conditions for running DTC P0151

Criteria 1

- DTCs P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351, P0358, P1258 are not set.
- The coolant temperature is greater than 48°C.
- The ignition voltage is greater than 9.0 volts.
- The fuel system is operating in Closed Loop.
- The fuel trim learn is enabled.
- The air/fuel ratio is between 14.5: and 14.7:1.
- The TP angle is between 0% and 70%.

Criteria 2

- DTCs P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351, P0358, P1258 are not set.
- The ignition voltage is greater than 9.0 volts.
- The Power Enrichment mode is enabled for at least 0.5 seconds.

Conditions for setting DTC P0151

Criteria 1

- The H02S signal voltage remains below 200 mV.
- The Criteria 1 conditions are present for at least 33 seconds.

Criteria 2

- The H02S signal voltage remains below 360 mV.
- The Criteria 2 conditions are present for at least 5.0 seconds.

Action taken when DTC P0151 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.
- Open Loop Fueling.

Conditions for clearing the Check Powertrain Lamp and DTC P0151

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0152 Heated Oxygen Sensor Circuit High Voltage Bank 2 Sensor 1

Conditions for running DTC P0152

Criteria 1

- DTCs P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351 -P0358, P1258, are not set.
- The ignition voltage is greater than 9.0 volts..
- The fuel system is operating in Closed Loop.
- The fuel trim learn is enabled,
- The air/fuel ratio is between 14.5:1 and 14.7:1.

Criteria 2

- DTCs P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351 -P0358, P1258 are not set.
- The ignition voltage is greater than 9.0 volts.
- Deceleration Fuel Cut-off mode is enabled for greater than one second.

Conditions for setting DTC P0152

Criteria 1

- The H02S signal voltage remains above 775 mV.
- The Criteria 1 conditions are present for at least 33 seconds.

Criteria 2

- The H02S signal voltage remains above 540 mV.
- The Criteria 2 conditions are present for at least five seconds.

Action taken when DTC P0152 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.
- Open Loop Fueling.

Conditions for clearing the Check Powertrain Lamp and DTC P0152

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fails.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0153 Heated Oxygen Sensor (H02S) Slow Response Bank 2 Sensor 1

Conditions for running DTC P0153

- DTCs P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351-P0358, P1258,are not set.
- The engine coolant temperature is greater than 65°C.
- The ignition voltage is greater than 9.0 volts.
- The fuel system is operating in Closed Loop.
- The engine speed between 1000 RPM and 2300 RPM.
- The engine air flow is between 20 g/s and 50 g/s.
- The EVAP canister purge duty cycle is greater than 0%.
- The engine run time is greater than 120 seconds.

Conditions for setting DTC P0153

- The lean to rich response (below 300 mV to above 600 mV) average time is greater than 100 milliseconds.
- The rich to lean response (above 600 mV to below 300 mV) average time is greater than 100 milliseconds.
- The above conditions are met for at least 100 seconds.

Action taken when DTC P0153 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.
- Open Loop Fueling.

Conditions for clearing the Check Powertrain Lamp and DTC P0153

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fails.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0154 Heated Oxygen Sensor Insufficient Activity Bank 2 Sensor 1

Conditions for running DTC P0154

- DTCs P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351-P0358, P1258,are not set.
- The ignition voltage is greater than 9.0 volts.
- The fuel system is operating in Closed Loop.
- The engine run time is greater than 70 seconds.
- The engine coolant temperature is greater than 48°C.

Conditions for setting DTC P0154

- The H02S signal voltage is steady between 350 mV and 550 mV.
- The conditions are present for at least 70 seconds.

Action taken when DTC P0154 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame and/or the Failure Records.
- Open Loop Fueling.

Conditions for clearing the Check Powertrain Lamp and DTC P0154

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fails.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0155 Heated Oxygen Sensor Heater Circuit Bank 2 Sensor 1

Conditions for running DTC P0155

- DTCs P0101,P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351-P0158, P1258 are not set.
- The intake air temperature and the engine coolant temperature are less than 50°C and are within 8°C of each other at engine start-up.
- The ignition voltage is between 10.0 volts and 18.0 volts.
- The engine air flow is less than 18g/s.

Conditions for setting DTC P0155

- The H02S voltage remains between 300 mV and 700 mV for a predetermined amount of time (depends on engine coolant temperature and air flow).

Action taken when DTC P0155 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0155

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail,
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0171 Fuel System Lean Bank 1

Conditions for running DTC P0171

- DTCs P0101, P01Q2, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351, P0352, P0353, P0354, P0355, P0356, P0357, P0358, P1111, P1112,P1258,are not set.
- The engine coolant temperature is between 50°C and 115°C .
- The barometric pressure is greater than 74 kPa.
- The mass air flow is between 5.0 g/s and 90 g/s.
- The manifold absolute pressure is between 26 kPa and 90 kPa.
- The intake air temperature is between -20°C and 90°C.
- The engine speed is between 400 RPM and 3000 RPM.
- The TP sensor angle is less than 90%.
- The vehicle speed is less than 137 km/h.

Conditions for setting DTC P0171

- The average Long Term Fuel Trim cell values are above a predetermined threshold.
- All the above conditions are present for at least six seconds.

Action taken when DTC P0171 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0171

- The PCM turns the Check Powertrain Lamp OFF after one drive trip that the diagnostic runs and does not fail within the same conditions that the DTC last failed.
  NOTE: If the last failure was during a non-typical driving condition, the Check Powertrain Lamp may remain ON longer than the one drive trip. Review the Freeze Frame/Failure Records for the last failure conditions.
- A last test failed (Current DTC) clears when the diagnostic runs and does not fail.

DTC P0172 Fuel System Rich Bank 1

Conditions for running DTC P0172

- DTCs P0101, P0102,P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351, P0352, P0353, P0354, P0355, P0356, P0357, P0358, P1111, P1112, P1258,are not set.
- The engine coolant temperature is between 50°C and 115°C.
- The barometric pressure is greater than 74 kPa.
- The mass air flow is between 5.0 g/s and 90 g/s.
- The manifold absolute pressure is between 26 kPa and 90 kPa.
- The intake air temperature is between -20°C and 90°C.
- The engine speed is between 400 RPM and 3000 RPM.
- The TP sensor angle is less than 90%.
- The vehicle speed is less than 137 km/h.

Conditions for setting DTC P0172

- The average Long Term Fuel Trim cell values are above a predetermined threshold.
- All the above conditions are present for at least 49 seconds.

Action taken when DTC P0172 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0172

- The PCM turns the Check Powertrain Lamp OFF after one drive trip that the diagnostic runs and does not fail within the same conditions that the DTC last failed.
  NOTE: If the last failure was during a non-typical driving condition, the Check Powertrain Lamp may remain ON longer than the one drive trip. Review the Freeze Frame/Failure Records for the last failure conditions.
- A last test failed (Current DTC) clears when the diagnostic runs and does not fail.

DTC P0174 Fuel System Lean Bank 2

Conditions for running DTC P0174

- DTCs P0101, P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351, P0352, P0353, P0354, P0355, P0356, P0357, P0358, P1111, P1112, P1258,are not set.
- The engine coolant temperature is between 50°C and 115°C.
- The barometric pressure is greater than 74 kPa.
- The mass air flow is between 5.0 g/s and 90 g/s.
- The manifold absolute pressure is between 26 kPa and 90 kPa.
- The intake air temperature is between -20°C-and 90°C.
- The engine speed is between 400 RPM and 3000 RPM.
- The TP sensor angle is less than 90%.
- The vehicle speed is less than 137 km/h.

Conditions for setting DTC P0174

- The average Long Term Fuel Trim cell values are above a predetermined threshold.
- All the above conditions are present for at least six seconds.

Action taken when DTC P0174 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0174

- The PCM turns the Check Powertrain Lamp OFF after one drive trip that the diagnostic runs and does not fail within the same conditions that the DTC last failed.
  NOTE: If the last failure was during a non-typical driving condition, the Check Powertrain Lamp may remain ON longer than the one drive trip. Review the Freeze Frame/Failure Records for the last failure conditions.
- A last test failed (Current DTC) clears when the diagnostic runs and does not fail.

DTC P0175 Fuel System Rich Bank 2

Conditions for running DTC P0175

- DTCs P0101, P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0335, P0336, P0351, P0352, P0353, P0354, P0355, P0356, P0357, P0358, P1111, P1112, P1258, are not set.
- The engine coolant temperature is between 50°C and 115°C.
- The barometric pressure is greater than 74 kPa.
- The mass air flow is between 5.0 g/s and 90 g/s.
- The manifold absolute pressure is between 26 kPa and 90 kPa.
- The intake air temperature is between -20°C and 90°C.
- The engine speed is between 400 RPM and 3000 RPM.
- The TP sensor angle is less than 90%.
- The vehicle speed is less than 137 km/h.

Conditions for setting DTC P0175

- The average Long Term Fuel Trim cell values are above a predetermined threshold.
- All the above conditions are present for at least six seconds.

Action taken when DTC P0175 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0175

- The PCM turns the Check Powertrain Lamp OFF after one drive trip that the diagnostic runs and does not fail within the same conditions that the DTC last failed.
  NOTE: If the last failure was during a non-typical driving condition, the Check Powertrain Lamp may remain ON longer than the one drive trip. Review the Freeze Frame/Failure Records for the last failure conditions.
- A last test failed (Current DTC) clears when the diagnostic runs and does not fail.

DTC P0125 Engine Coolant Temperature Sensor Excess Time To Closed Loop Fuel Control

Conditions for running DTC P0125

- DTCs P0112, P0113, P0117, P0118 are not set.
- The engine is operating.
- The engine coolant temperature is between -36°C and 40°C at engine start-up.
- The intake air temperature is greater than -7°C.
- The vehicle speed is greater than 1.6 km/h.

Conditions for setting DTC P0125

The closed loop coolant temperature of 34 °C is not reached within a predetermined time. The maximum allowable time depends on the start-up coolant temperature and the amount of airflow into the engine. The range for the time is from 2 minutes and 20 seconds to 22 minutes and 30 seconds.

Action taken when DTC P0125 Sets

- The PCM stores the DTC information into memory when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

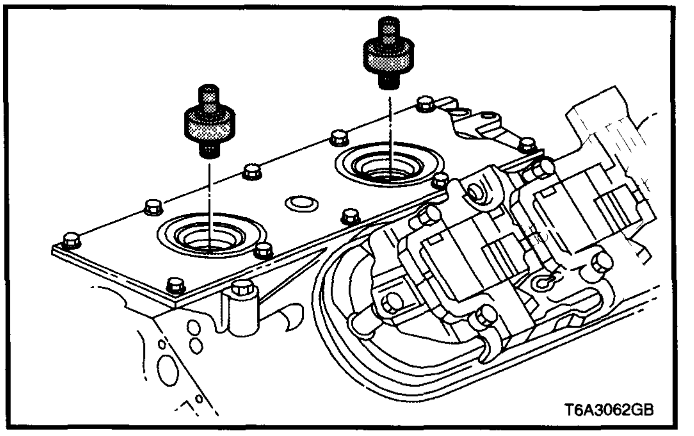
Conditions for clearing the Check Powertrain Lamp and DTC P0125

- The Check Powertrain Lamp will not be illuminated.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

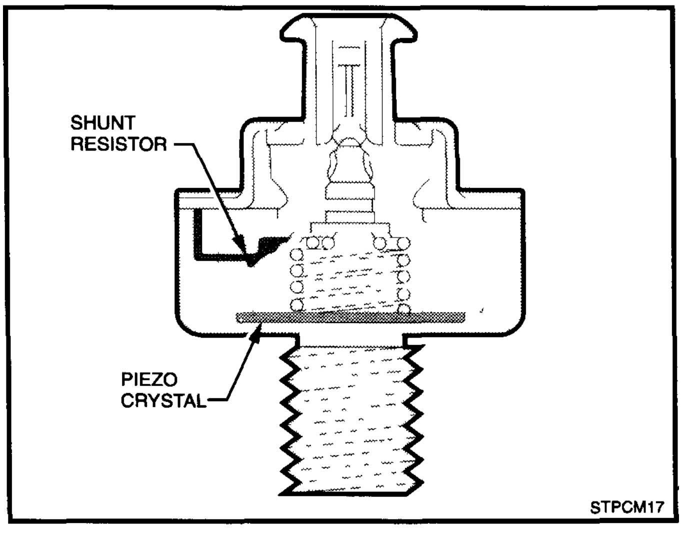
KNOCK SENSORS

Varying octane levels in today's petrol may cause detonation in some engines. Detonation is caused by an uncontrolled pressure in the combustion chamber. This uncontrolled pressure could produce a flame front opposite to that of the normal flame front produced by the spark plug.

The rattling sound normally associated with detonation is the result of two or more opposing pressures (flame fronts) colliding within the combustion chamber. Though light detonation is sometimes considered normal, heavy detonation could result in engine damage. Light detonation occurs when the point of maximum pressure has been exceeded. To control spark knock, two knock sensors are used on the GEN III V8 engine. This system is designed to retard spark timing up to 20° to reduce spark knock in the engine. This allows the engine to use maximum spark advance to improve driveability and fuel economy.



Knock Sensor Locations



Typical Knock Sensor

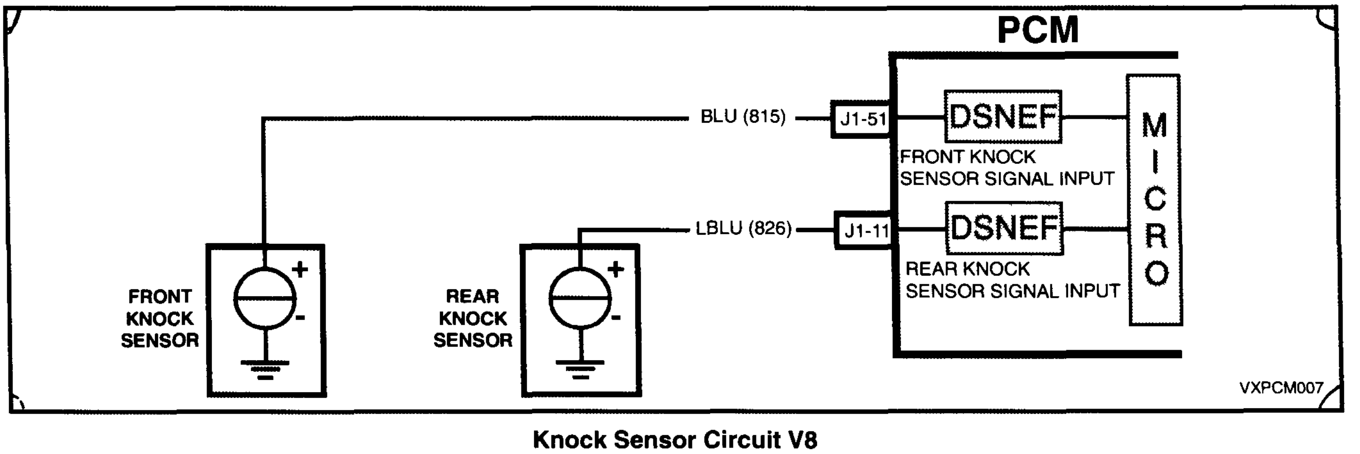
The knock sensors detect abnormal mechanical vibration (spark knocking) in the engine. There are several calibrations of knock sensors because each engine produces a different frequency of mechanical noise. The knock sensor is specifically chosen for this engine to best detect engine knock, over all the other noises in the engine.

The knock sensor produces an AC output voltage that increases with the severity of the knock. This signal voltage inputs to the PCM. This AC signal voltage to the PCM is processed by a Digital Signal Noise Enhancement Filter (DSNEF) module. This DSNEF module is used to determine if the AC signal coming in is noise or actual detonation. This DSNEF module is part of the PCM and cannot be replaced.

The processed knock sensor signal is then supplied to the PCM. The PCM then adjusts the ignition control system to reduce the spark advance. How much. the timing is retarded is based upon the amount of time knock is detected. After the detonation stops, the timing will gradually return to its calibrated value of spark advance. The Knock Sensor system will only retard timing after the following conditions are met:

- The engine run time is greater than 20 seconds.
- The engine coolant temperature is greater than 70°C.
- The engine speed is greater 1650 RPM.
- The manifold absolute pressure is less than 60 kPa.

DTC P0325 indicates an internal PCM malfunction related to the knock sensor system. DTCs P0327 and P0332 indicate that a knock sensor or knock sensor circuit is malfunctioning.



Knock Sensor Circuit V8

A failure in the Knock Sensors or Circuits will set one of the following DTCs:

DTC P0325 Knock Sensor System

Conditions for running DTC P0325

- The engine run time is greater than 20 seconds.
- The engine speed is between 1650 and 3000 RPM.
- The MAP is at or about 48 RPa.
- The engine coolant temperature is greater than 70°C.
- The throttle angle is greater than 0.5%.
- The TP sensor angle is steady within 1 %.
- Battery voltage is between 10 and 16 volts.

Conditions for setting DTC P0325

- A malfunction with the knock sensor system or circuits within the PCM are faulty.
- All above conditions present for at least three seconds.

Action taken when DTC P0325 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0325

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0327 Knock Sensor Circuit Front Sensor

Conditions for running DTC P0327

- The engine run time is greater than 20 seconds.
- The engine coolant temperature is greater than 70°C.
- The engine speed is between 1650 and 3000 RPM.
- The TP sensor angle is greater than 0.5%.
- The MAP is at or about 48 kPa.
- Battery voltage is between 10 and 16 volts.

Conditions for setting DTC P0327

- The PCM determines that this frequency is less than or greater than the expected amount for at least three seconds.

Action taken when DTC P0327 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0327

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0332 Knock Sensor Circuit Rear Sensor

Conditions for running DTC P0332

- The engine run time is greater than 20 seconds.
- The engine coolant temperature is greater than 70°C.
- The engine speed is between 1650 and 3000 RPM.
- The TP sensor angle is greater than 0.5%.
- The MAP is at or about 48 kPa.
- Battery voltage is between 10 and 16 volts.

Conditions for setting DTC P0332

- The PCM determines that this frequency is less than or greater than the expected amount for at least three seconds.

Action taken when DTC P0332 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0332

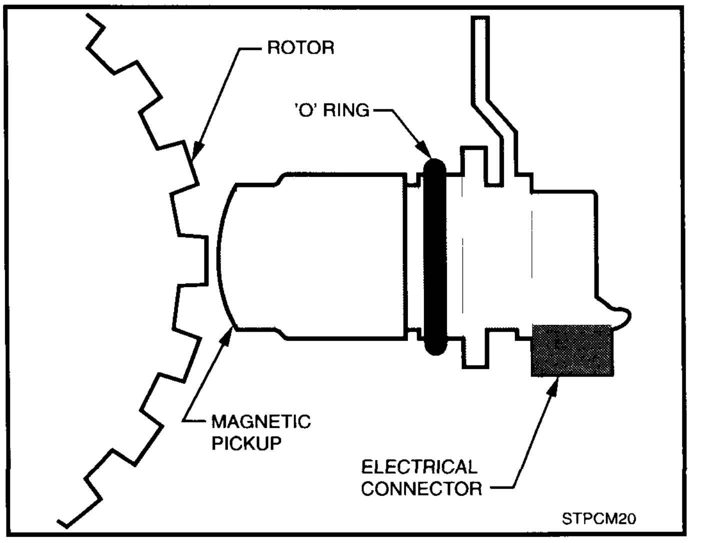
- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

VEHICLE SPEED SENSOR

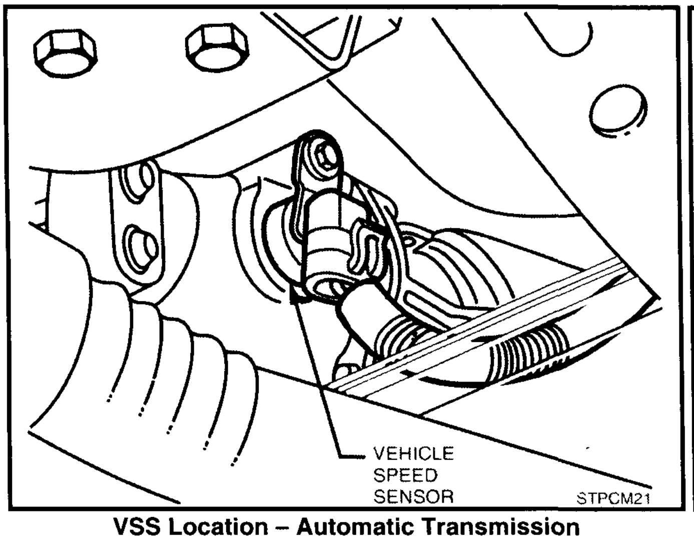
The PCM receives vehicle speed information from the Vehicle Speed Sensor (VSS) located on the rear of the transmission. The VSS basically consists of a magnetic core and a coil. As the output shaft turns, the teeth on the output shaft concentrate the magnetic field causing the magnetic flux to increase and then decrease as the teeth move in and out of the magnetic field, inducing a voltage into the coil, first, in a positive and then in a negative direction.

This AC voltage produced in the VSS sensor circuit is fed into the PCM, the PCM filters and shapes the signal. The PCM then counts the number of pulses received in a given time, to determine the vehicle speed.

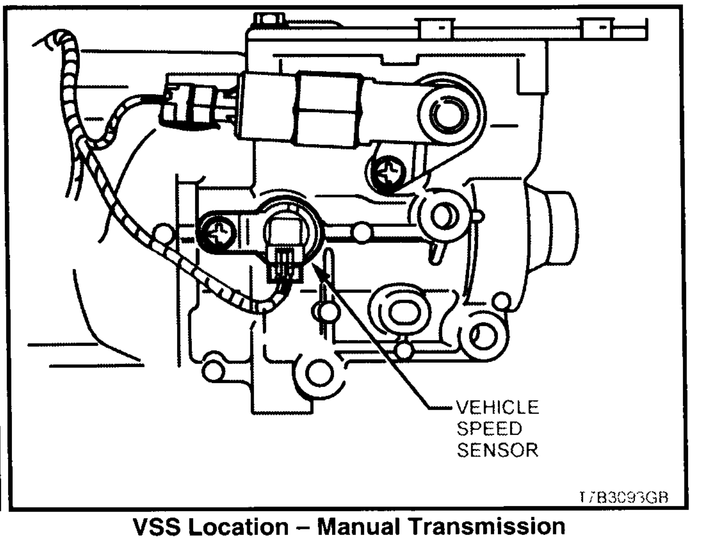
Once the PCM has calculated the vehicle speed it then pulses circuit 123 (Violet/White wire) to earth, this will cause the 12 volts at terminal 17 of the instruments to be pulled down to less than 0.2 volts. The instrument determines the vehicle speed and the kilometres from the numbers of pulses it receives. The PCM also transmits vehicle speed information to other control modules via the serial data bus normal mode message.



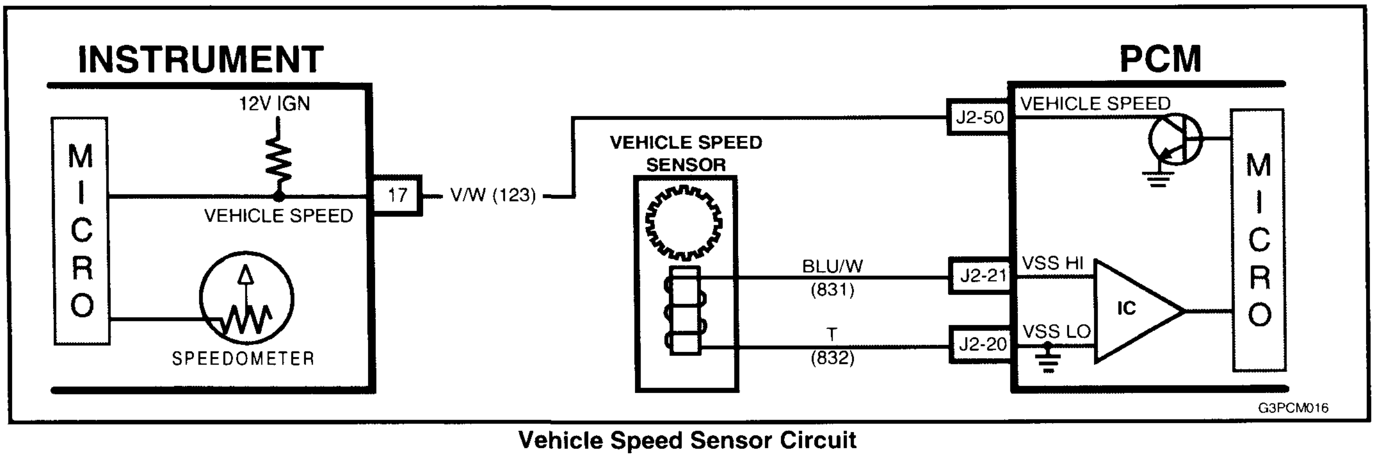
Vehicle Speed Sensor



VSS Location – Automatic Transmission



VSS Location – Manual Transmission



Vehicle Speed Sensor Circuit

A failure in the Vehicle Speed Sensor or Circuit will set on of the following DTCs:

DTC P0502 Vehicle Speed Sensor Circuit Low Input

Conditions for running DTC P0502

- No MAP sensor DTCs P0107 or P0108.
- No Throttle Position DTCs P0122 or P0123.
- No TFP manual valve position switch DTC P1810.
- The transmission is not in park or neutral.
- The Throttle Position angle is greater than 15%.
- The engine vacuum is 0-105 kPa.
- The engine speed is greater than 3000 RPM.
- The engine torque is between 40 - 543 Nm.

Conditions for setting DTC P0502

- The transmission output speed is less than 150 RPM for at least three **seconds.**

Action taken when DTC P0502 Sets

- The PCM does not illuminate the Check Powertrain Lamp.
- The PCM commands first gear only.
- The PCM commands maximum line pressure.
- The PCM inhibits TCC engagement.
- The PCM freezes shift adapts from being updated.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing DTC P0502

- A last test failed (current DTC) clears after one ignition cycle that the diagnostic runs and does not fail.

DTC P0503 Vehicle Speed Sensor Circuit Intermittent

Conditions for running DTC P0503

- No TFP manual valve position switch DTC P1810.
- The time since the last gear range change is greater than six seconds.
- The engine speed is greater than 300 RPM for five seconds.
- The engine is not in fuel cutoff.
- The transmission output speed rise does not exceed 600 RPM within six seconds.

Conditions for setting DTC P0503

- The transmission output speed drop is greater than 1300 RPM for three seconds when the transmission is not in park or neutral.

Action taken when DTC P0503 Sets

- The PCM does not illuminate the Check Powertrain Lamp.
- The PCM commands second gear only.
- The PCM commands maximum line pressure.
- The PCM inhibits TCC engagement.
- The PCM inhibits 4th gear if the transmission is in hot mode.
- The PCM freezes shift adapts from being updated.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freez

Conditions for clearing DTC P0503

- A last test failed (current DTC) clears after one ignition cycle that the diagnostic runs and does not fail.

DTC P0608 Vehicle Speed Output Circuit

Conditions for running DTC P0608

- The engine speed is greater than 600 RPM
- The ignition voltage is between 6.0 volts and 16.0 volts.

Conditions for setting DTC P0608

- The PCM detects that the commanded state of the driver and the actual state of control circuit do not match.
- The condition must be present for at least ten seconds.

Action taken when DTC P0608 Sets

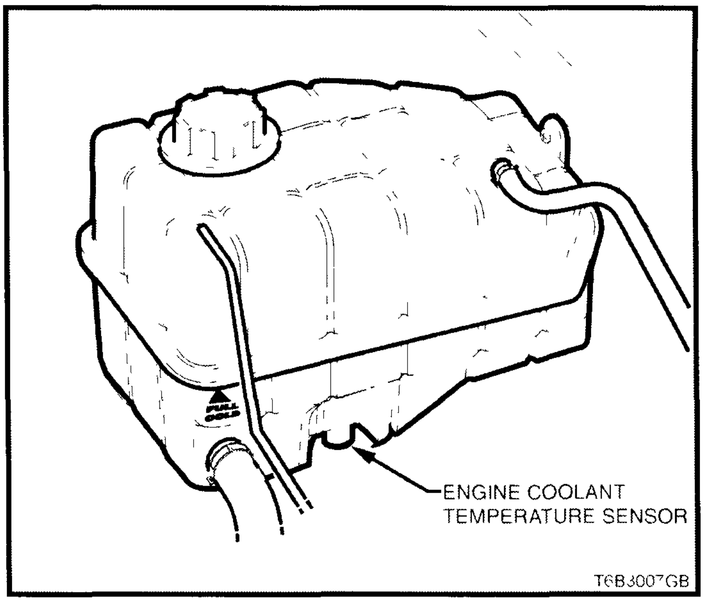
- The PCM stores the DTC information into memory when the diagnostic runs and fails.
- The Check Powertrain Lamp will not illuminate.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0608

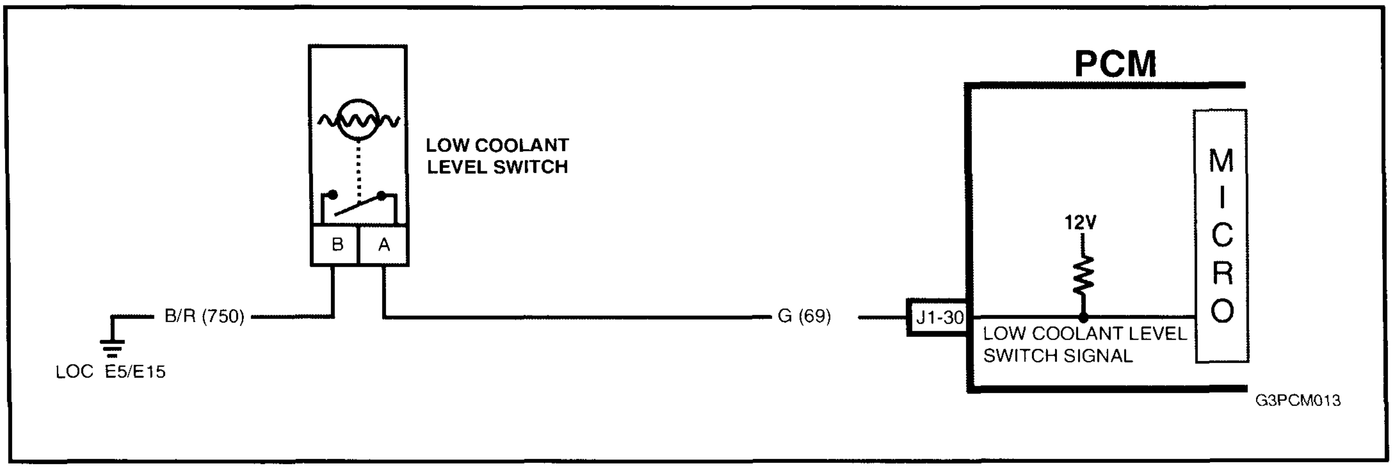
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

ENGINE COOLANT LEVEL SWITCH

The engine coolant level switch is a reed switch and is used to inform the PCM when the coolant level is at a calibrated low level. When the engine coolant is at normal operating level, the float inside the surge tank will rise, the magnet in the float will cause the reed switch contacts to close, pulling the PCM supplied voltage low. When the coolant level is low, the float will fall, the reed switch contacts will open, causing the PCM voltage signal to go high. The PCM will then send a serial data message to the instrument panel cluster instructing the instrument panel cluster to turn ON the Low Coolant Warning Lamp.

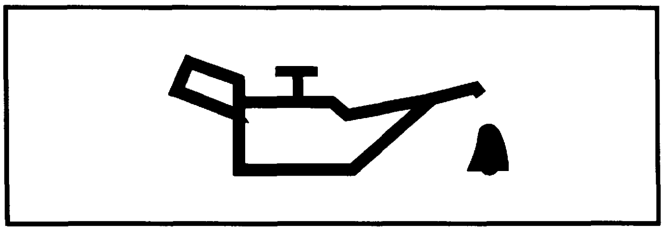


Engine Coolant level Sensor

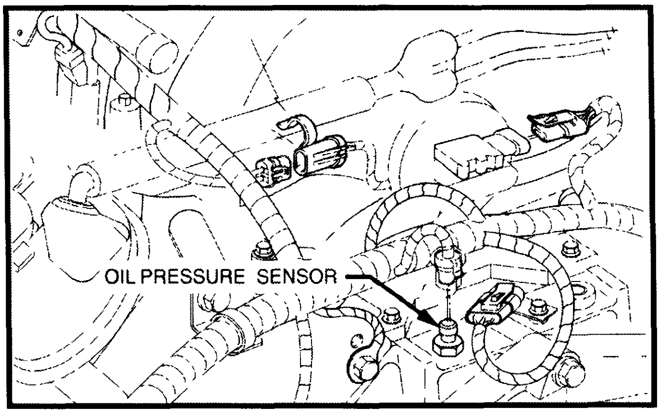


ENGINE OIL PRESSURE SENSOR

The Engine Oil Pressure Sensor is screwed into the oil gallery at the top rear of the engine block. The sensor has a five volt reference voltage, an earth, and a signal circuit. The PCM monitors the voltage on the signal circuit, this voltage will vary depending on engine oil pressure. The oil pressure sensor is used to determine when the oil pressure is below a certain value. By monitoring the voltage, the PCM calculates the engine oil pressure and determines when to turn ON the low oil warning lamp. The low oil warning lamp will be illuminated for two seconds when the ignition is first turned on as a bulb check. The PCM will only command the instruments to turn the low oil warning lamp ON, if the oil pressure is below a specified value, this value increases with RPM. The PCM commands the instruments to turn on the low oil warning lamp via the serial data bus normal mode message.



Oil Pressure Warning Lamp



Oil Pressure Sensor Location

A failure in the Oil Pressure Sensor or Circuit will set one of the following DTCs:

DTC P0522 Engine Oil Pressure Sensor Low Voltage

Conditions for running DTC P0522

- The engine is running.

Conditions for setting DTC P0522

- The Engine Oil Pressure Sensor voltage is less than 0.48 volts.

Action taken when DTC P0522 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0522

- A last test failed (Current DTC) will clear when the diagnostic runs and does not fail.

DTC P0523 Engine Oil Pressure Sensor High Voltage

Conditions for setting DTC P0523

- The engine is running.

Conditions for running DTC P0523

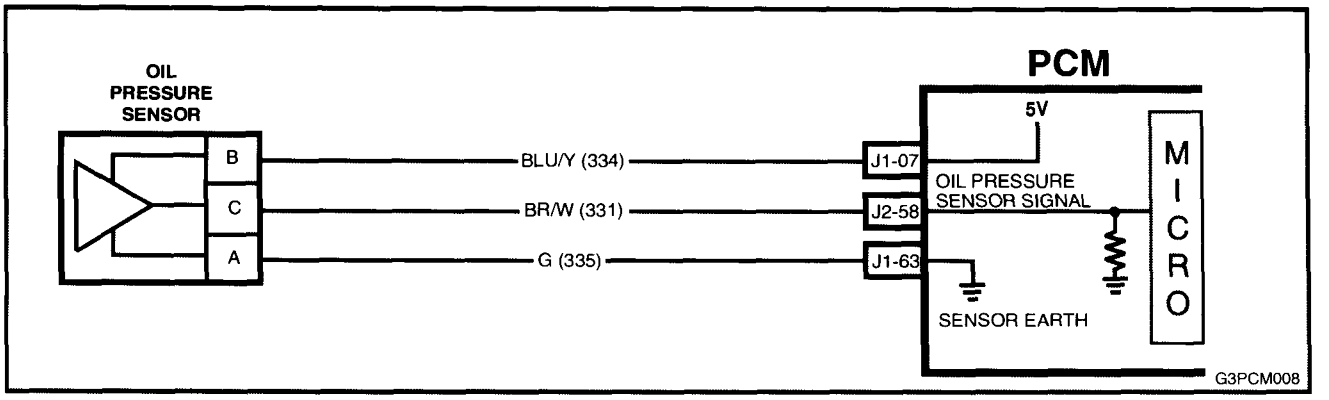
- The engine Oil Pressure Sensor voltage is greater than 4.5 volts.

Action taken when DTC P0523 Sets

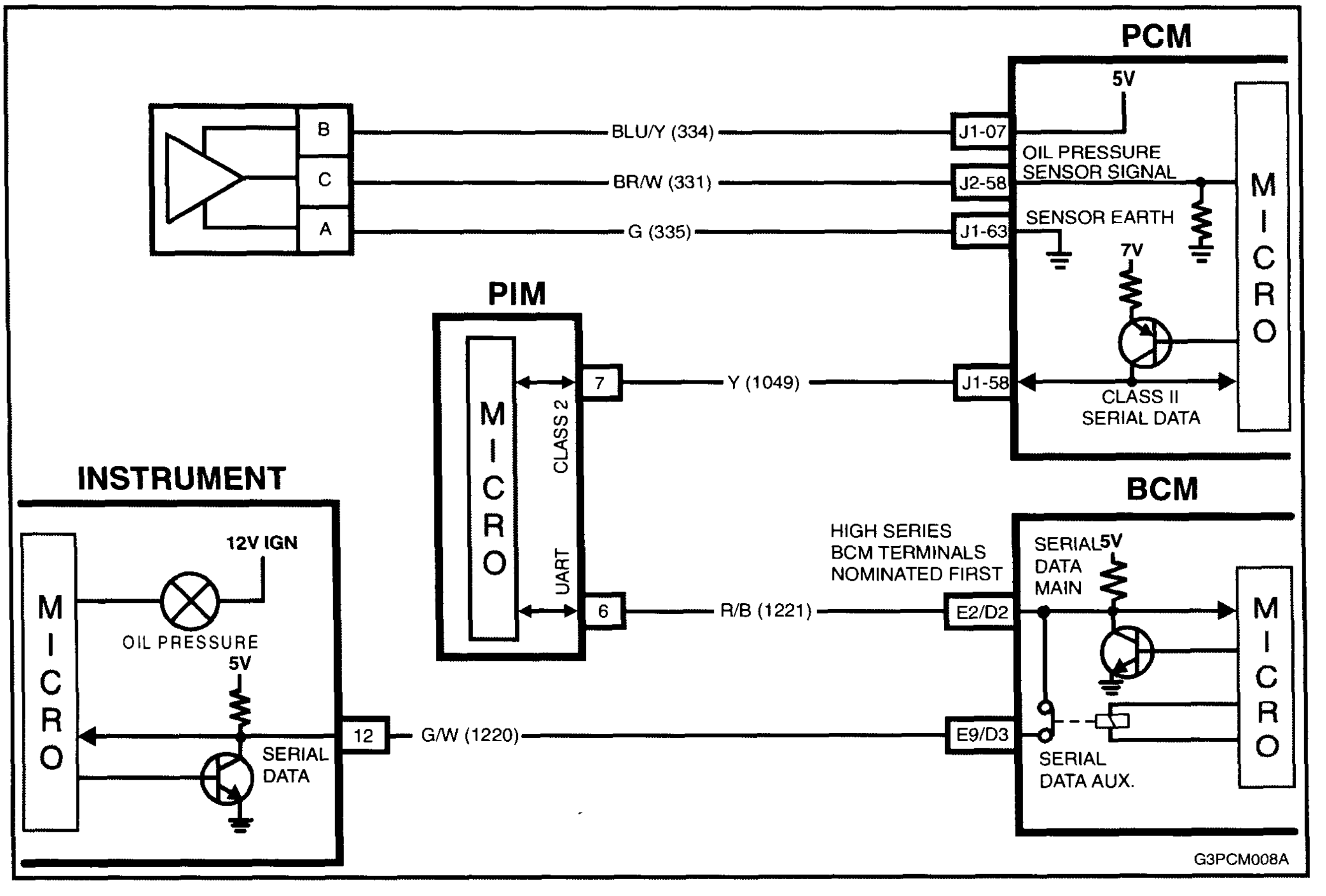
- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0523

- A last test failed (Current DTC) will not clear when the diagnostic runs and does not fail.



Oil Pressure Sensor Circuit



Oil Pressure Warning Lamp Circuit

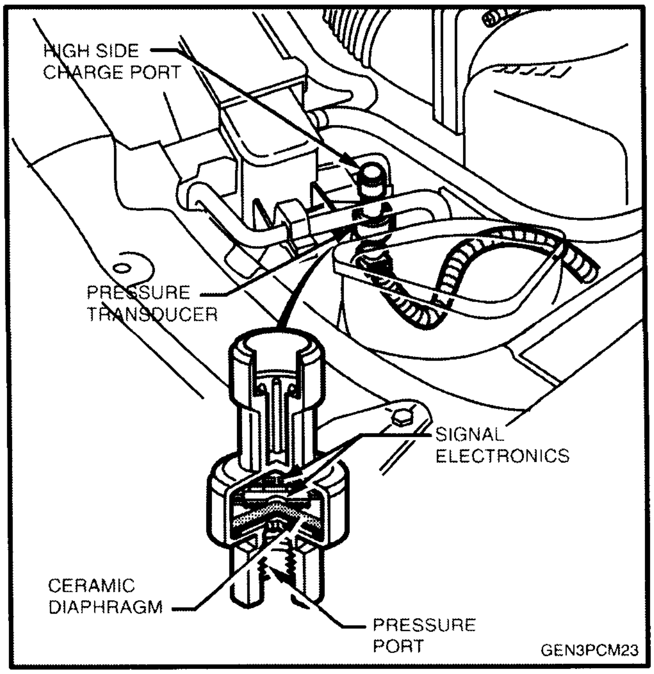
AIR CONDITIONING PRESSURE TRANSDUCER

The air conditioning pressure transducer is a sealed gauge reference capacitive pressure sensor with on board signal conditioning. It provides a zero to five volt output and requires a five volt regulated power supply. In operation the transducer senses applied pressure via the deflection of a two piece ceramic diaphragm with one half being a parallel plate capacitor.

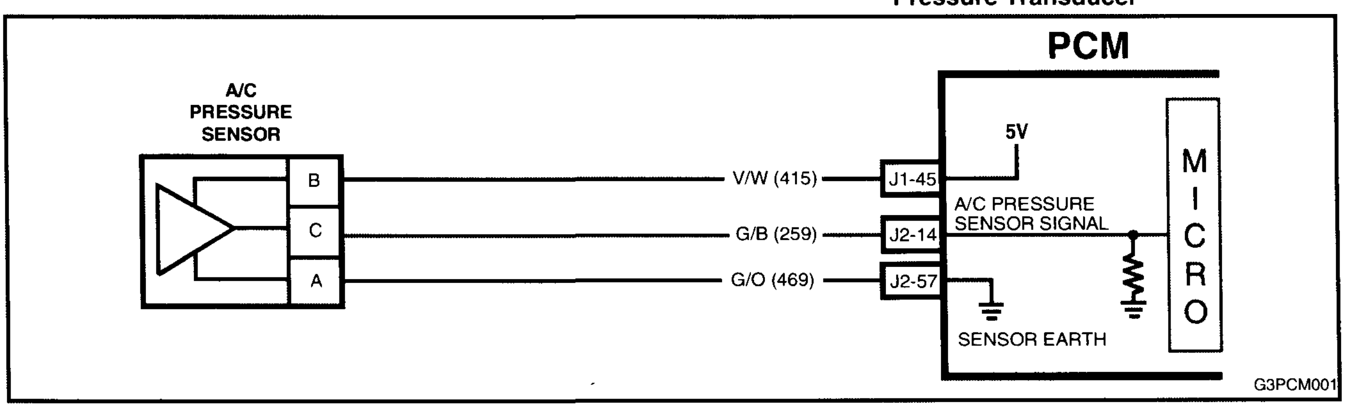
Changes in capacitance influenced by the refrigerant pressure under the ceramic diaphragm are converted to an analogue output by the transducers integral signal electronics. The pressure transducer's electronics are on a flexible circuit board contained in the upper section of the transducer. They provide linear calibration of the capacitance signal from the ceramic sensing diaphragm.

The PCM will disengage the A/C compressor at low or high refrigerant pressures and control the operation of the engine cooling fans.

Low Pressure Compressor Cut	OFF	at 180 kPa
	ON	at 240 kPa
High Pressure Compressor Cut	OFF	at 2900 kPa
	ON	at 2000 kPa
Engine Cooling Fan Low Speed	ON	at 1500 kPa
	OFF	at 1170 kPa
Engine Cooling Fan High Speed	ON	at 2400 kPa
	OFF	at 1900 kPa



Pressure Transducer



Air Conditioning Pressure Transducer Circuit

A failure in the A/C Refrigerant Pressure Sensor or Circuit will set the following DTC:

DTC P0530 A/C Refrigerant Pressure Sensor Circuit

Conditions for running DTC P0530

- The PCM detects an A/C request.

Conditions for setting DTC P0530

- A/C refrigerant pressure sensor indicates A/C refrigerant pressure is at or below 25 kPa for five seconds,

OR

- A/C refrigerant pressure sensor indicates A/C refrigerant pressure is at or above 3140 kPa for five seconds.

Action taken when DTC P0530 Sets

- The PCM does not illuminate the Check Powertrain Lamp.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0530

- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

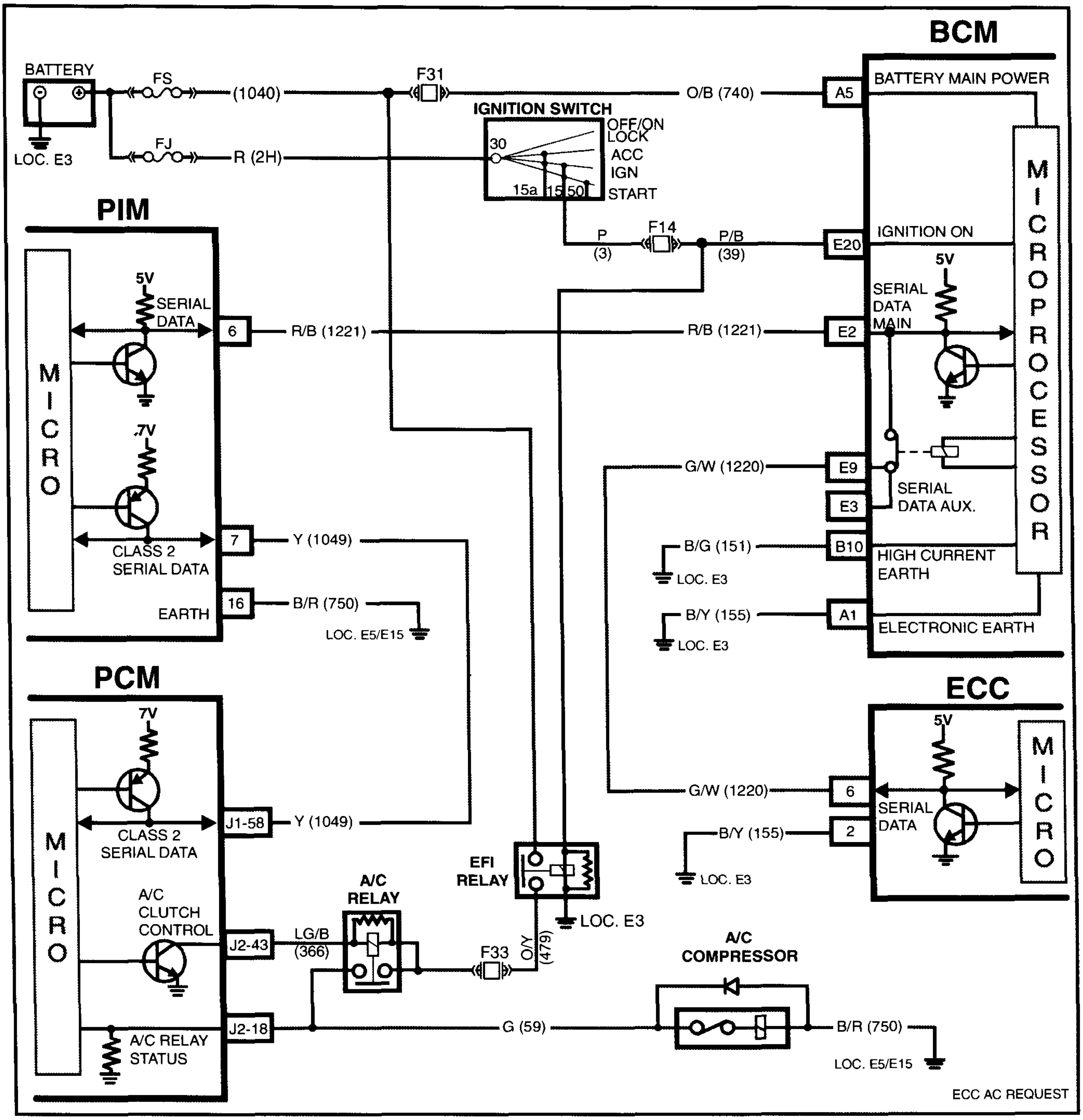
A/C REQUEST SIGNAL AND A/C CLUTCH CONTROL WITH ECC

The Electronic Climate Control (ECC) module requests the PCM to turn the A/C compressor clutch on or off via the PIM and the serial data bus normal mode message. The ECC module monitors information from it's sensors and switches and determines if the A/C compressor clutch should be on or off. The ECC control module will then request the PCM to turn the A/C compressor clutch on or off when required.

The PCM on receiving a request to turn on the A/C compressor will:

1. Adjust the Idle Air Control (IAC) valve position to compensate for the additional load placed on the engine by the air conditioning compressor, and then...
2. Energise the A/C compressor relay, to operate the A/C compressor if the pressure in the A/C system is within the correct operating range.

The PCM on receiving a request to turn on the A/C compressor, monitors the A/C pressure, coolant temperature and RPM to determine A/C clutch operation.



A/C Request Signal Circuit With ECC (Serial Data Bus Normal Mode Message)

Low Pressure		High Pressure		RPM	
Cut Out	Cut In	Cut Out	Cut In	Off	On
180	240	2900	2000	4800	4000

A/C REQUEST SIGNAL AND A/C CONTROL WITHOUT ECC

The BCM requests the PCM to turn the A/C compressor clutch on or off via the PIM and the serial data bus normal mode message. The BCM monitors the voltage at terminal D9 to determine the status of the momentary A/C master switch. When the A/C master switch is pressed, 12 volts is applied to terminal D9 via circuit 248 (Red/White wire), causing the voltage at D9 to be pulled high, 12 volts. The BCM sees this high voltage as an A/C master switch input signal.

On receiving this A/C master switch input signal, the BCM will request the PCM to energise the A/C clutch via the PIM and the serial data bus normal mode message, if the ignition is on and the blower motor is operating. If the A/C master switch is pressed again the BCM will request the PCM to turn off the A/C compressor.

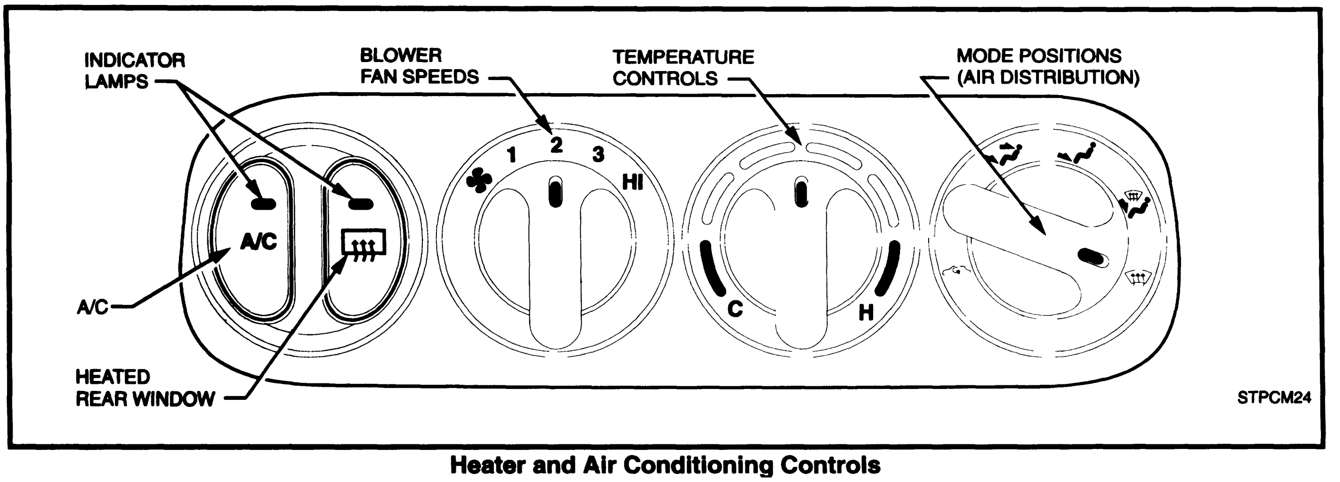
The operating status of the system will be remembered by the BCM, when the ignition is switched from on to off or when the blower is switched off. If the blower is off and the A/C master switch is pressed, then the next time the blower is switched on the air conditioning will be turned on. Turning the ignition off will cancel this button press function.

The system will reset to off when the battery is disconnected.

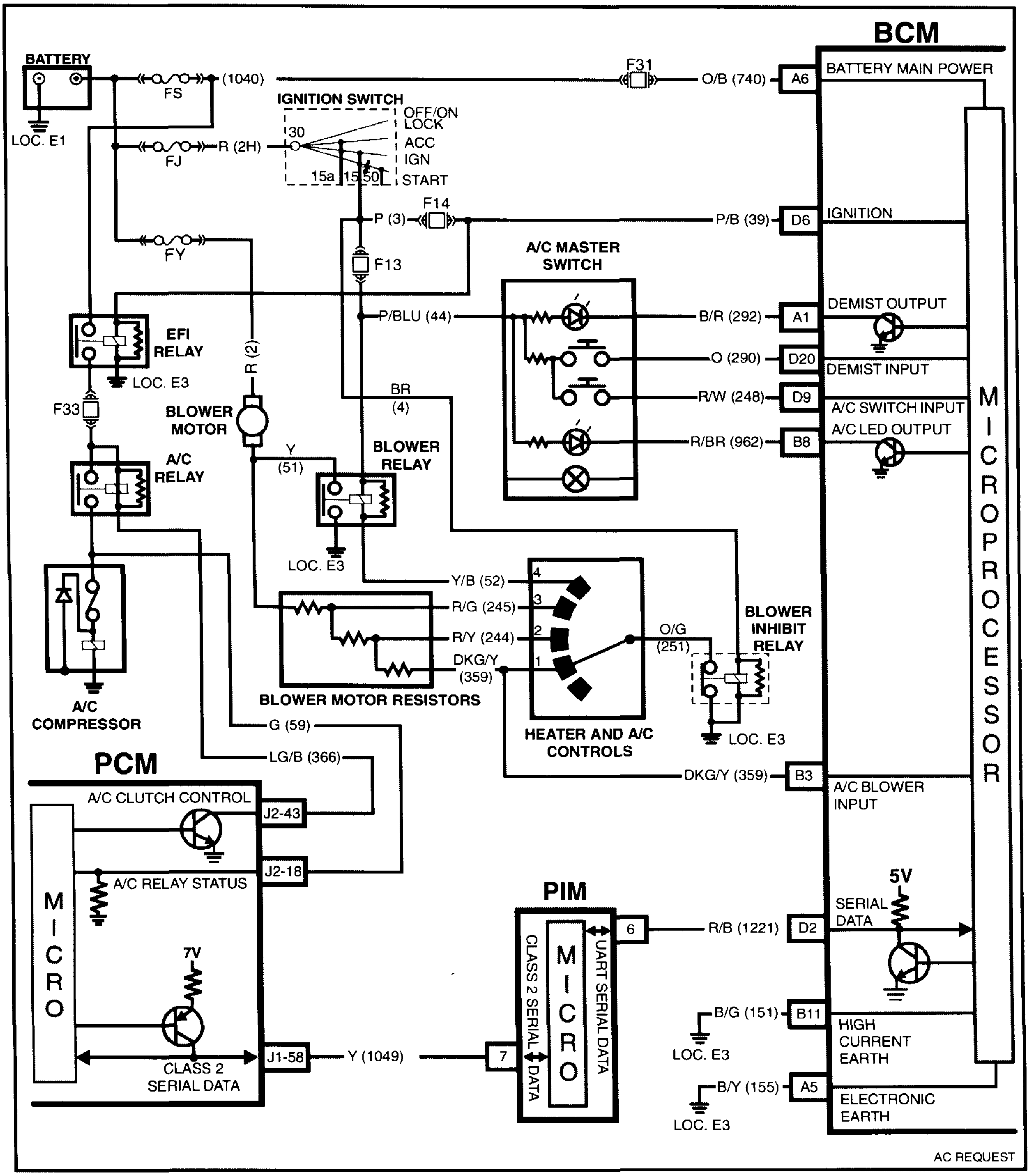
The PCM uses this signal to:

1. Adjust the Idle Air Control (IAC) position to compensate for the additional load placed on the engine by the air conditioning compressor, and then
2. Energise the A/C compressor relay, to operate the A/C compressor if the pressure in the A/C system is within the correct operating range.

   The PCM monitors the A/C pressure transducer to determine A/C system pressures.



Heater and Air Conditioning Controls



A/C Request Signal Circuit Without ECC

The PCM on receiving a request to turn on the A/C compressor, monitors the A/C pressure, coolant temperature and throttle position to determine A/C clutch operation.

Low Pressure		High Pressure		RPM	
Cut Out	Cut In	Cut Out	Cut In	Cut Out	Cut In
180	240	2900	2000	4800	4000

A failure in the A/C Clutch Circuit will set one of the following DTCs:

DTC P1539 A/C Clutch Status Circuit High Voltage

The PCM activates the A/C clutch relay when the PCM detects an A/C request Voltage is present at both the A/C compressor clutch and the A/C clutch status terminal at the PCM when the relay is activated A DTC P1539 sets if the PCM detects voltage on the A/C clutch status terminal when the system has not requested the A/C A short to voltage at any point in the A/C status circuit, or the A/C relay contacts are stuck, sets a DTC P1539

Conditions for running DTC P1539

- The A/C clutch is not requested

Conditions for setting DTC P1539

- Voltage is detected on the A/C status circuit for more than 15 seconds after the PCM has disengaged the A/C clutch relay

Action taken when DTC P1539 Sets

- The PCM stores the DTC information into memory when the diagnostic runs and fails
- The Check Powertrain Lamp will not be illuminated
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P1539

- A last test failed (Current DTC) will clear when the diagnostic runs and does not fail

DTC P1546 A/C Clutch Status Circuit Low Voltage

The PCM will activate the A/C clutch relay when the PCM detects that A/C has been requested When the PCM activates the relay, voltage should be present at both the A/C compressor clutch and the A/C clutch status circuit at the PCM, if voltage is not present DTC P1546 will set

DTC P1546 Sensor Circuit

Conditions for running DTC P1546

- The A/C clutch is requested

Conditions for setting DTC P1546

- The PCM commands the A/C ON and the PCM does not detect a voltage on the A/C clutch status line for more than five seconds

Action taken when DTC P1546 Sets

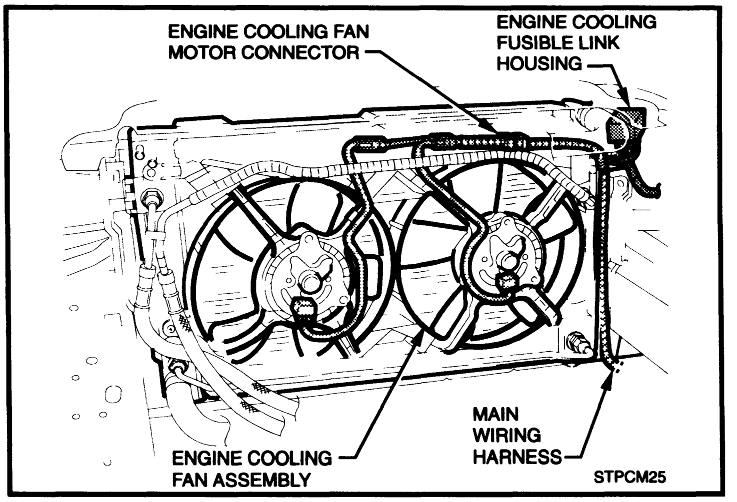
- The PCM stores the DTC information into memory when the diagnostic runs and fails
- The Check Powertrain Lamp will not be illuminated
- The PCM records the operating conditions at the time the diagnostic fails The PCM stores this information in the Freeze Frame/Failure Records

Conditions for clearing the Check Powertrain Lamp and DTC P1546

- A last test failed (Current DTC) will clear when the diagnostic runs and does not fail

ENGINE COOLING FANS

The PCM determines operation of the two speed engine cooling fans based on A/C request, A/C system pressure, engine coolant temperature and vehicle speed signal inputs. Each engine cooling fan motor has four terminals, two negative and two positive terminals. The two negative terminals are the relay controlled circuits for the fan operation. The two positive terminals are the direct power feed from a fusible link to the fan motors. When an earth signal is applied to one of the negative terminals, the fan motors will operate at low speed. When an earth signal is applied to both negative terminals, both fan will operate at high speed. The engine cooling fan high speed relay is controlled by the PCM. The PCM controls the earth path for the engine cooling fan high speed relay. Cooling fan low speed is controlled by the PCM via the PIM and serial data bus to the BCM.



Engine Cooling Fans

The BCM controls the earth path for the engine cooling fan low speed relay. The engine cooling fan high speed and the engine cooling fan low speed relays are used to control the earth signal to the electric motors that drive the fans. The PCM determines operation of the two, two speed engine cooling fans based on A/C request, engine coolant temperature, A/C refrigerant pressure sensor and vehicle speed signal inputs.

ENGINE COOLING FAN LOW SPEED

The engine cooling fan low speed relay is energised by the BCM.

The cooling fan low speed relay will be turned ON when:

- The A/C request indicated (YES) and either:
- the vehicle speed is less than 30 km/h.
  or
- A/C pressure is greater than 1500 kPa
  or
- The coolant temperature is greater than 98°C.
- **or**
- If the coolant temperature is greater than 113°C, when the ignition is switched off, the relay is energised for approximately four minutes, this is known as Low Fan Run On.
- **or**
- If an engine coolant temperature sensor fault is detected and a DTC such as DTC P0177, P0188, P01114 or P01115 is set.

The cooling fan low speed relay will be turned OFF when any of the following conditions have been met:

- An A/C request is not indicated (NO) and the coolant temperature is less than 95°C.
- **or**
- An A/C request is indicated (YES) and the vehicle speed is greater than 50 km/h and A/C pressure is less than 1170 kPa and the coolant temperature is less than 98°C.

ENGINE COOLING FAN HIGH SPEED

- The engine cooling fan high speed relay is controlled by the PCM. The PCM will only turn ON' the engine cooling fan high speed relay fan if the engine cooling fan low speed relay has been "ON" for two seconds and the following conditions are satisfied.
- There is a BCM message response fault which will cause a PIM DTC B2002.
- An engine coolant temperature sensor fault is detected and a DTC such as DTC P0177, P0188, P01114 or P01115 is set.
- Coolant temperature greater than 108°C.
- The A/C refrigerant pressure is greater than 2400 kPa.

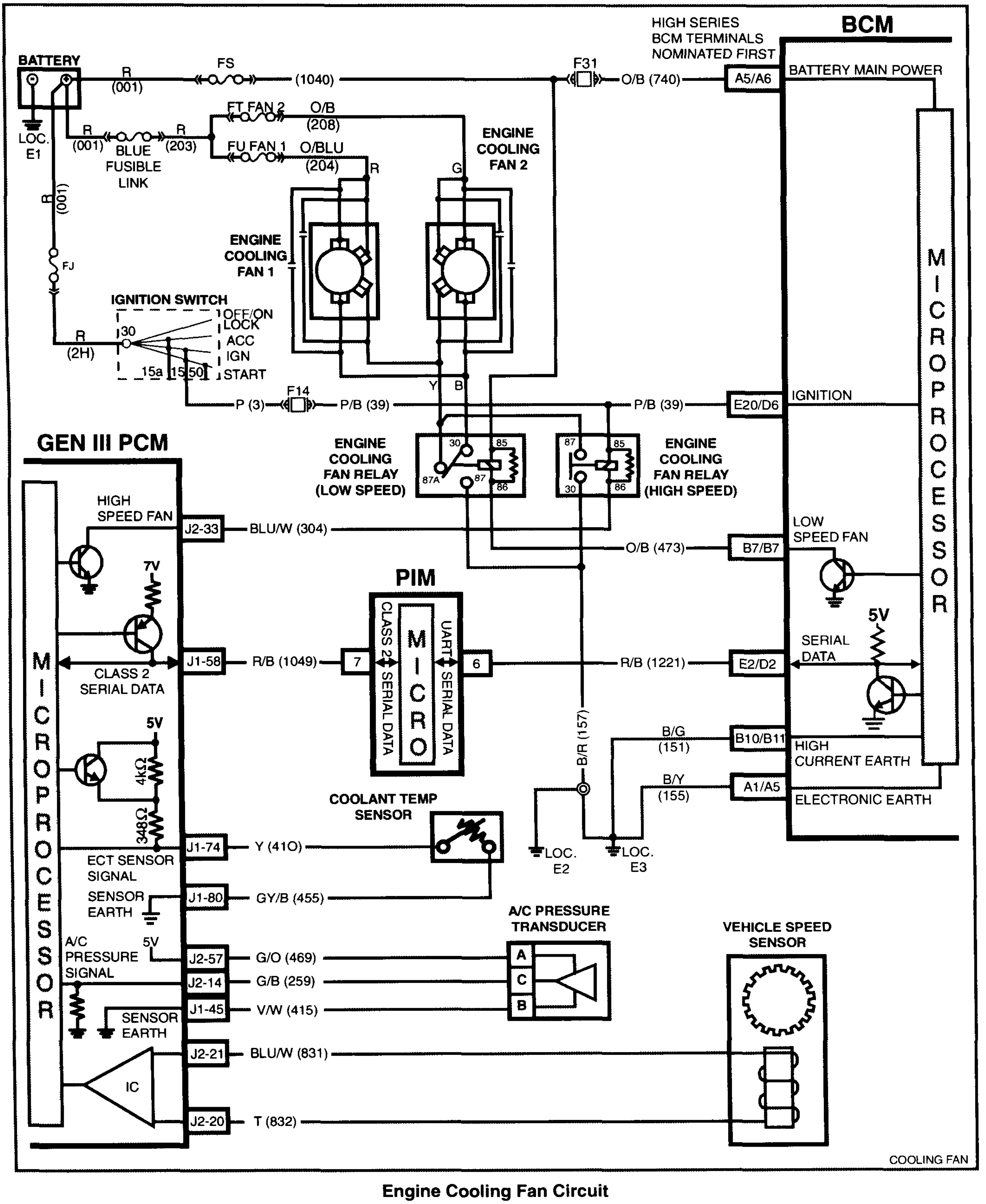
If the low speed fan was OFF when the criteria was met to turn the high speed fan ON, the high speed fan will come ON 5 seconds after the low speed fan is turned ON. If both the engine cooling fan relays are ON, the PCM will turn OFF the high speed relay when:

- The engine coolant temperature is less than 102°C.
- A/C request not indicated (NO).
- A/C request indicated (YES) and A/C pressure is less than 1900 kPa.

Note: All cooling fans will be turned off in the vehicle speed is greater than 104 kph.

Low Speed Response

The engine cooling fan Low Speed Relay is energised by the BCM. When the PCM determines that the low speed fan relay should be enabled, the PCM will send a message on the Class II serial data circuit to the PIM. The PIM will inturn convert the PCM Class 2 message to a UART message and supply this UART message to the BCM. This message will request the BCM to supply the needed earth signal for the Low Speed Relay to operate. After the BCM provides the earth signal for the Low Speed Relay, the BCM will send a message back to the PIM confirming that the earth signal was commanded. A failure in this response communication will cause a PIM DTC B2002 to set.



Engine Cooling Fan Circuit

A failure in the Cooling Fan Circuits will set one of the following DTCs:

DTC P0481 Cooling Fan High Speed Relay Control

Conditions for running DTC P0481

- The engine speed is greater than 600 RPM.
- The ignition voltage is between 6.0 and 16.0 volts.

Conditions for setting DTC P0481

- The PCM detects that the commanded state of the circuit and the actual state of the circuit do not match.
- The conditions must be present for at least 10 seconds.

Action taken when DTC P0481 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0481

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

Powertrain Interface Module DTC B2002 Low Speed Fan No BCM Response

Conditions for running DTC B2002

- The ignition is on.

Conditions for setting DTC B2002

- The PIM sends a Low Speed Request to the BCM, with no Low Speed Response back from the BCM.

Action taken when DTC B2002 Sets

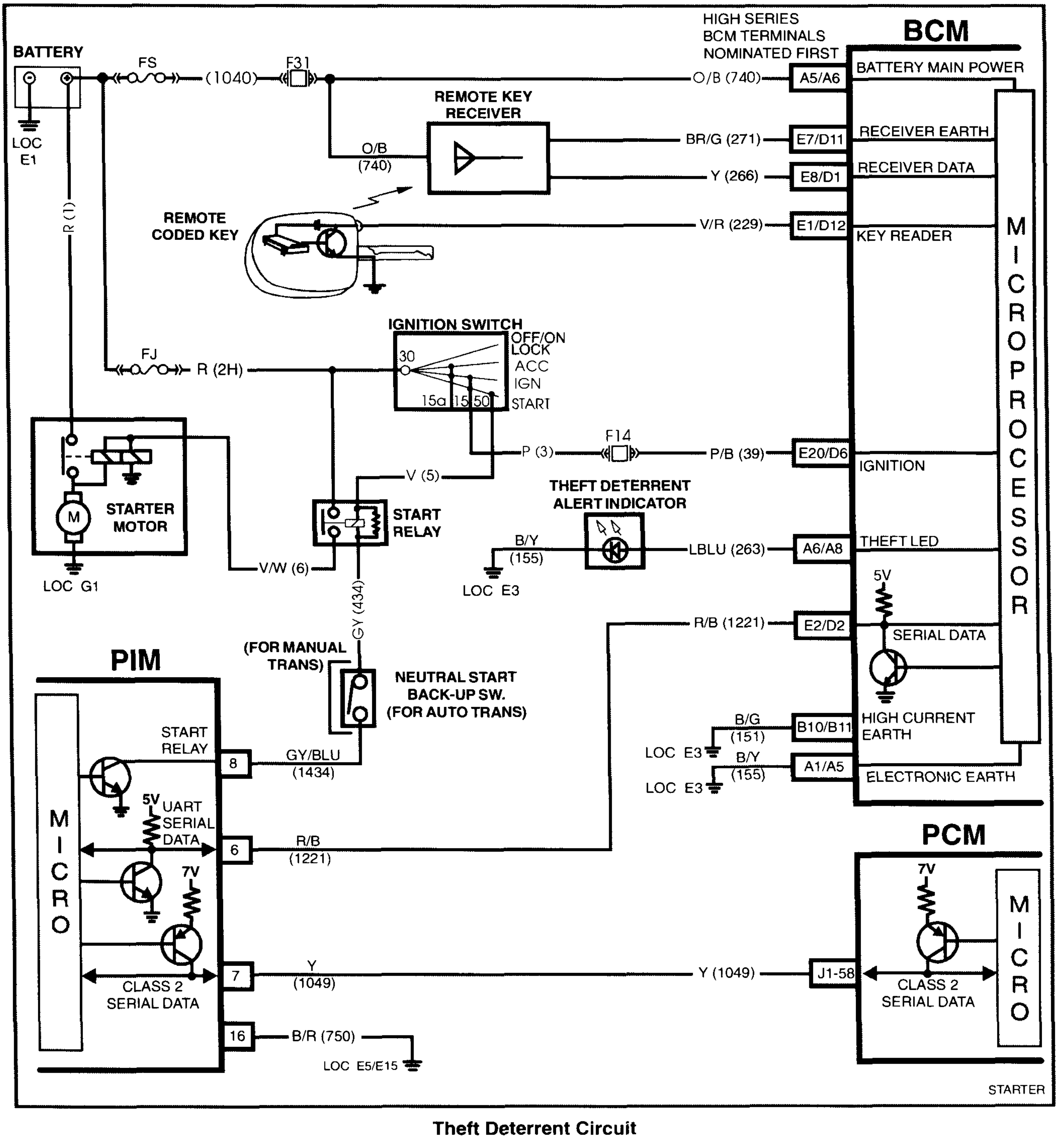
- The DTC will set when the diagnostic runs and fails.
- The Check Powertrain Lamp will not be illuminated.

Conditions for clearing DTC B2002

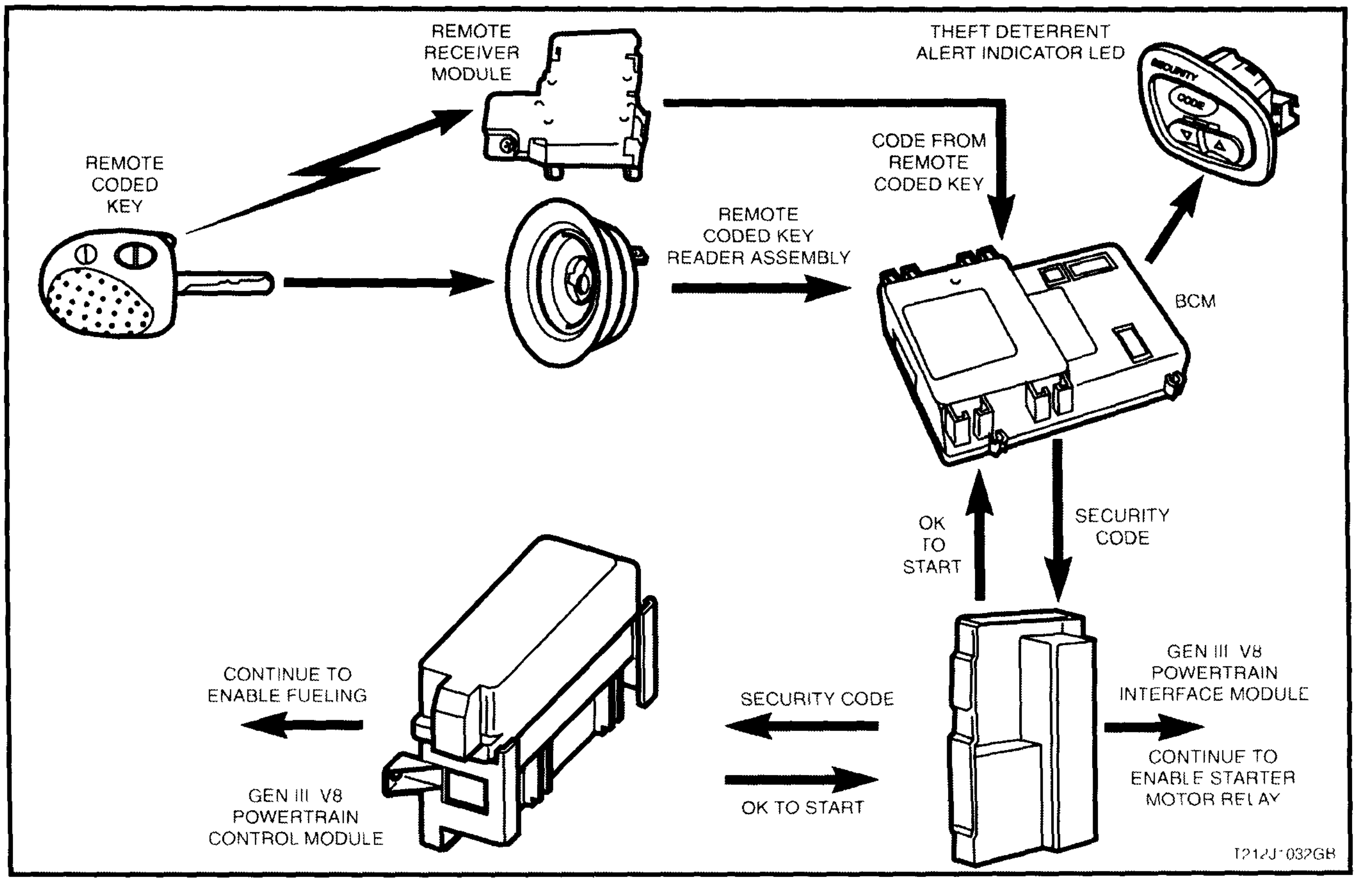
- A current DTC will clear when the PIM receives a Low Speed Fan Response from the BCM.

THEFT DETERRENT INPUT

When the ignition switch is turned from off to on, the BCM will transmit security information to the PIM via the DART serial data bus, circuit 1221. The PIM compares the received security information with it's stored security information and if the information matches, the PIM will enable the starter relay, and supply security information (password) via Class II Serial Data to the PCM. If this password matches the password stored in the PCM, the system enables the fuel injection. The PCM will return an OK to start message to the BCM via the PIM, which tells the BCM to switch from short loop mode to the long loop mode. If the PIM does not send a password or if the PCM does not receive it, the vehicle will not start unless the PCM is in Vehicle Theft Deterrent (VTD) Fail-Enable mode. The BCM will only transmit the correct security information to the PIM if the BCM has been disarmed via the remote coded key. If the BCM, PIM or PCM lose communications with each other after the system has received the correct password, the PCM goes into VTD Fail-Enable mode. This allows the driver to restart the vehicle on future ignition cycles until communications between the BCM, PIM or PCM are restored. If the BCM, PIM or PCM lose communications before the PCM receives the BCM password, the PCM disables the fuel injection until communication is restored. In both cases DTC P1626 sets. The PCM will not disable the fuel injection once the PCM enables the fuel within a given ignition cycle in order to prevent stalling as a result of theft deterrent system faults.



Theft Deterrent Circuit



Theft Deterrent System

A failure in the Theft Deterrent System or Circuits will set one of the following DTCs:

DTC P1626 Theft Deterrent System Fuel Enable Circuit

Conditions for running DTC P1626

- The engine is cranking.

Conditions for setting DTC P1626

- The system has reached fuel enable decision point.
- The PCM is in Fail Enable Mode due to loss of communication with the PIM after the system received the correct password earlier in the ignition cycle.
- The PCM does receive the password message from the PIM prior to the theft deterrent Fuel Decision Point.

Action taken when DTC P1626 Sets

- The PCM enables the fuel injection on future ignition cycles only if the PCM is in Fail-Enable Mode.
- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
  NOTE: This DTC is usually set if communication is lost. The Check Powertrain Lamp may not operate.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P1626

- A last test failed (Current DTC) will clear when the diagnostic runs and does not fail.

DTC P1630 Theft Deterrent Powertrain Control Module In Learn Mode

Conditions for running DTC P1630

- The PCM is in the learn password mode.

Conditions for setting DTC P1630

- The PCM is ready to learn a new password from the PIM, but the PIM is not sending a valid password or not sending a password at all.

Action taken when DTC P1630 Sets

- The engine cranks but may not start.
- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P1630

- The last test failed (Current DTC) will clear when the diagnostic runs and does not fail.

DTC P1631 Theft Deterrent Password Incorrect

Conditions for running DTC P1631

- The ignition is on and the PCM is waiting for the correct password.

Conditions for setting DTC P1631

- The PCM detects an incorrect password from the PIM.

Action taken when DTC P1631 Sets

- The engine may crank but will not start.
- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

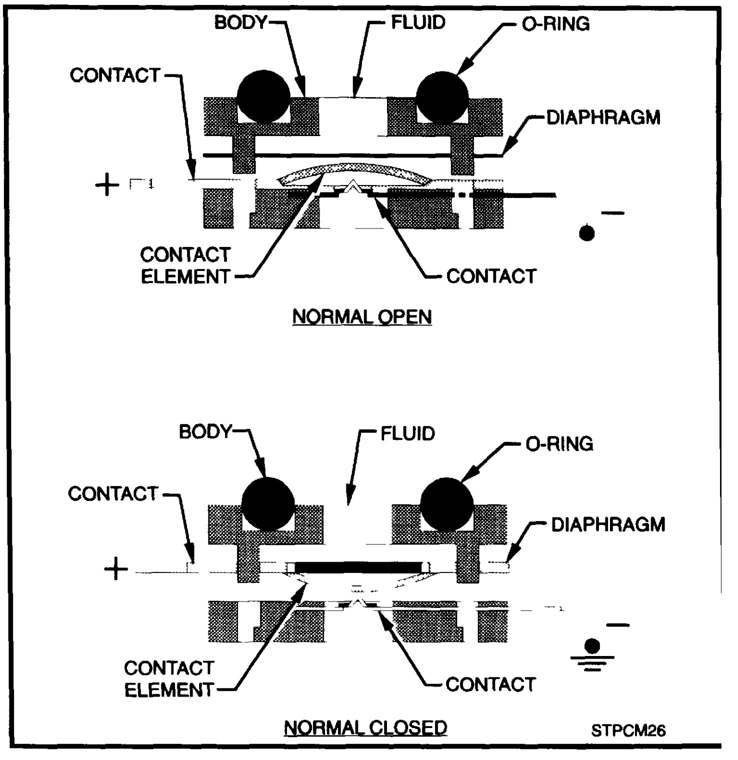
Conditions for clearing the Check Powertrain Lamp and DTC P1631

- A last test failed (Current DTC) will clear when the diagnostic runs and does not fail.

TRANSMISSION FLUID PRESSURE MANUAL VALVE POSITION SWITCH ASSEMBLY

This gear range sensing device called a Transmission Fluid Pressure (TFP) manual valve position switch assembly is used by the PCM to sense which gear range has been selected by the vehicle operator. The TFP manual valve position switch is located on the valve body and consists of five pressure switches, two normally closed and three normally open, combined into one unit.

The normally open fluid pressure switches are the D4, LO and Reverse fluid pressure switches. They are normally open and electrical current is stopped at these switches when no fluid pressure is present. Fluid pressure moves the diaphragm and contact element until the contact element touches both the positive contact and the earth contact. This creates a closed circuit and allows current to flow from the positive contact, through the switch and to earth. The normally closed fluid pressure switches are the D2 and D3 fluid pressure switches. They are normally closed and electrical current is free to flow from the positive contact to the earth contact when no fluid pressure is present. Fluid pressure moves the diaphragm to disconnect the positive and earth contacts. This opens the switch and stops current from flowing through the switch.



Transmission Fluid Pressure (TFP) Manual Valve Position Switch

The PCM applies system voltage to the TFP manual valve position switch assembly on three separate wires. An open circuit measures 12 Volts while an earthed circuit measures 0 Volts. The switches are opened or closed by fluid pressure. The combination of which switches are open and closed is used by the PCM to determine actual manual valve position. The TFP manual valve position switch assembly however cannot distinguish between park and neutral because the monitored valve body pressures are identical in both cases.

LO This switch will have hydraulic pressure applied to it in manual 1st gear only and will be closed.

REV This switch will have hydraulic pressure applied to it in reverse only and will be closed.

D2 This switch will have hydraulic pressure applied to it in manual 1st and 2nd gear and will be open.

D3 This switch will have hydraulic pressure applied to it in manual 1st, 2nd and 3rd gear and will be open.

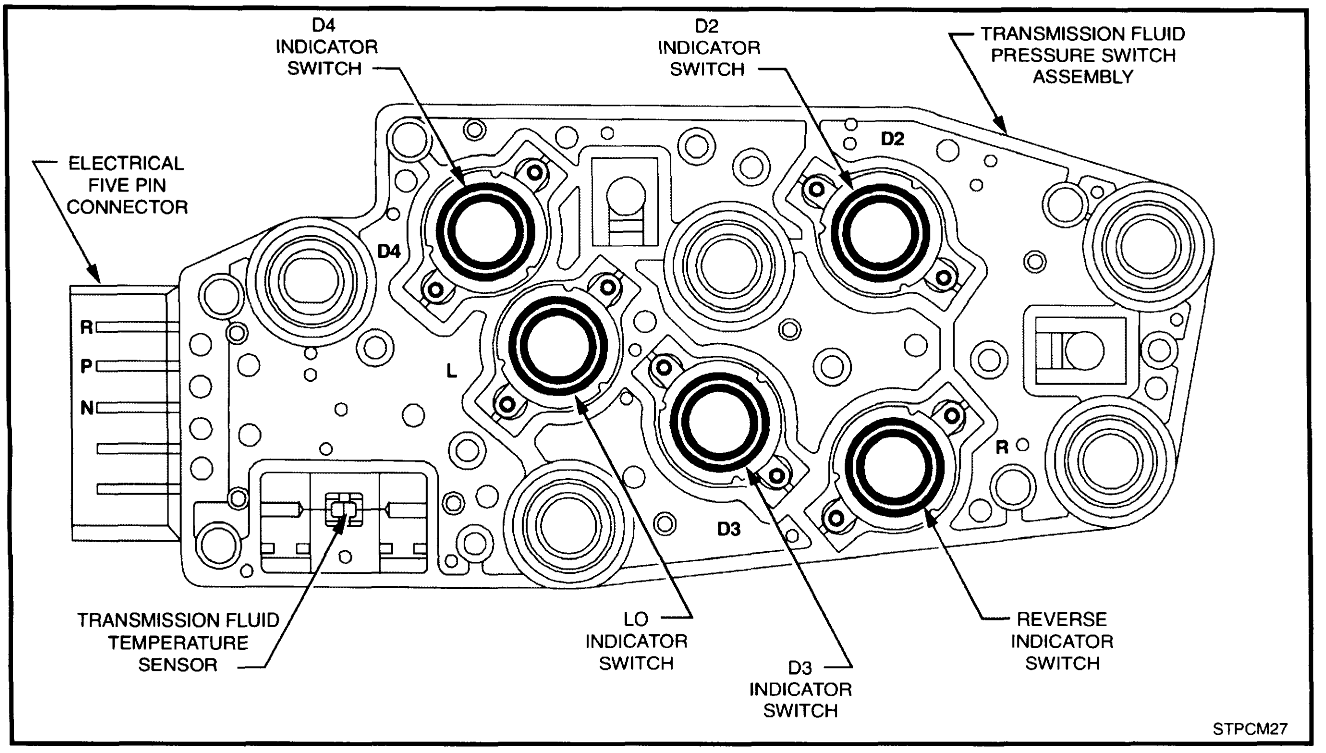
D4 This switch will have hydraulic pressure applied to it in all drive gears except reverse and will be closed.

RANGE	FLUID PRESSURE				
INDICATOR	REV	D4	D3	D2	LO
PARK					
REVERSE	X				
NEUTRAL					
D		X			
3		X	X		
2		X	X	X	
1		X	X	X	X

Pressure Applied to TFP Manual Valve Switches

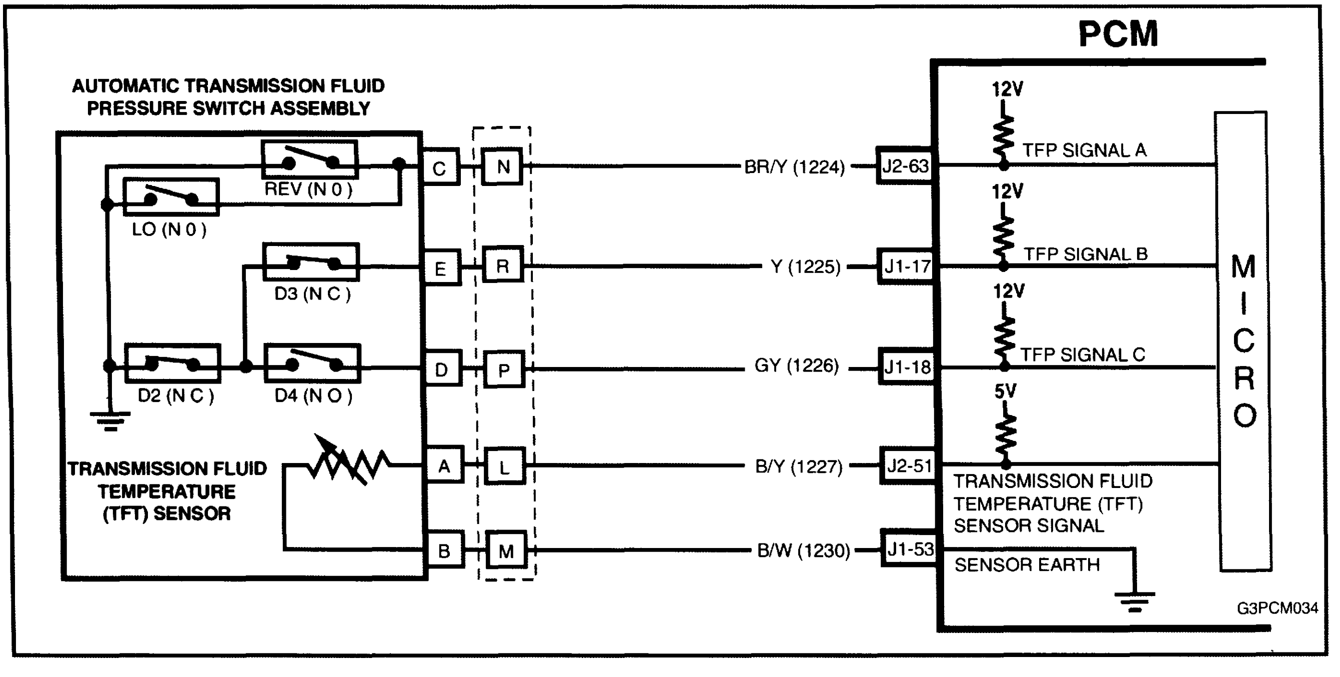
These TFP manual valve position switch inputs are used to help control line pressure, torque converter clutch apply and shift solenoid operation. To monitor TFP manual valve position switch operation, the PCM compares the actual voltage combination of the switches to a TFP manual valve position switch combination chart stored in its memory.

There are two possible combinations of the switches within the TFP manual valve position switch assembly that do not represent an actual gear range. If either of these combinations are detected by the PCM, DTC 1810 will set. DTC 1810 will also set if a valid gear range combination appears at the wrong time.



Transmission Fluid Pressure Manual Valve Switch Assembly

VALID COMBINATION CHART			
	RANGE SIGNAL A	RANGE SIGNAL B	RANGE SIGNAL C
PARK	12V / OPEN	0V / EARTHED	12V / OPEN
REVERSE	0V / EARTHED	0V / EARTHED	12V / OPEN
NEUTRAL	12V / OPEN	0V / EARTHED	12V / OPEN
D	12V / OPEN	0V / EARTHED	0V / EARTHED
3	12V / OPEN	12V / OPEN	0V / EARTHED
2	12V / OPEN	12V / OPEN	12V / OPEN
1	0V / EARTHED	12V / OPEN	12V / OPEN
ILLEGAL	0V / EARTHED	12V / OPEN	0V / EARTHED
ILLEGAL	0V / EARTHED	0V / EARTHED	0V / EARTHED



TFP Switch Assembly Circuit

A failure in the TFP Switch Assembly or Circuits will set the following DTCs:

DTC P1810 TFP Valve Position Switch Circuit

Conditions for running DTC P1810

- No VSS assembly DTCs P0502 or P0503 are set.
- The system voltage is between 8-18 volts.
- The engine speed is greater than 300 RPM for at least 5 seconds.
- The engine is not in fuel cutoff.
- The engine torque is between 54-542 Nm.
- The Map reading is between 0-105 kPa.

Conditions for setting DTC P1810

- DTC P1810 sets if any of the following conditions occurs:

  Condition 1

  - The PCM detects an invalid TFP manual valve position switch state for 60 seconds.

  Condition 2

  - The engine speed is less than 80 RPM for 0.1 second; then the engine speed is 80-550 RPM for 0.07 second; then the engine speed is greater than 550 RPM.
  - The vehicle speed is less than 3 km/h.
  - The PCM detects a gear range of 2, D or R during an engine start.
  - All conditions are met for at least 5 seconds.

  Condition 3

  - The TP angle is 8-45%.
  - The PCM commands fourth gear.
  - The TCC is locked ON.
  - The speed ratio is 0.65-0.8 (speed ratio is engine speed divided by transmission output speed).
  - The PCM detects a gear range of P or N when operating in D.
  - All conditions are met for 10 seconds.

Action taken when DTC P1810 Sets

- The PCM illuminates the Check Powertrain Lamp during the second consecutive trip in which the conditions for setting the DTC are met.
- The PCM commands D2 line pressure.
- The PCM commands a D4 shift pattern.
- The PCM freezes shift adapts from being updated.
- The PCM stores DTC P1810 in PCM history during the second consecutive trip in which the conditions for setting the DTC are met.

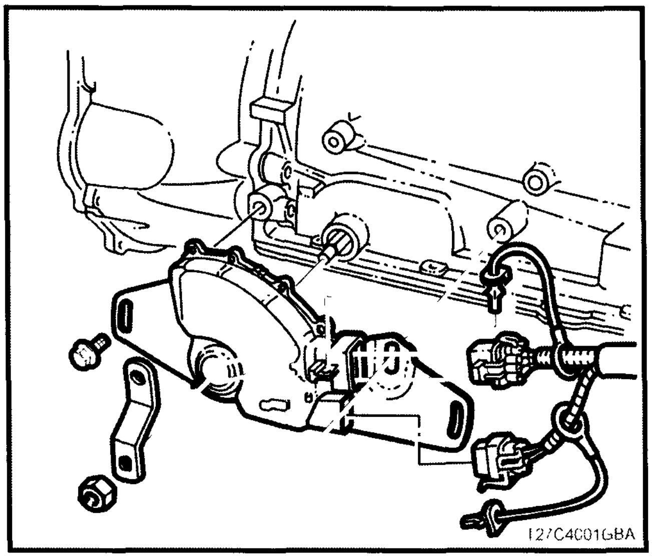
Conditions for clearing the Check Powertrain Lamp and DTC P1810

- The PCM turns OFF the Check Powertrain Lamp during the trip in which the diagnostic test runs and passes.
- The PCM clears the DTC from the PCM history if the vehicle completes 40 warm-up cycles without this or another related diagnostic fault occurring.

PARK, REVERSE, NEUTRAL, DRIVE, LOW (PRNDL) SWITCH

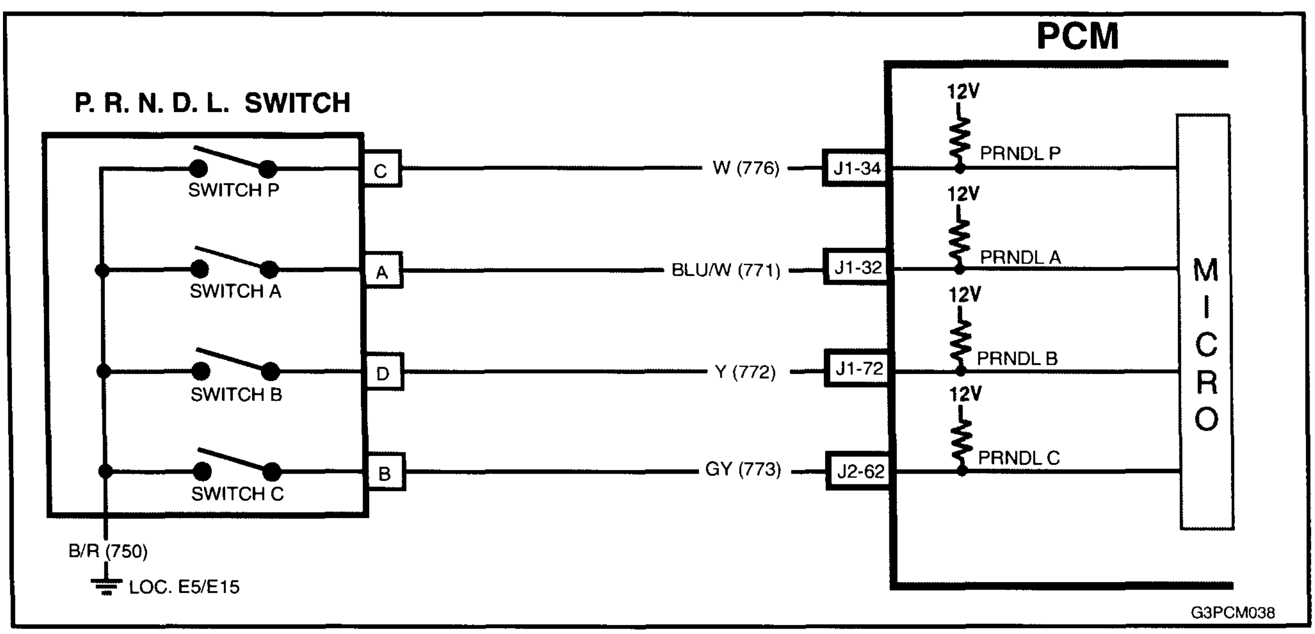
The transmission PRNDL switch is a multi-signal switch which sends signals to the PCM to indicate gear lever position, Park, Reverse, Neutral, Drive, 3, 2, or 1 . The PCM will then determine the signal from the PRNDL switch and send a command to the instruments via the PIM and the serial data normal mode message commanding the instruments to turn ON the correct gear indicator lamp for the gear that is has been selected.

The PRNDL switch uses four discrete circuits to pull four PCM voltages low in various combinations to indicate each gear range. The voltage level of the circuits is represented as CLOSED = earthed, and OPEN = open circuit. The four states displayed represents P, A, B, and C inputs.



PRNDL Switch

GEAR POSITION SELECTED	TECH 2 PRNDL DISPLAY (P, A, B, C)			
	P	A	B	C
PARK (P)	CLOSED (0V)	CLOSED (0V)	OPEN (12V)	OPEN (12V)
REVERSE (R)	OPEN (12V)	CLOSED (0V)	CLOSED (0V)	OPEN (12V)
NEUTRAL (N)	CLOSED (0V)	OPEN (12V)	CLOSED (0V)	OPEN (12V)
DRIVE 4 (D)	OPEN (12V)	OPEN (12V)	CLOSED (0V)	CLOSED (0V)
DRIVE 3 (3)	CLOSED (0V)	CLOSED (0V)	CLOSED (0V)	CLOSED (0V)
DRIVE 2 (2)	OPEN (12V)	CLOSED (0V)	OPEN (12V)	CLOSED (0V)
DRIVE 1 (1)	CLOSED (0V)	OPEN (12V)	OPEN (12V)	CLOSED (0V)



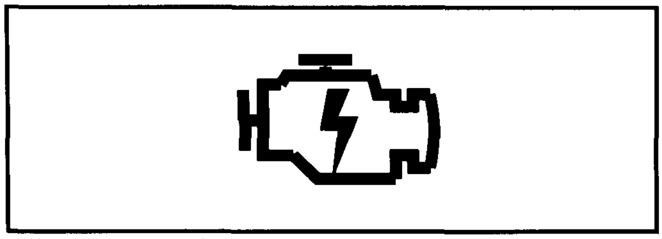
PRNDL Switch Circuit

CHECK POWERTRAIN LAMP

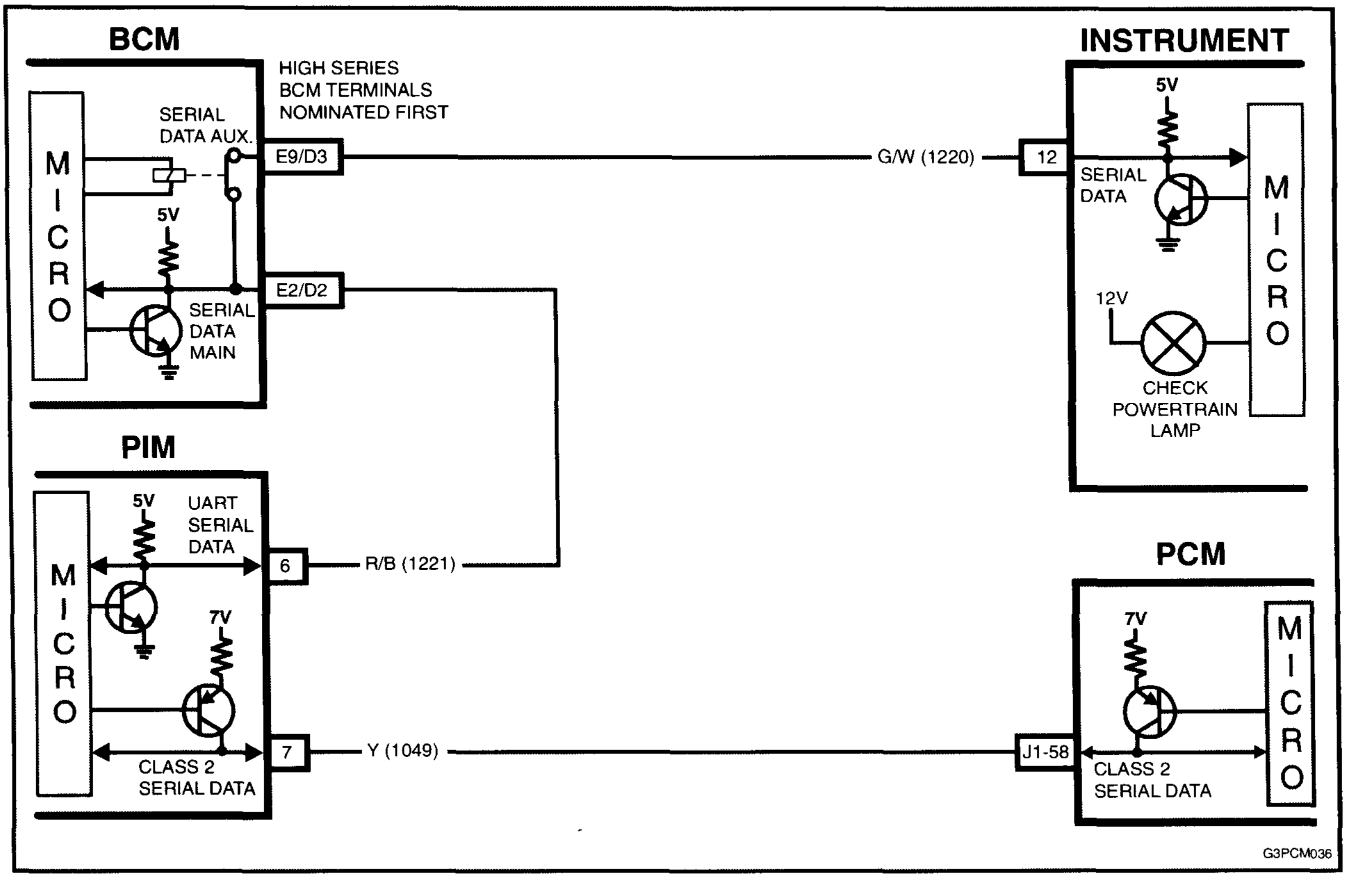
The instruments receive Check Powertrain Lamp information (CPL) from the PCM via the PIM and the serial data bus normal mode message.

The PCM will command the instruments to turn on the Check Powertrain Lamp for two seconds when the ignition is first turned on and when a DTC has been set and the DTC requires the lamp to be illuminated.

If the instruments do not receive a normal mode message from the PCM, the Check Powertrain Lamp will be illuminated continuously.



Check Powertrain Lamp



Check Powertrain Lamp Circuit

IGNITION SYSTEM

The ignition system on the GEN III V8 engine features a multiple coil ignition and is known as coil near plug. The spark plug leads are short compared with a distributor ignition system. Eight ignition coils/modules are individually mounted above each cylinder on the rocker covers and fire sequentially. There is an Ignition Control (1C) circuit for each ignition coil/module. The eight ignition control circuits are connected to the PCM. All timing decisions are made by the PCM, which triggers each coil/module individually. Each ignition coil/module has a power feed, an earth circuit and a reference low circuit.

Ignition System Overview

The electronic ignition system provides a spark to ignite the compressed air/fuel mixture at the correct time. To provide optimum engine performance, fuel economy, and control of exhaust emissions, the PCM controls the spark advance of the ignition system.

The electronic ignition system does not use the conventional distributor and coil. The ignition system consists of the following components:

- Eight ignition coils/modules
- Eight Ignition Control (1C) circuits
- Camshaft Position (CMP) sensor
- 1 X Camshaft reluctor wheel
- Crankshaft Position (CKP) sensor
- 24X Crankshaft reluctor wheel
- Powertrain Control Module (PCM)

Ignition Coils

This system puts out very high ignition energy for plug firing. Because the spark plug leads are shorter, less energy is lost to spark plug lead resistance. Also, since the firing is sequential, each coil has far more time to saturate as opposed to the three in a waste spark arrangement. Furthermore, no energy is lost to the resistance of a waste spark system. The ignition coil/modules are fused separately for each bank of the engine are supplied with the following circuits:

- Ignition feed circuit
- Ignition control circuit
- Earth circuit
- Reference low circuit

Circuits Affecting Ignition Control

To properly control ignition timing, the PCM relies on the following information:

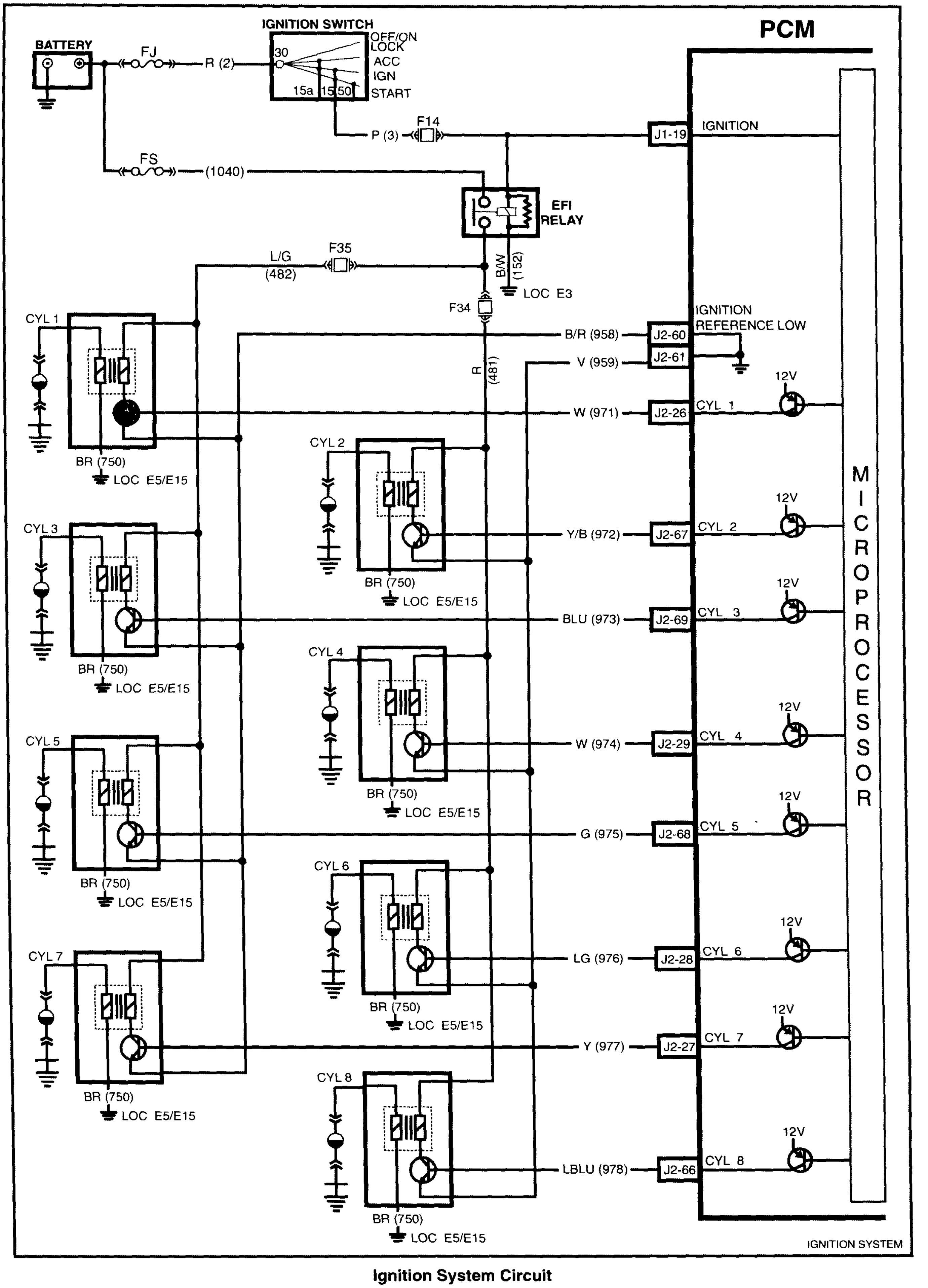
- Mass Air Flow
- Engine Load (manifold pressure or vacuum)
- Atmospheric (Barometric) Pressure
- Engine Coolant Temperature
- Intake Air Temperature
- Throttle Position Sensor
- Crankshaft Position
- Engine Speed (RPM)
- Automatic Transmission Range from the Transmission Range switch.

The PCM is responsible for maintaining correct spark and fuel injection timing for all driving conditions. To provide optimum driveability and emissions. The PCM calculates the desired spark advance from information received from the sensors and triggers the appropriate ignition coil/modules at the desired time to provide the spark advance needed.

Results Of Incorrect Operation

An ignition control circuit that is open, earthed, or short circuited will set an ignition control circuit DTC. If a fault occurs in the 1C output circuit when the engine is running, the engine will experience a misfire. DTCs P0351-P0358 will set when a malfunction is detected with an Ignition Control circuit.

If the engine cranks but will not run or immediately stalls, Engine Cranks But Will Not Run diagnostic table must be used to determine if the failure is in the ignition system or the fuel system. If DTC P0341, P0342, P0343, P0335, P0336 is set, the appropriate diagnostic trouble code table must be used for diagnosis.



Ignition System Circuit

A failure in the Ignition System Coils/Modules or Circuit will set one of the following DTCs:

DTC P0351 Ignition Control #1 Circuit
DTC P0352 Ignition Control #2 Circuit
DTC P0353 Ignition Control #3 Circuit
DTC P0354 Ignition Control #4 Circuit
DTC P0355 Ignition Control #5 Circuit
DTC P0356 Ignition Control #6 Circuit
DTC P0357 Ignition Control #7 Circuit
DTC P0358 Ignition Control #8 Circuit

Conditions for Running the DTC

- The ignition voltage is between 9.0 volts and 17.0 volts.

Conditions for setting DTC

- The PCM detects the ignition control circuit is earthed, open or shorted to a voltage.
- All conditions met for at least 15 seconds.

Action taken when DTC Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC

- The PCM turns the Check Powertrain Lamp OFF when the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

FUEL SYSTEM

BASIC FUEL SYSTEM OPERATION

The fuel control system used on the GEN III V8 is a "Returnless" or "Demand" system. The fuel system starts with the fuel in the fuel tank. A single in-tank high pressure fuel pump with an integrated fuel pressure regulator (located inside a modular fuel sender assembly) is used. From the high pressure pump, fuel flows through a fuel filter, then back into the fuel tank via the fuel pressure regulator. Fuel is supplied to the fuel rail and injectors by a single fuel feed line.

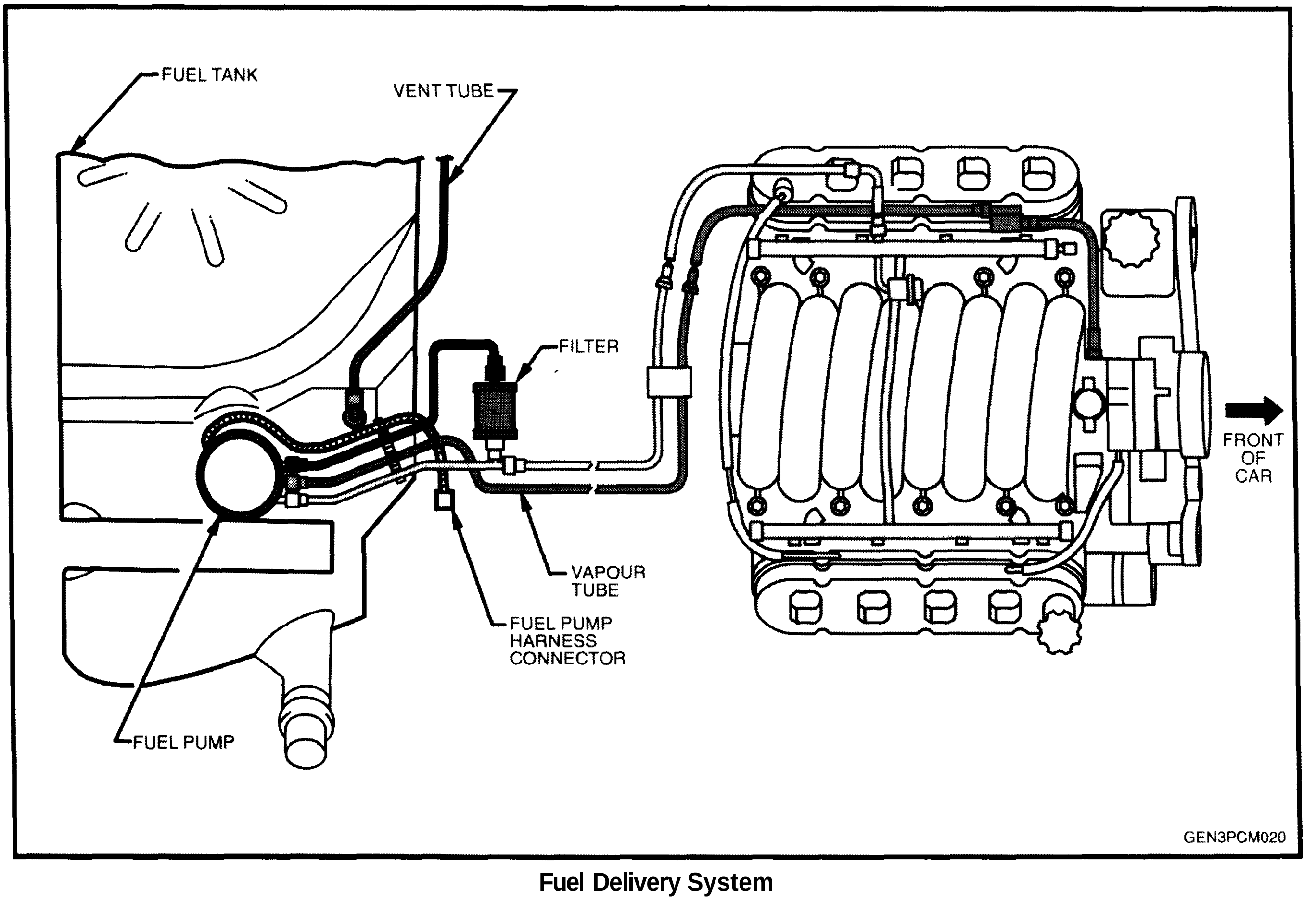
The high pressure in-tank single pump is capable of providing fuel at more than 410 kPa. A pressure regulator in the modular fuel sender assembly maintains the fuel pressure at a regulated pressure of 410 kPa.

The injectors, located in each runner of the intake manifold just ahead of the inlet ports to the cylinder head, are controlled by the PCM. They deliver fuel in one of several modes. The fuel pump is energised by the PCM via the fuel pump relay.

SYSTEM COMPONENTS

The Fuel Control System is made up of the following components:

- PCM
- Fuel Tank
- Modular fuel sender assembly
    - Fuel pump assembly
    - Fuel pressure regulator
- Fuel filter
- Fuel pressure supply line
- Fuel pump relay
- Fuel rail
- Injectors



Fuel Delivery System

Gerotor Fuel Pump Operation

Fuel passes through the pump in two distinct stages;

Vapour Separation

The first fill impeller section of the pump assembly consists of an inlet body (4), impeller (6), umbrella check valve (3), and inlet plate (8). A seal (2) at the pump inlet prevents air leaks and also functions as a vibration isolator. The fuel pump is primed as bulk fuel enters the pump at the inlet body (4) and flows from the inlet body to the rotating impeller (6). The centrifugal force set up by the impeller, separates and expels vapour from the fuel. Following separation, liquid fuel is transferred to the high pressure section, while the separated vapour is forced back to the tank through a vent at the pump inlet.

An umbrella check valve (3) is used at the impeller section to prevent air from entering through the vapour port and to vent any fuel vapour that may have collected in the pump during shut down. This allows for faster priming at low fuel levels.

High Pressure Vapour Separation

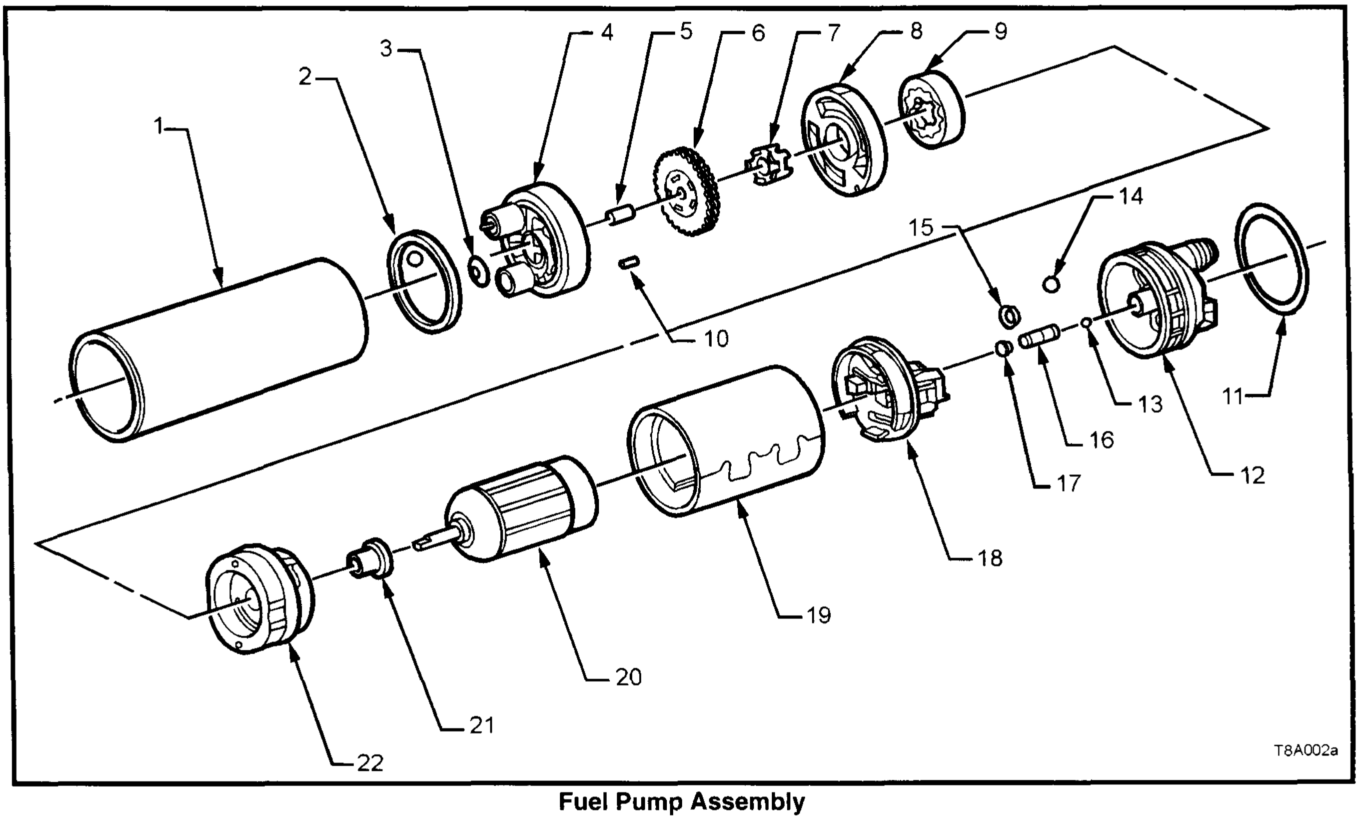
The second stage of the pumping section is a high pressure, positive displacement Gerotor design pump (similar to that commonly used in engine oil pumps) that creates the high pressures required for the fuel injection system. The Gerotor section contains a composite bushing (21), an inner and outer rotor (9), an inlet plate (8) and plate and ring assembly (22). Stainless steel pins (10) keep the pump elements aligned.

As the inner rotor is turned, liquid fuel from the impeller section is drawn into the high pressure Gerotor, through the inlet ports. The inner rotor and outer rotor then transport the fuel to the outlet porting at a constant volume, in order to reduce pressure pulses. The decreasing volume of the pumping chamber at the outlet ports creates positive flow to the engine fuel system.

Attached to the pump outlet is a diverter that allows the primary fuel volume to flow into the flex pipe and also deliver a portion of the flow to the jet pump assembly.

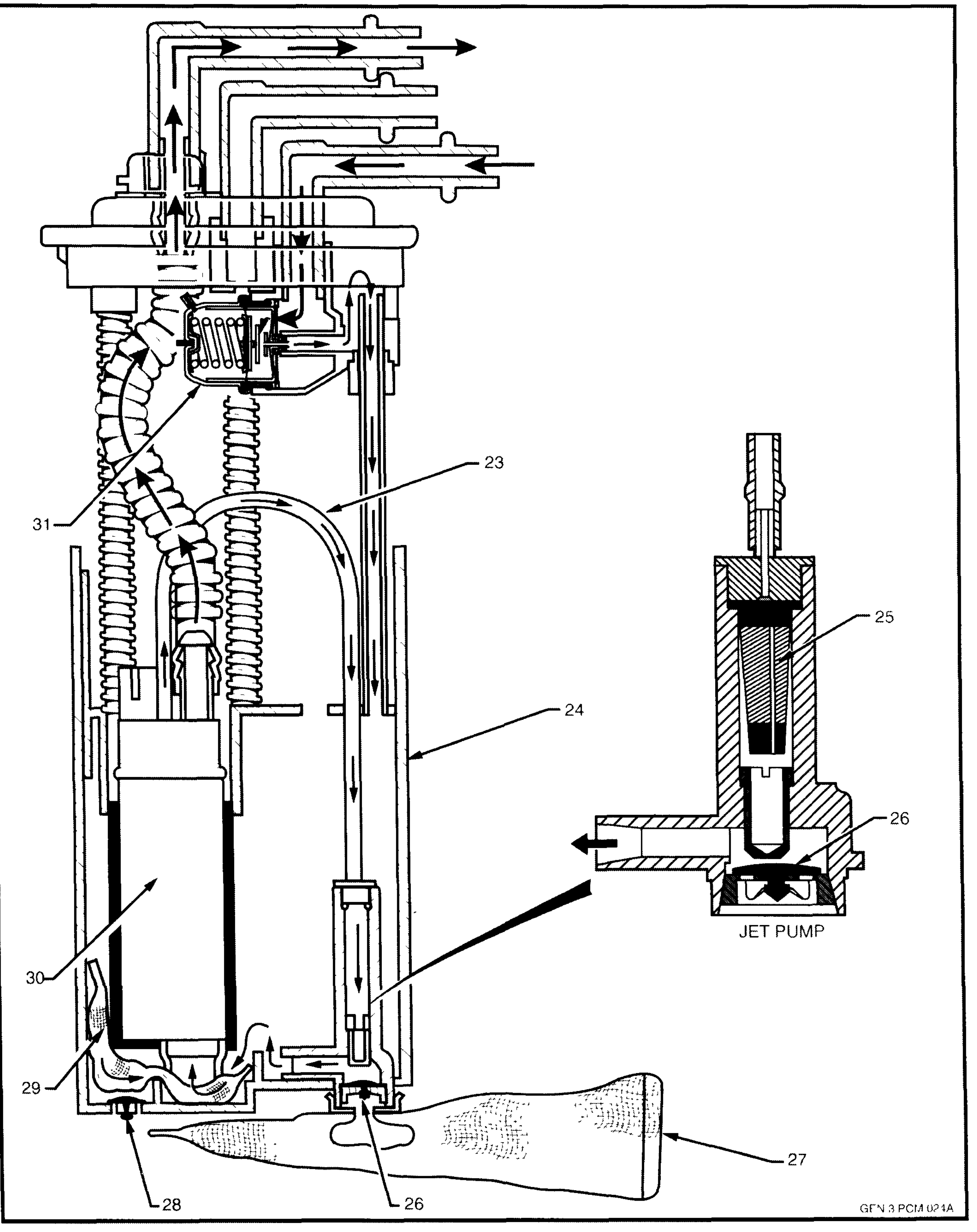
Action of this diverted fuel from the outlet of the fuel pump, passing through the jet pump, creates a low pressure area at its base, causing the umbrella valve (26) to unseat, drawing cooler fuel into the reservoir.

Fuel enters the high pressure pump stage from the impeller section at a low pressure, and leaves through the outlet ports at a much higher pressure.



Fuel Pump Assembly

1. Shell	**6.** Impeller	**11.** O-Ring	**16.** Relief Valve Spring	**21.** Bushing
2. Pump Inlet Seal	**7.** Driver	**12.** End Cap	**17.** Relief Valve Retainer	**22.** Plate & Ring Assembly
3. Umbrella Check Valve	**8.** Inlet Plate	**13.** Relief Valve Ball	**18.** Carrier Assembly	
4. Pump Inlet Body	**9.** Gerotor Assembly	**14.** Check Valve Ball	**19.** Field Magnet Assembly	
5. Pilot Pin	**10.** Alignment Pin	**15.** Valve Seat	**20.** Armature	



GEN III V8 Modular Fuel Sender Fuel Flow

23. Diverter Pipe
24. Reservoir
25. Jet Pump Filter
26. Primary Umbrella Valve
27. External Filter Screen
28. Secondary Umbrella Valve
29. Internal Filter Screen
30. Gerotor Fuel Pump
31. Pressure Regulator

Modular Fuel Sender Operation

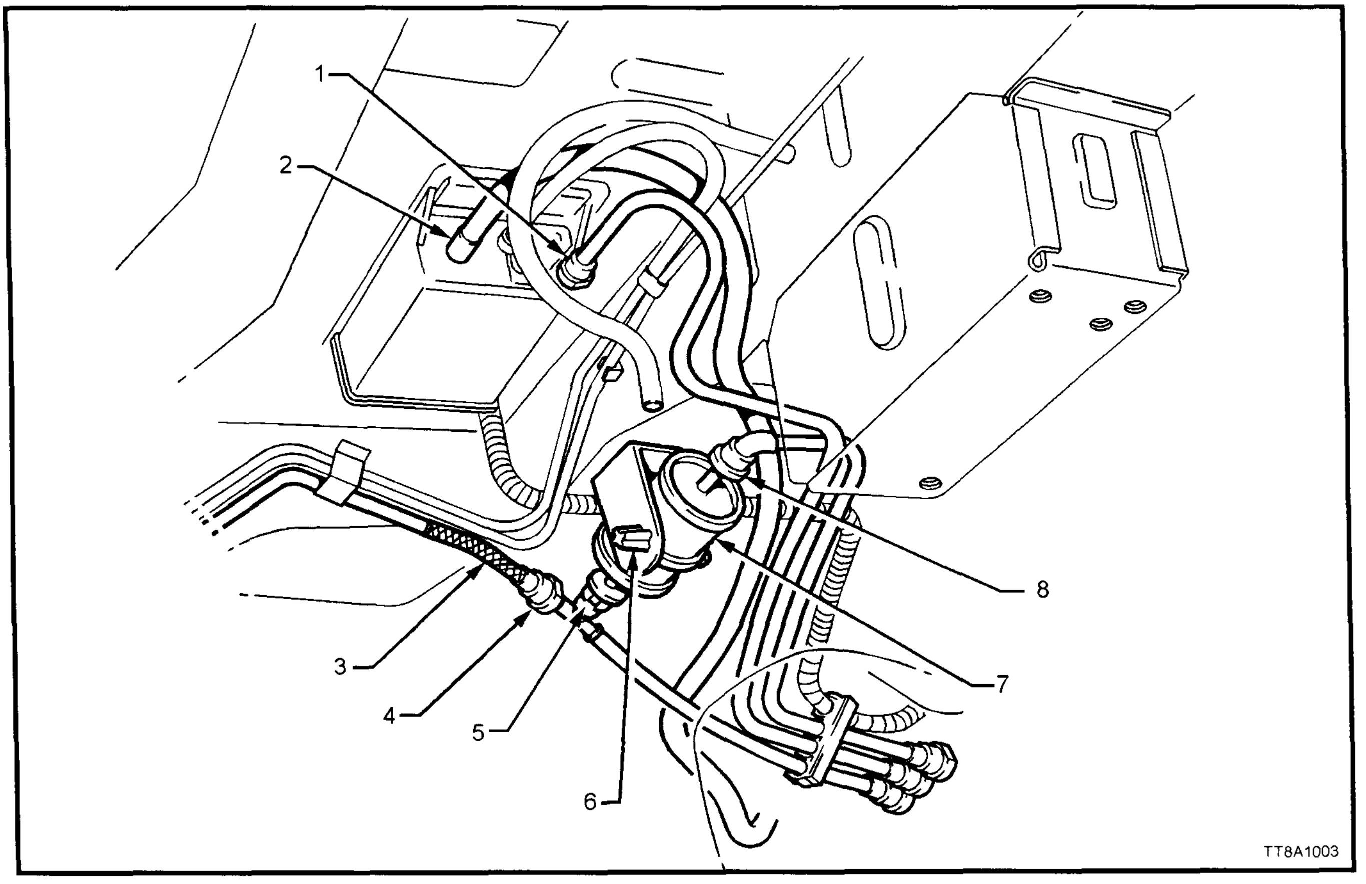
During fuelling, fuel enters the reservoir through the secondary umbrella valve (28), located in the bottom of the reservoir, and self fills to tank levels without jet pump operation When the fuel pump is off, the reservoir remains full Maximum pickup of fuel occurs at the external strainer (27) and the primary umbrella valve (26) Primary fuel flow proceeds to the fuel pump strainer (29) and the impeller stage of the fuel pump Whenever the engine is running, a portion of the pressurised fuel from the bleed at the end cap assembly is directed through the diverter pipe (23) to the jet pump Return fuel empties into the reservoir via the return line

Fuel Sender Assembly Strainers

Fuel sender assembly strainers are located in the fuel tank to separate water from fuel and to prevent foreign particles from entering the system In low fuel conditions, the strainer fabric also acts as a wick to draw sufficient fuel to the inlet of the fuel sender or pump Should the external filter screen become blocked or restrict fuel entry, then the secondary umbrella valve will unseat, allowing fuel to enter the reservoir area Contaminants that pass through the fuel pump are filtered out in the downstream, in-line fuel filter before reaching the injectors Close clearance control between the components prevents internal leakage, ensuring high efficiency pumping

Single Line Fuel Delivery System

High pressure fuel from the Gerotor fuel pump flows through the fuel pump flex pipe and exits the assembly through the fuel feed output fitting on the cover From this point, fuel flows through the in-line filter mounted to a bracket secured to the floor pan Fuel is then directed to the engine bay and fuel rail, where the fuel delivery system then becomes pressurised When this pressure exceeds a pre-determined value, the fuel pressure regulator opens, allowing excess system pressure to discharge back to the module reservoir

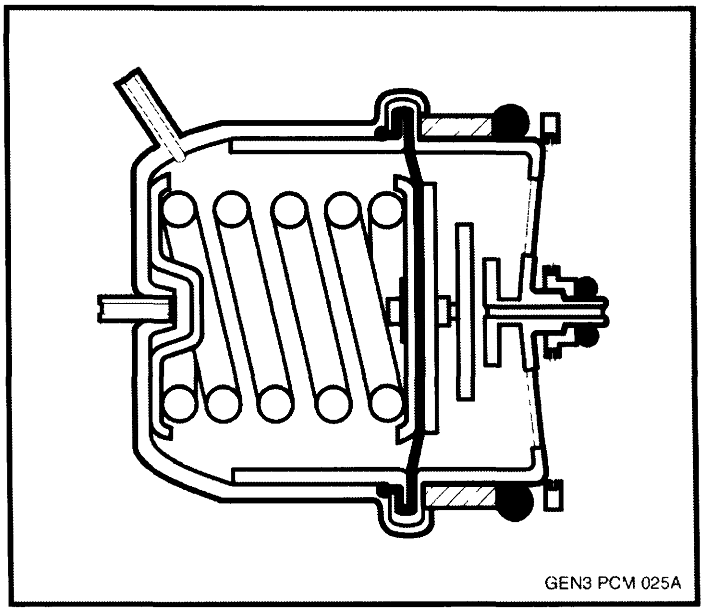


Fuel Lines

1. Quick Connect, Fuel Tank Vapour Line to Canister
2. Filler Neck Breather Hose
3. Flexible Line, Fuel Feed to Engine
4. Quick Connect, Fuel Feed Line
5. Quick Connect, Fuel Filter 'T' piece
6. Retaining Tangs, Fuel Filter Strap
7. Fuel Filter
8. Quick Connect, Fuel Feed Line from Fuel Tank

Fuel Pressure Regulator

The fuel pressure regulator is a diaphragm operated relief valve with fuel pump pressure on one side and atmospheric pressure combined with mechanical spring pressure on the other. The function of the regulator is to maintain a regulated pressure at the injectors at all times by controlling the flow into the return line.

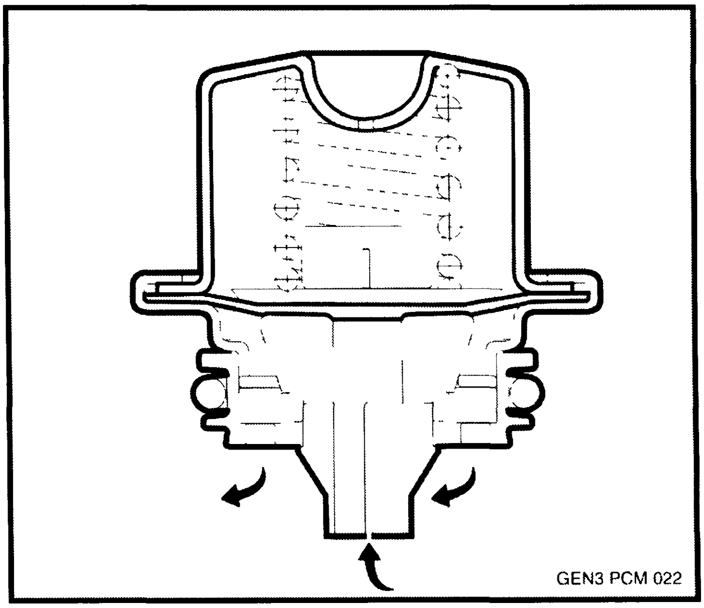


Fuel Pressure regulator

Pulsation Damper

The fuel pulsation damper is located on the fuel rail. The dampener is diaphragm operated with fuel pressure on one side and spring pressure on the other.

IMPORTANT: The procedure detailed in the Service Manual for filter replacement, MUST be followed, both in the sequence of removal and installation of a replacement filter. Failure to observe these instructions will most probably result in permanent damage to the flexible line, resulting in unnecessary parts replacement and expense.

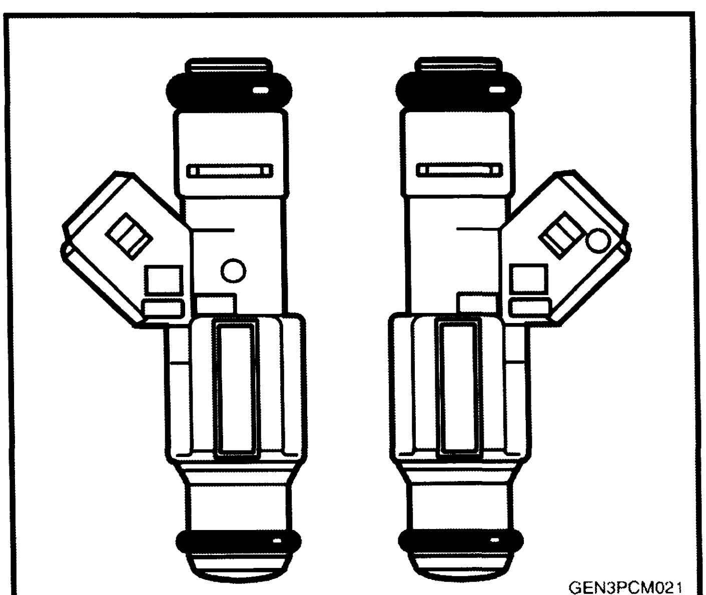


Pulsation Dampener

Fuel Injectors

The director plate top-feed fuel injectors are controlled by the PCM, and meter pressurised fuel to a single engine cylinder. The PCM energises the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate.

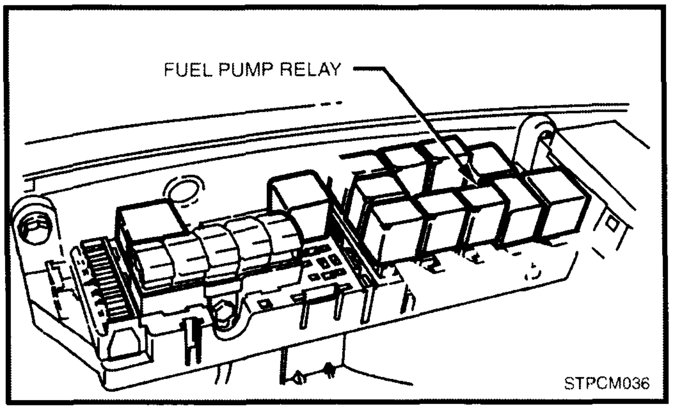
The director plate has multiple machine holes that control the fuel flow, generating a conical spray pattern of finely atomised fuel at the injector tip. Fuel is directed at the intake valve, causing it to become further atomised and vaporised before entering the combustion chamber.



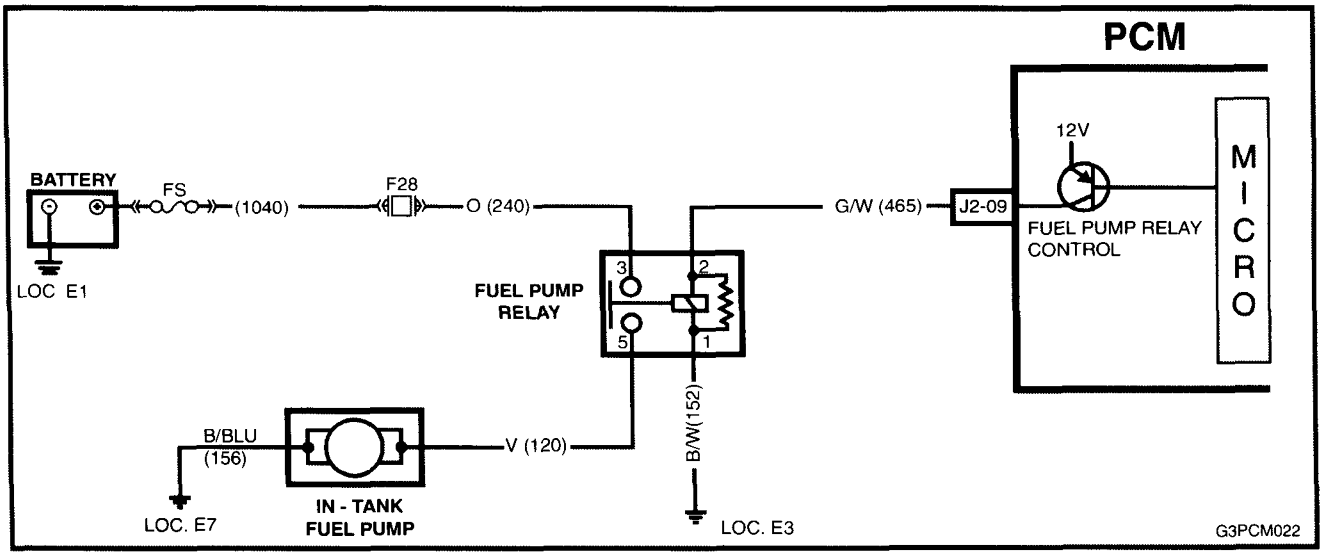
Director Plate Top-Feed Fuel Injectors

FUEL PUMP ELECTRICAL CIRCUITS

When the ignition switch is turned to on or crank after having been off for at least 10 seconds, the PCM will immediately energise the fuel pump relay to operate the fuel pump. This builds up the fuel pressure quickly. If the engine is not cranked within two seconds, the PCM will shut the fuel pump relay off and wait until the engine is cranked. As soon as the engine begins cranking, the PCM will sense the engine turning from the crankshaft position signal, and turn the relay on again to run the fuel pump.



Fuel Pump Relay Location



Fuel Pump Electrical Circuit

A failure in the Fuel Pump or Circuit will set the following DTC:

DTC P0230 Fuel Pump Control Circuit

Conditions for running DTC P0230

- The engine speed is greater than 400 RPM.
- The ignition voltage is between 6.0 volts and 16.0 volts.

Conditions for setting DTC P0230

- The PCM detects that the commanded state of the circuit and the actual state of the circuit do not match.
- All of the above conditions present for at least ten seconds.

Action taken when DTC P0230 Sets

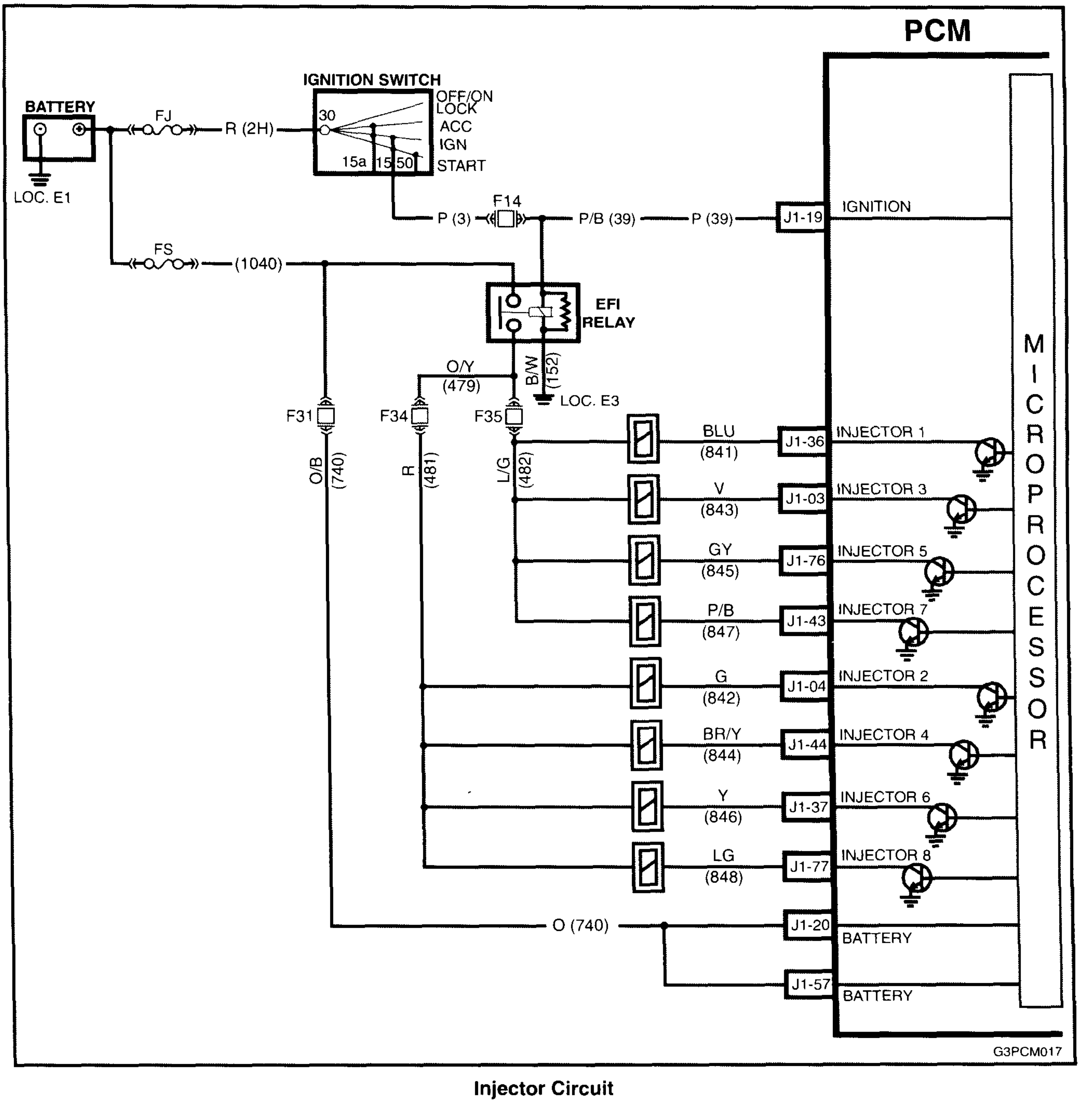
- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0230

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last failed (current DTC) clears when the diagnostic runs and does not fail.

FUEL INJECTORS

The fuel injectors are electrically operated fuel flow control valves. They are supplied with battery voltage from the ignition switch via fuse F14, the EFI relay and fuses F34 and F35. The injectors are controlled by the PCM providing the earth circuit. The injectors are never fully energised on, as that would flood the engine with too much fuel. The PCM supplies the earth circuit in short pulses. The longer the duration of the pulse (pulse width), the more fuel is injected into the engine. Inside, the injectors have a coil of electrical wire that becomes an electromagnet when energised. The resistance of these windings is important for the PCM to operate correctly.



Injector Circuit

FUEL CONTROL SYSTEM

The purpose of closed loop fuel control is to control tailpipe emissions consisting of hydrocarbons (HC), Carbon Monoxide (CO), and Oxides of Nitrogen (NOx) At the same time, the system must achieve good engine performance and good fuel economy

The closed loop system regulates exhaust emissions by controlling the air/fuel ratio at an optimum level during various driving conditions The most efficient air/fuel ratio to minimise exhaust emissions is 147 to 1, this allows the 3-way catalytic converter to operate at maximum efficiency to control exhaust pollutants Because of the constant measuring of the exhaust gases by the oxygen sensors, and adjusting of the fuel injector pulse width by the PCM, the fuel injection system is called a closed-loop control system

FUNCTION

The fuel supply system delivers fuel at a regulated pressure to the fuel rail The fuel injectors, located directly ahead of each inlet port of the cylinder head, act as fuel flow control valves, spraying atomised fuel into the inlet ports when they are electrically pulsed by the PCM The injectors are wired individually so they are pulsed individually This type of fuel injection is referred to as sequential injection because the injectors are individually controlled and in a specific order once every two crankshaft revolutions

The PCM controls the amount of fuel injected into the engine by controlling the length of time the injectors are held open This length-of-time is called pulse width To increase the amount of fuel injected, the pulse width is lengthened, to decrease the amount of fuel injected, the pulse width is shortened

Mass Air Flow System

The Mass Air Flow system is based upon an Air Flow Meter that measures the mass of the air entering the engine

Two specific sensors provide the PCM with the basic information for the fuel management portion of its operation Engine speed (RPM) from the crankshaft position signal and the amount of air entering the engine from the Mass Air Flow (MAF) sensor

Speed Density System

Three specific sensors provide the PCM with the basic information for the Speed Density System Engine speed and air density factors The engine speed (RPM) comes from the Crankshaft Position Sensor Air density is derived from IAT and MAP sensor inputs The IAT sensor measures the air temperature that is entering the engine The IAT signal works in conjunction with the MAP sensor to determine air density As the intake manifold pressure increases, the air density in the intake manifold also increases additional fuel is required This information from the IAT and MAP sensors is used by the PCM to control injector pulse width

The speed density system is used

- In conjunction with the mass air system to determine fueling management
- To monitor Mass Air Flow (MAF) sensor operation (to determine if there is a MAF sensor malfunction)
- To take over fueling management operation when there is a Mass Air Flow (MAF) sensor malfunction

MODES OF OPERATION

Starting Mode

With the ignition switch in the ON position, the PCM energises the fuel pump relay for two seconds, allowing the fuel pump to build system pressure The PCM first checks speed density, then switches to the Mass Air Flow (MAF) sensor The PCM also uses the Engine Coolant Temperature (ECT), Throttle Position (TP), and Manifold Absolute Pressure (MAP) sensors to determine the proper air/fuel ratio for starting This ranges from 8.5:1 to 14.7:1 depending on coolant temperature Once the first crankshaft position signal is received, the PCM will pulse all of the fuel injectors After the first prime pulse has been injected, the PCM will wait until it receives a good camshaft position signal When a good camshaft position signal is received, the PCM then operates the fuel injectors in sequential mode

Sequential Fuel Injection Mode

When the engine is first cranked over, all injectors will be energised simultaneously. After the engine has been started and a good camshaft signal has been processed, the PCM will energise each individual injector in the normal firing order. This mode of operation helps to stabilise idle, reduce emissions and reduce fluctuations in fuel pressure.

Clear Flood Mode

If the engine floods, clear the engine by pressing the accelerator pedal down all the way. The PCM then pulses the injectors at an air/fuel ratio of approximately 20:1. The PCM holds this injector rate as long as the throttle stays wide open and the engine speed is below 300 RPM. If the throttle position becomes less than 80 percent, the PCM returns to the starting mode.

Run Mode

The run mode has two conditions called Open Loop, and Closed Loop. When the engine is first started, and engine speed is above a predetermined RPM, the system begins Open Loop operation. The PCM ignores the signal from the oxygen sensors and calculates the air/fuel ratio based on inputs from the MAF, MAP, ECT, TP and IAT sensors. The system stays in Open Loop until meeting the following conditions:

Both oxygen sensors have varying voltage output, showing that they are hot enough to operate properly.

The ECT sensor is above a specified temperature.

A specific amount of time has elapsed after starting the engine.

The system begins closed loop operation after reaching these values. In Closed Loop, the PCM calculates the air/fuel ratio (injector on-time) based on the signal from various sensors, but mainly the H02S. This allows the air/fuel ratio to stay very close to 14.7:1.

Acceleration Mode

When the driver presses on the accelerator pedal, air flow into the cylinders increases rapidly, while fuel flow tends to lag behind. To prevent possible hesitation, the PCM increases the pulse width to the injectors to provide extra fuel acceleration. The PCM determines the amount of fuel required based on throttle position, coolant temperature, manifold air pressure, mass air flow and engine speed.

Catalyst Protection Mode

During sustained heavy loads the PCM increases the pulse width to the injectors to provide extra fuel, to prevent the catalytic converter from overheating.

Deceleration Mode

When the driver releases the accelerator pedal, air flow into the engine is reduced. The PCM looks at the corresponding changes in throttle position, manifold air pressure and mass air flow. The PCM reduces the amount of fuel by decreasing the pulse width, but does not completely shut of the fuel.

Decel Fuel Cutoff Mode

Decel fuel cutoff disables fuel delivery during a sustained deceleration to reduce emissions and to improve fuel economy. When deceleration from road speed occurs, the PCM can cut off fuel pulses completely for short periods.

'Power Enrichment Mode

When battery voltage is low, the PCM compensates for the weak spark delivered by the ignition system in the following ways:

Increasing the amount of fuel delivered.

Increasing the idle RPM.

'Increasing ignition dwell time.

Fuel Cut OFF Mode

The fuel cutoff mode is enabled at high engine RPM, as an overspeed protection for the engine. When cutoff is in effect due to high RPM, injection pulses will resume after engine RPM drops slightly.

Also no fuel is delivered by the injectors when the ignition is (off). This prevents dieseling. Also, fuel pulses are not delivered if the PCM does not receive a CKP signal, which means the engine is not running.

Open Loop Mode

After the engine is running, the PCM will operate the fuel control system in the open loop mode. In open loop, the PCM ignores the signal from the oxygen sensors, and calculates the air/fuel ratio injector pulse width based on inputs from the CKP signal (RPM input) and these sensors: MAF, MAP, IAT, ECT, and TP sensor.

The system will stay in the open loop mode until all the closed loop mode criteria have been met, or not at idle, refer open loop idle mode description.

In open loop, the calculated pulse width may give an air/fuel ratio other than 14.7 to 1. An example of this would be when the engine is cold, because a richer mixture is needed to ensure good driveability.

ff-

In closed loop mode, the PCM initially calculates injector pulse width based on the same sensors used in open loop The difference is that in closed loop, the PCM uses the oxygen sensor signals to modify and precisely fine tune the fuel pulse width calculations in order to precisely maintain the 14.7 to 1 air/fuel ratio that allows the catalytic converter to operate at its maximum conversion efficiency

Power Enrichment (PE) Mode

The power enrichment mode delivers a rich mixture to the cylinders during a large throttle position change command from the driver During the power enrichment mode, the PCM will not make fuelling changes based on the oxygen sensor signals

Battery Voltage Correction Mode

At low battery voltages, the ignition system may deliver a weak spark, and the injector mechanical movement takes longer to open The PCM will compensate by

- Increasing ignition coil dwell time
- Increasing idle RPM
- Increasing injector pulsewidth

Adaptive Learning

Adaptive learning is the ability of the PCM to determine and remember its most recent operating experience The PCM uses this remembered information to learn from experience and to make adjustments with respect to what it learnt If the engine were to develop a restricted fuel filter, the PCM will change the fuel injector pulse width richer to compensate for this condition and will remember to keep this fuel injector pulse in memory until the restriction is corrected After the restriction has been fixed, the PCM will eventually go back to the original preprogrammed fuel injector pulse Adaptive learning is an on-going process that continues throughout the life of the engine

Short Term Fuel Trim

Short Term Fuel Trim (STFT) represents short term corrections to the fuel injector pulse width calculations, based on the oxygen sensor input signals to the PCM

When the engine is started cold, in open loop, the PCM will control the fuel injection pulse width based upon various sensor inputs such as RPM, ECT, IAT, MAP, MAF and TP sensor until the oxygen sensors become hot enough to operate properly During this open loop period, both Short Term Fuel Trim (STFT) and Long Term Fuel Trim (LTFT) are disabled and will read 0% on a Tech 2 scan tool

When the oxygen sensors have reached normal operating temperature, they will produce a varying voltage to the PCM and provide a good indication of what has happened in the combustion chambers

At this time the PCM will switch from open loop to closed loop and the STFT will start to constantly monitor the oxygen sensor signals, so that the PCM can modify fuel injector pulse width with greater accuracy than in open loop

STFT monitors the oxygen sensor signals so that it can adjust the fuel injector pulse width to maintain an air/fuel ratio of 14.7 to 1 for maximum catalytic converter efficiency An STFT value of 0% is equivalent to an air/fuel ratio of 14.7 to 1 and an average oxygen sensor signal voltage of 450 mV

The normal position for STFT is 0%, any change from this value indicates the STFT is changing the fuel injector pulse width The amount of pulse width change depends upon how far the STFT value is from 0% If the STFT value is above 0%, the fuel injector pulse width is being increased, thus adding more fuel If the STFT value is below 0%, the fuel injector pulse width is being decreased, thus removing fuel

if an engine has a restricted fuel filter, the low fuel pressure will result in less fuel being injected and allows more air into the charge than is needed to ignite the amount of fuel the fuel injector has injected, therefore, a lean air/fuel ratio exists in the combustion chamber After combustion has taken place, the exhaust gases still contain more oxygen content than normal and the oxygen sensors read this as low voltage, say 200 mV The STFT detects that the oxygen sensor signals are low and will increase the value to nchen up the air/fuel mixture On a Tech 2 scan tool it will display STFT as a value above 0% This STFT change will increase the injector pulse width allowing the fuel injectors to stay open longer and inject more fuel

If the additional fuel was injected and the oxygen sensor signal voltages are still low, the STFT will continue to increase its value until the oxygen sensor signal voltages go above 450 mV If the STFT continues to detect low oxygen sensor signal voltages it will continue to try and compensate tor the lean exhaust condition until it runs out of its authority in the particular Long Term Fuel Trim (LTFT) cell it's operating in At this point, the PCM will reset STFT to 0% and go through this procedure again until it can control the system

If after a specified amount of resets have been tried and failed, the PCM knows that it cannot control for the failure and the STFT will remain at its maximum value

STFT values are based on the oxygen sensor signal voltage readings, therefore, STFT is used by the PCM to make quick changes to the fuel injector pulse width over a short period of time

Long Term Fuel Trim

LTFT is used to adjust for engine to engine variation and to adjust for engine ageing LTFT is a portion of the PCM memory used to adjust fuel delivery across all operating conditions of the engine The PCM monitors the STFT and will adjust the long term trend of the fuel injector pulse width if the STFT has been at a value for a certain period of time LTFT is used to change the long term fuel injector pulse width and is only operational when the fuel control system is in Closed Loop A normal LTFT value is 0% and should follow the STFT value

If an engine has a restricted fuel filter, the low fuel pressure will result in less fuel being injected and will cause the STFT value to go higher than 0%, say 2% If this STFT value change does not compensate for the restricted fuel filter, the PCM will continue to increase the STFT value The STFT may climb as high as its maximum calibrated value if there is a severe restriction The PCM will continue to monitor STFT as it climbs, but it will not make any changes to the fuel injector pulse width for a specific period of time After a specific period of time has elapsed and the STFT value has remained above say +8%, the LTFT will move up to say 4% and wait again to detect if the STFT has dropped back down to 0% If not, the STFT will gradually move toward its maximum calibrated value limit until it gains control of the fuel injection system If STFT and LTFT are both set at their maximum value limit, the fuel control system is out of the limits of control and will set a Diagnostic Trouble Code and go into open loop operation

The PCM will keep the latest LTFT values stored in its LTFT memory cells MAP sensor readings and engine RPM are used by the LTFT to determine what cell to read LTFT values are stored in the PCM's long term memory, for use each time the engine's RPM and load matches one of the LTFT cells All LTFT values are reset to 0% when the PCM's long term memory power supply is disconnected The Tech 2 scan tool also has the ability to reset LTFT to 0% with a special command

Long Term Fuel Trim Cell

The LTFT function of the PCM is divided up into cells 0-22 arranged by MAP sensor readings and Engine RPM Each cell corresponds to a region on a MAP vs RPM table Each region is calibrated to a LTFT value of 0% A value of 0% in a given block indicates no fuel adjustment is needed for that engine load condition A higher number, say + 4%, indicates that the PCM has detected a lean exhaust indication under those conditions, and is adding fuel (increasing fuel injector pulse width) to compensate Conversely, a lower number, say -6%, indicates that the PCM has detected a rich exhaust indication under those load conditions, and is subtracting fuel (decreasing fuel injector pulse width) to compensate

As the vehicle is driven from a standing start and accelerated or decelerated from various engine speeds, the engine's LTFT calibration will change from one cell to another cell As the LTFT changes cell so does STFT, however, STFT will only make short term corrections in whatever LTFT cell the engine is operating in When the engine is idling, it can be in one of two cells Depending upon canister purge, the engine will idle in cell 20 If the engine was running at idle and the canister purge was on, we would be in cells 16-19 depending on AC clutch status and PRNDL position

Whatever cell the engine is operating in, the PCM will read that cell's particular LTFT value and electronically adjust the fuel injector base pulse width to compensate for a rich or lean condition in the engine If an engine has a restricted fuel filter and the customer has driven the vehicle like this for quite some time, the LTFT value would be high, and the PCM would be compensating for this condition by adding more fuel Because the STFT value is above 0%, LTFT will also be greater than 0% in most of the cells to compensate for the lean exhaust If you suspect a dnveability problem associated with an over rich or over lean condition, then use the STFT value to detect what the fuel control system is doing at the present time Use the LTFT to identify what the system has learned over a greater period of time to compensate for the condition

Use the LTFT cells to determine if the fuel control system is commanding rich or lean throughout the operating range If it is only rich or lean at idle or part throttle, look for components that would cause problems in these areas

All LTFT cell values are reset to 0% when long term memory power to the PCM is removed

The Tech 2 scan tool has the ability to reset all LTFT cells to 0%

ELECTRONIC TRACTION CONTROL

When the ABS/ETC control module senses spin from the drive wheels due to too much engine torque for the road conditions, it enters the traction control mode.

The ABS/ETC module monitors both front and rear wheel speeds through the wheel speed sensors. If at any time during acceleration the ABS/ETC module detects drive wheel slip, it will request:

- The PCM, via the spark retard circuit, to retard the amount of spark advance.
- The PCM, to restrict transmission downshifting.
- The throttle relaxer control module to reduce the engine throttle opening by a certain percentage to bring engine torque into a specific range.

  The throttle relaxer control module accomplishes this by commanding the throttle relaxer to override the accelerator pedal cable and physically reduce the throttle body butterfly opening by winding the throttle cable back.

  This is achieved via two high speed Pulse Width Modulated (PWM) circuits between the ABS/ETC module and the throttle relaxer control module. The ABS/ETC control module sends a message to the throttle relaxer control module on the requested throttle position (DKR) circuit. The throttle relaxer control module then reports the modified throttle position opening back to the ABS/ETC control module via the actual throttle position (DKI) circuit.

Simultaneously with engine spark retard and throttle position intervention, the ABS/ETC control module will activate the ABS isolation valves, turn on the ABS pump motor and supply brake pressure to the over spinning wheel(s).

The isolation valves isolate the front brake hydraulic circuits from the master cylinder and rear brake hydraulic circuits. Once the rear brake hydraulic circuits are isolated, pressure can be applied to the rear wheels without affecting any other brake hydraulic circuits. The ABS/ETC module opens the priming valve, allowing fluid to be drawn from the master cylinder to the pump motor, turns on the ABS pump motor to apply pressure, begins cycling the ABS assembly's inlet and outlet valves, and closes the switching valve, ensuring fluid is directed to the wheel not back into the master cylinder.

The inlet and outlet valve cycling aids in obtaining maximum road surface traction in the same manner as the Anti-Lock Brake mode. The difference between Traction Control and Anti-Lock Brake mode is that brake fluid pressure is increased to lessen wheel spin (Traction Control mode), rather than reduced to allow greater wheel spin (Anti-Lock Brake mode).

If at any time during Traction Control mode, the brakes are manually applied, the brake switch signals the ABS/ETC module to inhibit brake intervention and allow for manual braking (throttle reduction and spark retard intervention can still occur if necessary).

Engine Spark and Throttle Position Intervention

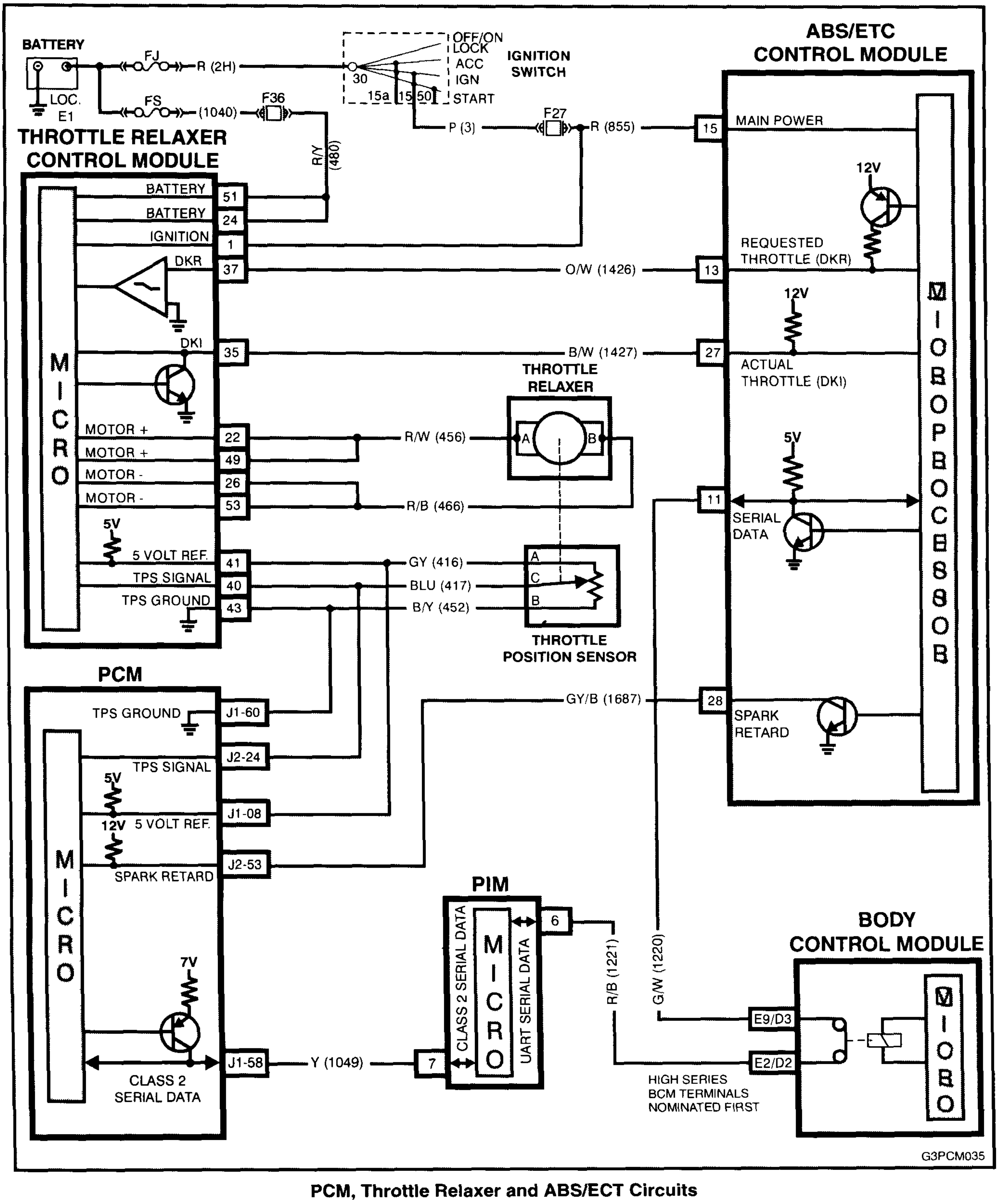
Simultaneously to brake intervention, the ABS/ETC control module communicates with the Powertrain Control Module (PCM) and the throttle relaxer control module requesting the PCM to retard the spark advance and for the throttle relaxer control module to reduce the throttle opening.

With the engine running, the PCM continually supplies and monitors a 12 volt pull-up to the spark retard circuit. The ABS/ETC control module requests spark retard by pulling this voltage low. The PCM then responds by reducing the spark advance of the engine and restricting transmission downshifting.

The ABS/ETC control module constantly sends a Pulse Width Modulated (PWM) signal at 90% with a frequency of "lOOHz to the throttle relaxer control module on the requested throttle position line (DKR). This signal is to indicate to the throttle relaxer control module that the traction control system (ETC) is in a state of readiness.

With the engine idling, the ABS/ETC control module constantly sends a Pulse Width Modulated (PMW) signal with a duty cycle of 90% to the throttle relaxer control module via the requested throttle position line (DKR). The throttle relaxer control module responds on the actual throttle position line (DKI) with a PWM signal with a duty cycle of 9%.

When the ABS/ETC control module determines that a reduction in throttle is required, it reduces the PWM signal on the requested throttle position line (DKR), from 90% (no throttle reduction) to as low as approximately 14% (maximum throttle reduction). The throttle relaxer control module then drives the throttle relaxer motor, overriding the accelerator pedal command (drivers foot), pulling the throttle cable back, and thus, closing the amount of throttle opening.



PCM, Throttle Relaxer and ABS/ECT Circuits

IDLE AIR CONTROL VALVE

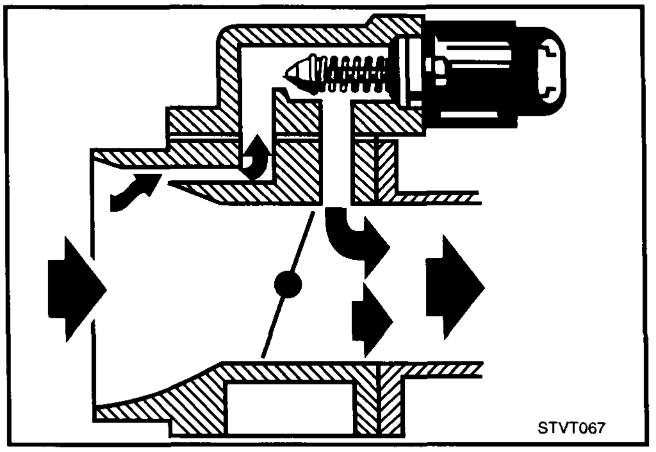
The purpose of the Idle Air Control (IAC) valve, is to control engine idle speed, and prevent engine stalling due to changes in engine load at idle. The IAC valve, mounted in the throttle body, controls bypass air around the throttle valve. By extending the pintle (to decrease air flow) or retracting the pintle (to increase air flow), a controlled amount of air can move around the throttle valve.

If RPM is too low, more air is bypassed around the throttle valve to increase RPM. If RPM is too high, less air is bypassed around the throttle valve to decrease RPM. The IAC valve moves in small steps numbered from 0 (extended pintle, bypass air passage fully shut) to 500 (retracted pintle, maximum bypass airflow) as commanded by the PCM.

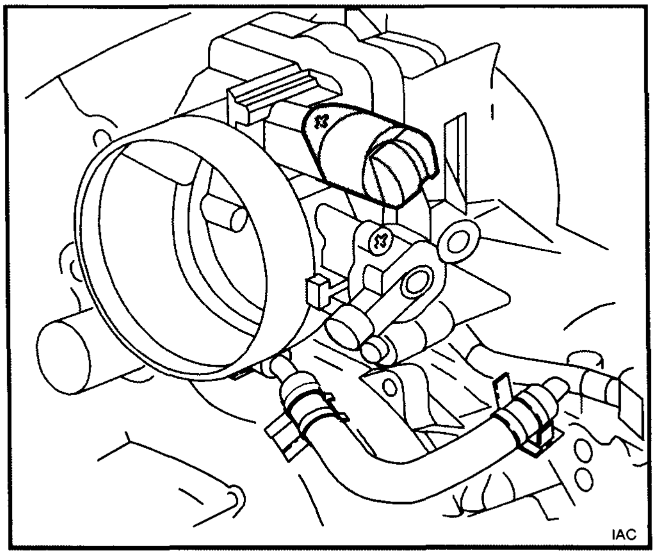
If the IAC valve is disconnected or reconnected with the engine running, the PCM can lose track of the actual position of the IAC. This will also happen if the PCM connectors, fuse F31, or battery terminals are disconnected. If this happens, the PCM will reset the IAC valve, after the engine has been run for at least five seconds. The reset procedure goes like this:

The PCM commands the IAC valve to shut the idle air passageway in the throttle body. It does so by issuing enough extend pulses to move the IAC valve pintle fully shut in the bore, regardless of where the actual position was. Then, the PCM calculates the IAC valve is at a fully shut position, and calls that position 0 steps. Next, the PCM issues retract steps to properly position the pintle. The IAC valve can also be reset with Tech 2.

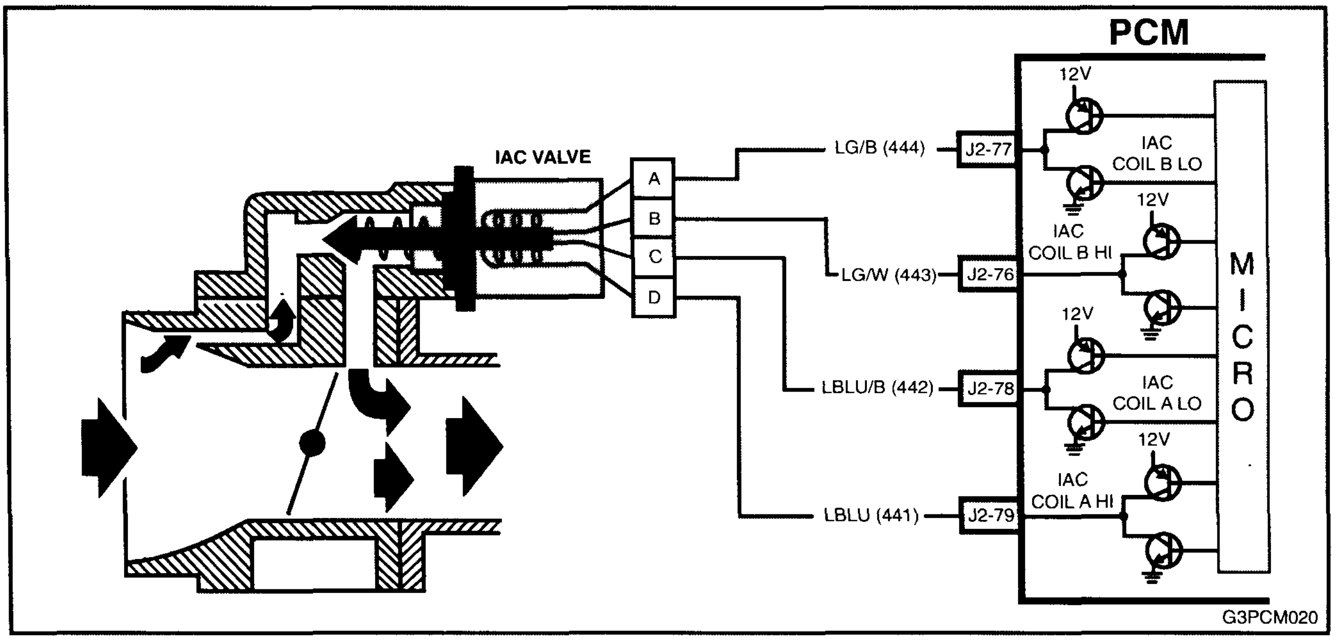
The IAC valve affects only the idle RPM of the engine. If it is open fully, too much air will be allowed into the manifold and idle speed will be too high. If it is stuck closed, too little air will be allowed into the intake manifold, and idle speed will be too low.



IAC Valve



IAC Valve Location



IAC Valve Circuit

The following DTCs will set if the PCM detects an engine speed outside the IAC's operating range.

DTC P0506 Idle Speed Low

Conditions for running DTC P0506

- DTCs P0101, P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0171, P0172, P0174, P0175, P0443,are not set.
- The engine run time is greater than 60 seconds.
- The engine coolant temperature is greater than 60°C.
- The intake air temperature is greater than -10°C.
- The barometric pressure is greater than 65 kPa.
- The ignition voltage is between 9.0 and 17.0 volts.
- The vehicle speed is less than two km/h.

Conditions for setting DTC P0506

- The actual idle speed is 100 RPM less than the desired idle speed.
- All of the above conditions are present for at least 15 seconds.

Action taken when DTC P0506 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0506

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

DTC P0507 Idle Speed High

Conditions for running DTC P0507

- DTCs P0101, P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0171, P0172, P0174, P0175, P0443, are not set.
- The engine run time is greater than 60 seconds.
- The engine coolant temperature is greater than 60°C (140°F).
- The intake air temperature is greater than -10°C (14°F).
- The barometric pressure is greater than 65 kPa.
- The ignition voltage is between 9.0 and 17.0 volts.
- The vehicle speed is less than two km/h.

Conditions for setting DTC P0507

- The actual idle speed is 100 RPM more than the desired idle speed.
- All of the above conditions are present for 15 seconds.

Action taken when DTC P0507 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

Conditions for clearing the Check Powertrain Lamp and DTC P0507

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

EVAPORATIVE EMISSION CONTROL SYSTEM

The Evaporative Emission Control System (EECS) captures fuel vapours, which would normally escape from the fuel tank and enables them to be consumed in the combustion process. The EECS is the charcoal canister storage method. This method transfers fuel vapour from the fuel tank to an activated carbon (charcoal) storage canister to hold vapours when the vehicle is not operating. When the engine is running, the fuel vapour is purged from the carbon element by intake air flow and consumed in the normal combustion process. The fuel tank cap is not vented to atmosphere, but is fitted with a valve to allow both pressure and vacuum relief. The canister is a three port design:

The fuel vapour is absorbed by the charcoal in the canister. When the engine is running, air is drawn into the canister through the atmospheric port at the top of the canister assembly. The air mixes with the vapour and the mixture is drawn into the intake manifold via the canister purge line. The purge port on the canister is controlled by a PCM activated purge solenoid valve. The solenoid valve controls the manifold vacuum signal from the throttle body. The vapour inlet port allows fuel vapour to enter the canister from the fuel tank. The atmospheric port allows fresh air to be drawn into the canister. This system has a remote mounted canister purge control solenoid valve. The PCM supplies a Pulse Width Modulated (PWM) earth to energise the solenoid to control vacuum to the canister. The duty cycle of the PWM signal varies with mass air flow, intake air temperature and throttle position.

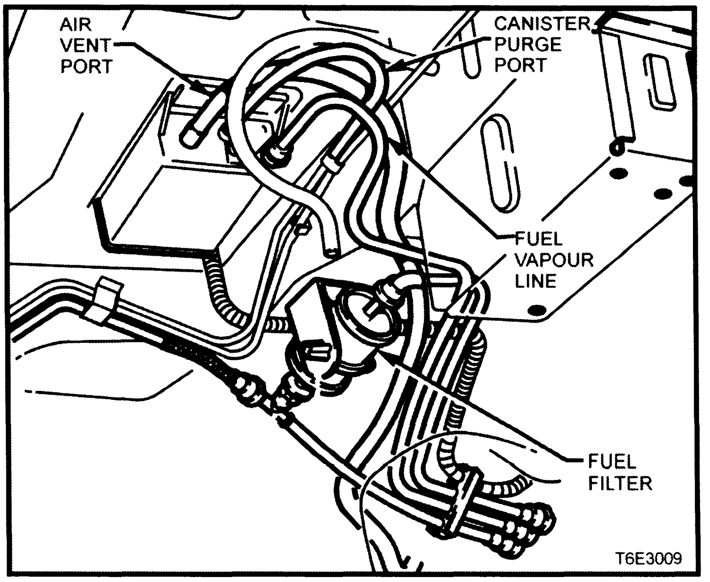
Under cold engine conditions, the solenoid valve is turned off by the PCM, which blocks vacuum to the canister and prevents purge.

The PCM turns on the solenoid valve and allows purge when:

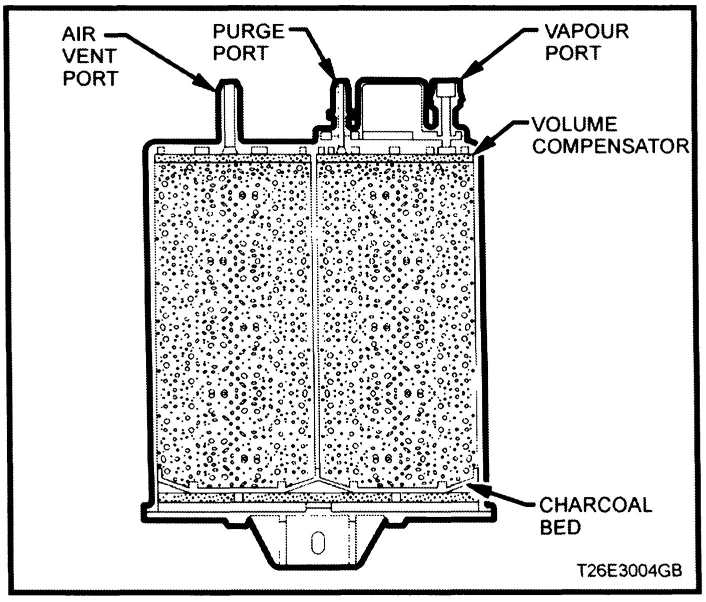
- The engine coolant temperature is below 30°C at start up.
- The engine has been running for at least two minutes
  OR
- The engine coolant temperature is above 30°C at start up.
- The engine has been running for at least 30 seconds.
- The engine is not in Decel Fuel Cutoff Mode
- The throttle opening is less than 96%.
- Engine is in Closed Loop or Open Loop Fuel Mode.

A higher purge rate is used under conditions that are likely to produce large amounts of vapour, when the following conditions are met:

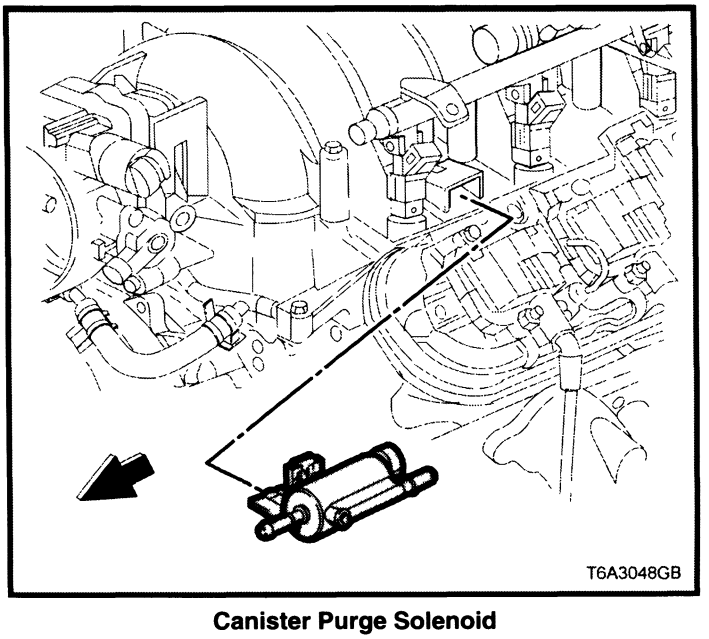
- Intake Air Temperature is above 50°C.
  OR
- The engine coolant temperature is above 100°C.
- The engine has been running more than 15 minutes.



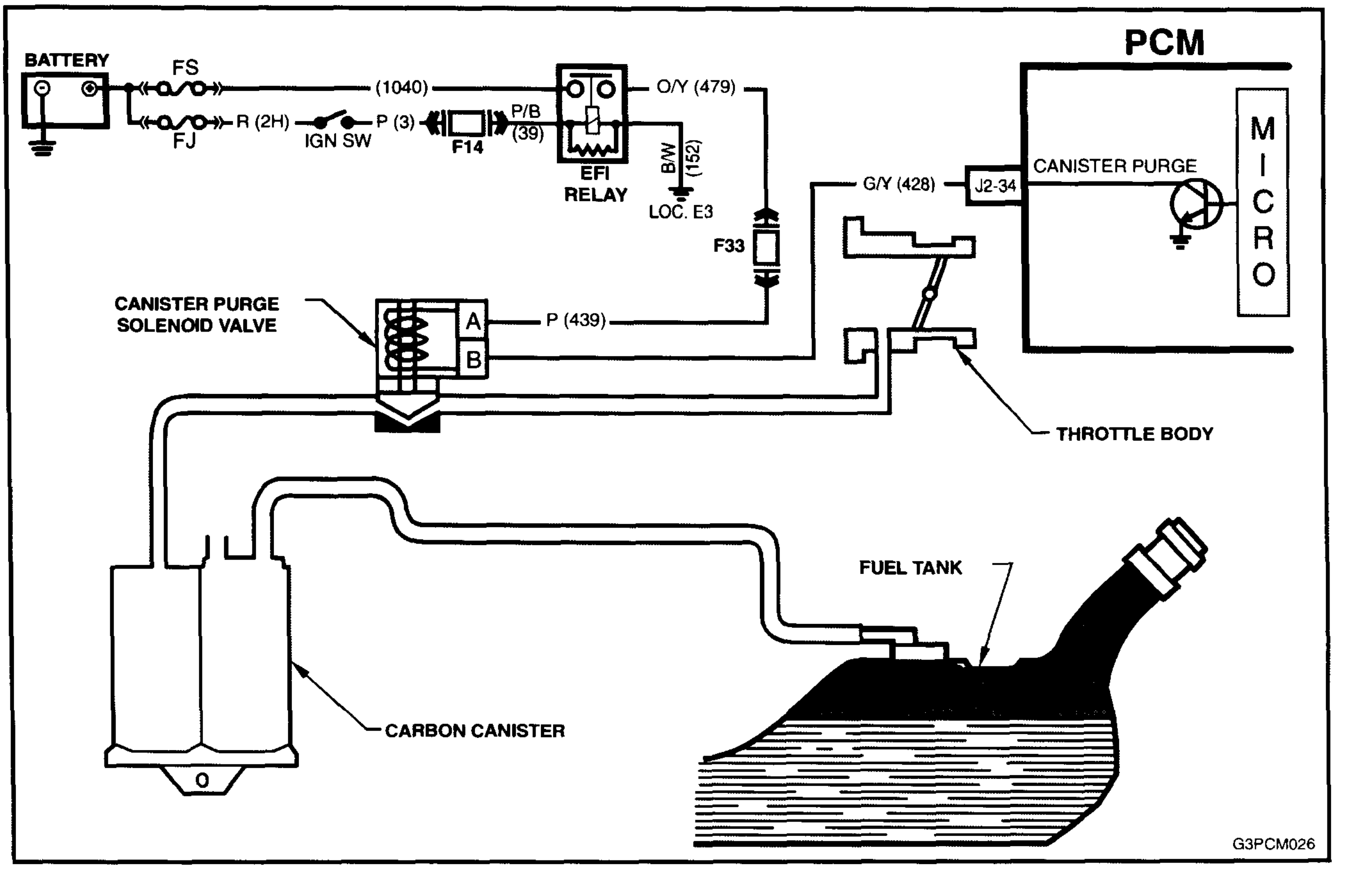
Canister Location



Fuel Vapour Canister



Canister Purge Solenoid



Evaporative Emission Control System Circuit

A failure in the Evaporative Canister Purge Solenoid or Circuit will set the following DTC:

DTC P0443 EVAP Purge Solenoid Control Circuit

Conditions for running DTC P0443

- The engine speed is greater than 400 RPM.
- The ignition voltage is between 6.0 volts and 16.0 volts.

Conditions for setting DTC P0443

- The PCM detects that the commanded state of the circuit and the actual state of the circuit do not match.
- The conditions are present for at least ten seconds.

Action taken when DTC P0443 Sets

- The PCM illuminates the Check Powertrain Lamp when the diagnostic runs and fails.
- The PCM records the operating conditions at the time the diagnostic fails. The PCM stores this information in the Freeze Frame/Failure Records.

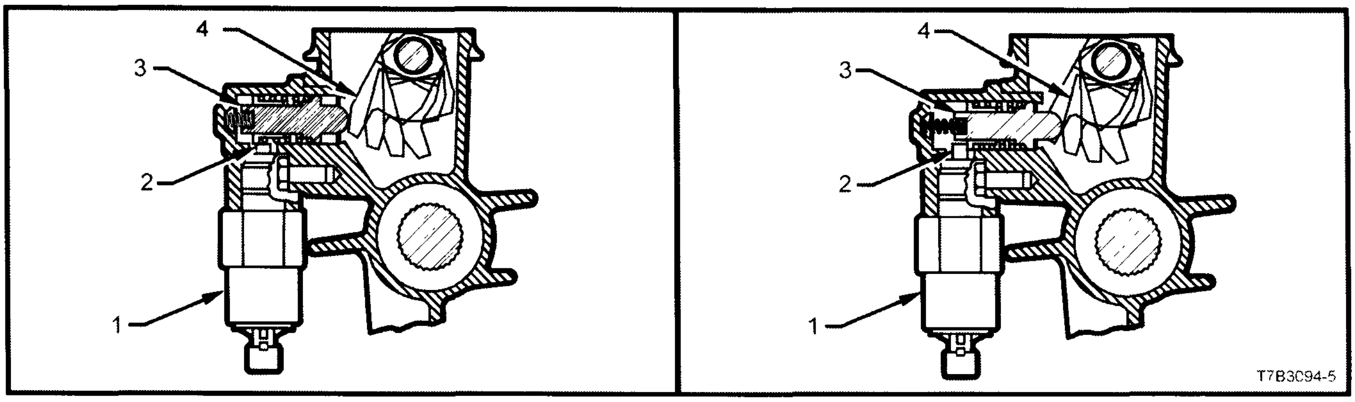
Conditions for clearing the Check Powertrain Lamp and DTC P0443

- The PCM turns the Check Powertrain Lamp OFF after one ignition cycle that the diagnostic runs and does not fail.
- A last test failed (current DTC) clears when the diagnostic runs and does not fail.

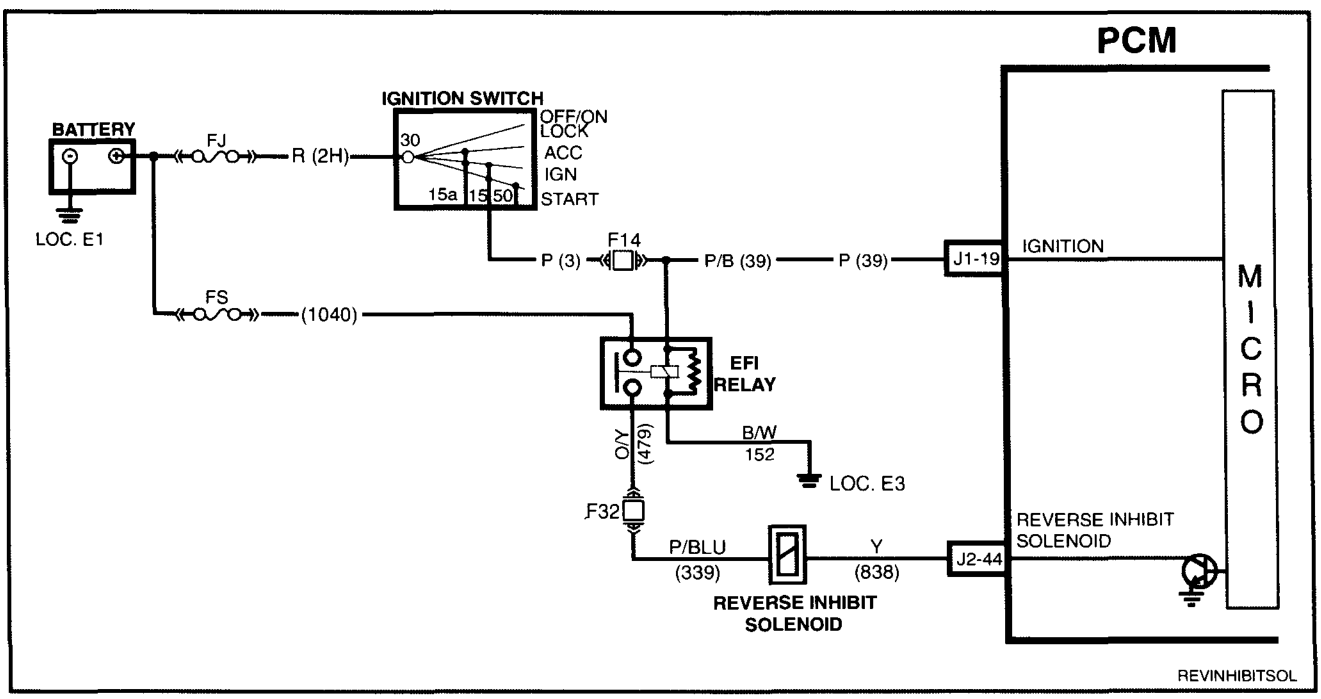
REVERSE INHIBIT SOLENOID

The manual transmission is fitted with a reverse inhibit mechanism that prevents the selection of reverse gear, above road speeds of 8 km/h. If the engine is running and the vehicle speed is less than 8 km/h the reverse inhibit solenoid (1) is energised by the PCM, pulling the solenoid plunger (2) down, this allows the reverse lockout plunger (3) to move, enabling selection of reverse gear.

Above 8 km/h, the PCM de-energises the reverse inhibit solenoid, causing the solenoid plunger (2) to block the movement of the spring loaded, reverse lockout plunger (3). When activated, the rear offset lever (4) is blocked from rotating to the reverse selection position.



Road Speed Less Than 8 km/h **Road Speed Greater Than 8 km/h**



Reverse Inhibit Solenoid Circuit

TECH 2 TEST MODES AND DISPLAYS FOR PCM DIAGNOSIS

As a prerequisite to any PCM diagnostics the user must be familiar with the proper use of TECH 2. The following pages list the major TECH 2 functions and provide a brief explanation of their operation for diagnosing the PCM.

Once GEN III V8 has been selected the following functions are available:

FO: Diagnostic Trouble Codes

In this test mode, DTCs stored by the PCM maybe displayed or cleared. When FO: Diagnostic Trouble Codes an there are an additional four modes:

- **FO: Read DTC Info Ordered By Priority:** DTC(s) will be displayed in numerical order.
- **F1: Clear DTC Information:** Clears all DTC(s) in the PCM memory. Also clears Freeze Frame/Failure Records, so before clearing DTC(s), be sure to retrieve Freeze Frame / Failure Record information.
- **F2: DTC Information:** Shows DTC(s) which are set that match the criteria. Each DTC has it's own page of information. If multiple DTCs are set, the user must page through the display of codes.
  - **FO: History:** This DTC search will display only DTC(s) that are stored in the PCM memory as Valid Faults.
  - **F1: MIL SVS or Message Requested:** This DTC search will display only DTC(s) for which the PCM is requesting the Check Powertrain Lamp to turn "ON".
  - **F2: Last Test Failed:** This DTC search will display only DTCs that failed the last time the test ran.
  - **F3: Test Failed Since Code Cleared:** This DTC search will display all DTCs that have reported a test failure since the last time DTCs were cleared.
  - **F4: Not Ran Since Code Cleared:** This DTC search will display only DTCs that have not ran since DTCs were last cleared. Any displayed DTCs have not run, therefore their condition (passing or failing) is unknown.
  - **F5: Failed This Ignition:** This DTC search will display all DTCs that have failed at least once during the current ignition cycle.
- **F3: Freeze Frame / Failure Records:** Shows Freeze Frame / Failure Records information. Freeze Frame / Failure Records are types of snapshots stored in the memory of the PCM and contain 32 data parameters.

F1: Data Display

This mode displays data parameters for the controller being diagnosed. When entering this mode, there are two modes;

- **FO: Engine Data:** In this test mode, the Tech 2 continuously monitors and displays system data, such as: engine speed, engine coolant temperature etc.
- **F1: Fuel Trim Data:** In this test mode, the Tech 2 scan tool continuously monitors and displays system data, such as: engine speed data, engine coolant temperature, H02S, Fuel Trim Cell etc.

F2:Snapshot

In this test mode, the Tech 2 scan tool captures data before and after a snapshot triggering condition which may or may not set a DTC.

F3: Miscellaneous Tests

In this test mode, the Tech 2 scan tool performs software override commands of the PCM, to assist in problem isolation during diagnostics.

FO: Output Tests

FO: Fuel Pump: Fuel Pump Relay can be commanded on and off.

F1: A/C Clutch: A/C Compressor Clutch can be commanded on and off.

F2: Check Powertrain Lamp: Check Powertrain Lamp can be commanded on and off.

F3: High Fan: High Speed Cooling Fan operation can be commanded on and off.

F4: Canister Purge: Canister Purge can be commanded on (100%) and off (0%).

F1: IAC System

FO: RPM Control: Used to control engine RPM from 600 RPM to 1675 RPM.

F1: IAC Control: Used to control IAC steps from 0 to 120.

F2: IAC Reset: Used to reset IAC if the IAC is lost or if IAC has been replaced.

F3: Base Idle: Used to set the engine to base idle.

F2: Reset Cells

Resets all Long Term Fuel Trim values to 0%

F3: 02 Loop Status

With the engine running, Open or Closed Loop fuel control can be commanded.

F4: Function Tests

In this test mode, Tech 2 performs various automated tests to assist in problem isolation during trouble shooting. To operate any of the Function Tests, simply select the appropriate test mode from the Function Test application menu and follow the instructions as per TECH 2. When the Function Tests option is selected, the following options will become available.

FO: IAC Circuit: This function automatically cycles the IAC valve in and out a calibrated number of steps and cycle times, and compares the initial IAC valve steps to the end IAC valve steps to determine if the IAC valve is controlling RPM properly and not losing steps.

Preconditions: Coolant temperature greater than 80°C, vehicle speed zero km/h, engine running at idle, air conditioning turned off and engine cooling fans turned on.

F1: Power Balance: This function automatically turns off each injector sequentially for five seconds, while the engine RPM is monitored. At the end of the test the minimum RPM for each cylinder is displayed.

Preconditions: Vehicle speed less than two km/h, engine running at idle, air conditioning turned off and the engine cooling fans are turned on.

F3: Wiring Harness: During this function test TECH 2 monitors the following inputs: RPM, ECT, MAF, TPS, Battery Voltage, Injector Voltage and VSS. If a change occurs in these circuits greater than the limits listed below, the TECH 2 logs the failure and prompts the technician to check the appropriate circuit.

Parameter	RPM	ECT	MAF	IAT	TPS	Bat. V	Inj. V	VSS
Tolerance	100 RPM	0.5 V	300 Hz	0.5 V	0.5 V	2 V	2 V	2 km/h

Preconditions: Engine running, vehicle speed less than two km/h.

F4: Fuel Injector Balance: This function is designed to check the fuel flow through each injector while the engine is not running. A fuel pressure gauge has to be connected to the fuel rail. TECH 2 first turns on the fuel pump. After pressure is established the fuel pump is turned off again and the injector is turned on for a predetermined time. Pressure drop has to be read afterwards on the fuel gauge for each injector. This can be performed only once per injector.

Preconditions: Vehicle speed less than 2 km/h, engine not running.

SERVICE PROGRAMMING SYSTEM

The Gen III PCM does not contain a removable FROM, it uses an EEPROM (Flash Memory) which is non removable. The PCM is programmed from the factory with the proper calibrations for vehicle operation. In the event that the PCM is replaced, or an updated calibration is required to correct a vehicle's operating condition, the new PCM or the new calibration will have to be down loaded to the PCM EEPROM (Flash Memory). Down loading is accomplished through the vehicle DLC using the TECH 2 Service Programming System (SPS) and the Technical Information System (TIS).

The service replacement PCM EEPROM (Flash Memory) will not be programmed. DTC P0601 and P0602 indicates the Flash Memory is not programmed or has malfunctioned.

Conditions for setting DTC P0601

- The PCM is unable to correctly read data from the EEPROM (Flash Memory)

Conditions for setting DTC P0602

- No software data is present in the ECU

The SPS procedure has to be performed as follows:

- Connect TECH 2 to DLC, turn TECH 2 on, at the TECH 2 title screen press ENTER and select the following:
- F1: Service Programming System (SPS).
- FO: Request Info (FO: Request Info will be flashing).
- (X)1999.
- WH Statesman or Caprice.
- Then follow TECH 2 screen instructions.
- Turn off ignition and disconnect TECH 2 from the vehicle.
- Using the RS232 connector lead, Hardware Key and TECH 2 power lead, connect TECH 2 to a Personal Computer (PC) with TIS 2000 installed.
- Turn TECH 2 on (TECH 2 must be at the title screen).
- Open TIS 2000 and select Service Programming System and follow the screen instructions.
- When the data transfer is completed and the Program Controller screen is displayed close TIS 2000.
- Disconnect TECH 2 from the PC and reconnect TECH 2 to the vehicles DLC.
- Connect TECH 2 to DLC, turn TECH 2 on, at the TECH 2 title screen press ENTER and select the following:
- F1: Service Programming System (SPS)
- F1: Program ECU (F1: Program ECU will be flashing)
- Then follow TECH 2 screen instructions.
- When TECH 2 displays Programming Successful, press the EXIT key.
- Turn off ignition and disconnect TECH 2 from the vehicle.

BCM Link to PCM/PIM

If one or more of PCM, PIM or BCM have been replaced, the modules must be security linked to each other. If the procedure is not performed, the vehicle will not crank or run.

This linking procedure has to be performed as follows:

- Connect TECH 2 to DLC and select the following:
- Diagnostics / (X) 1999 / WH Statesman or Caprice / BODY / BODY CONTROL MODULE / SECURITY / BCM LINK TO PCM/PIM / select applicable engine and follow TECH 2 instructions.

  NOTE: On vehicles with a GEN III V8 engine it will be necessary to obtain TIS approval during the linking procedure. When instructed to obtain TIS approval by TECH 2, use the following procedure:
- Disconnect TECH 2 from the vehicle.
- Using the RS232 connector lead, Hardware Key and TECH 2 power lead, connect TECH 2 to a Personal Computer (PC) with TIS 2000 installed.
- Turn TECH 2 on so that the TECH 2 screen displays "TECH 2".
- Open TIS 2000 and select Enable Programming, then follow the screen instructions.
- When TIS 2000 displays the Programming Enabled screen close TIS 2000.
- Disconnect TECH 2 from the PC and reconnect TECH 2 to the vehicles DLC.
- On TECH 2, select Diagnostics / (X) 1999 / WH Statesman or Caprice / BODY / BODY CONTROL MODULE / SECURITY / BCM LINK TO PCM/PIM / select applicable engine and follow TECH 2 instructions again.
- For additional information regarding TECH 2 and this linking procedure, refer to TECH 2 DIAGNOSIS FOR BCM in Section 12J-1 LOW SERIES BCM in Volume 14C or Section 12J-2 HIGH SERIES BCM in Volume 14D of the VT Series Service Manual.

NOTES