

# ELECTRONIC CONTROL MODULES

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## ELECTRONIC CONTROL MODULES

### STANDARD PROCEDURE - PCM/SKIM PROGRAMMING

**NOTE:** Before replacing the PCM for a failed driver, control circuit, or ground circuit, be sure to check the related component/circuit integrity for failures not detected due to a double fault in the circuit. Most PCM driver/control circuit failures are caused by internal component failures (i.e. relays and solenoids) and shorted circuits (i.e. pull-ups, drivers, and switched circuits). These failures are difficult to detect when a double fault has occurred and only one DTC has been set.

When a PCM (JTEC) and the SKIM are replaced at the same time, perform the following steps in order:

- (1) Program the new PCM (JTEC).
- (2) Program the new SKIM.
- (3) Replace all ignition keys and program them to the new SKIM.

### PROGRAMMING THE PCM (JTEC)

The SKIS Secret Key is an ID code that is unique to each SKIM. This code is programmed and stored in the SKIM, the PCM, and the ignition key transponder chip(s). When replacing the PCM, it is necessary to program the secret key into the new PCM using the DRB III® scan tool. Perform the following steps to program the secret key into the PCM.

- (1) Turn the ignition switch to the On position (transmission in Park/Neutral).
- (2) Use the DRB III® and select THEFT ALARM, SKIM, then MISCELLANEOUS.
- (3) Select PCM REPLACED (GAS ENGINE).
- (4) Enter secured access mode by entering the vehicle four-digit PIN.
- (5) Select ENTER to update PCM VIN.

**NOTE:** If three attempts are made to enter secure access mode using an incorrect PIN, secured access mode will be locked out for one hour. To exit this lockout mode, turn the ignition switch to the ON position for one hour, then enter the correct PIN. (Ensure all accessories are turned off. Also monitor the battery state and connect a battery charger if necessary).

- (6) Press ENTER to transfer the secret key (the SKIM will send the secret key to the PCM).

## ELECTRONIC CONTROL MODULES (Continued)

(7) Press Page Back to get to the Select System menu and select ENGINE, MISCELLANEOUS, and SRI MEMORY CHECK.

(8) The DRB III® will ask, "Is odometer reading between XX and XX?" Select the YES or NO button on the DRB III®. If NO is selected, the DRB III® will read, "Enter Odometer Reading (From I.P. odometer)". Enter the odometer reading from the instrument cluster and press ENTER.

**PROGRAMMING THE SKIM**

(1) Turn the ignition switch to the On position (transmission in Park/Neutral).

(2) Use the DRB III® and select THEFT ALARM, SKIM, then MISCELLANEOUS.

(3) Select PCM REPLACED (GAS ENGINE).

(4) Program the vehicle four-digit PIN into SKIM.

(5) Select COUNTRY CODE and enter the correct country.

**NOTE: Be sure to enter the correct country code. If the incorrect country code is programmed into SKIM, it cannot be changed and the SKIM must be replaced.**

(6) Select YES to update VIN (the SKIM will learn the VIN from the PCM).

(7) Press ENTER to transfer the secret key (the PCM will send the secret key to the SKIM).

(8) Program ignition keys to the SKIM.

**NOTE: If the PCM and the SKIM are replaced at the same time, all vehicle ignition keys will need to be replaced and programmed to the new SKIM.**

**PROGRAMMING IGNITION KEYS TO THE SKIM**

(1) Turn the ignition switch to the On position (transmission in Park/Neutral).

(2) Use the DRB III® and select THEFT ALARM, SKIM, then MISCELLANEOUS.

(3) Select PROGRAM IGNITION KEYS.

(4) Enter secured access mode by entering the vehicle four-digit PIN.

**NOTE: A maximum of eight keys can be learned to each SKIM. Once a key is learned to a SKIM it (the key) cannot be transferred to another vehicle.**

(5) Obtain ignition keys to be programmed from the customer (8 keys maximum).

(6) Using the DRB III®, erase all ignition keys by selecting MISCELLANEOUS, and ERASE ALL CURRENT IGN. KEYS.

(7) Program all of the ignition keys.

If ignition key programming is unsuccessful, the DRB III® will display one of the following messages:

- **Programming Not Attempted** - The DRB III® attempts to read the programmed key status and there are no keys programmed into SKIM memory.

- **Programming Key Failed (Possible Used Key From Wrong Vehicle)** - SKIM is unable to program an ignition key transponder due to one of the following:

- The ignition key transponder is faulty.
- The ignition key transponder is or has been already programmed to another vehicle.

- **8 Keys Already Learned, Programming Not Done** - The SKIM transponder ID memory is full.

- **Learned Key In Ignition** - The ID for the ignition key transponder currently in the ignition lock cylinder is already programmed in SKIM memory.

**COMMUNICATION****DESCRIPTION - CCD DATA BUS**

The Chrysler Collision Detection (also referred to as CCD or C<sup>2</sup>D ) data bus system is a multiplex system used for vehicle communications on many DaimlerChrysler vehicles. Within the context of the CCD system, the term "collision" refers to the system's ability to avoid collisions of the electronic data that enters the data bus from various electronic control modules at approximately the same time.

Multiplexing is a system that enables the transmission of several messages over a single channel or circuit. Many DaimlerChrysler vehicles use this principle for communication between the various microprocessor-based electronic control modules.

Many of the electronic control modules in a vehicle require information from the same sensing device. In the past, if information from one sensing device was required by several controllers, a wire from each controller needed to be connected in parallel to that sensor. In addition, each controller utilizing analog sensors required an Analog/Digital (A/D) converter in order to "read" these sensor inputs. Multiplexing reduces wire harness complexity, sensor current loads and controller hardware because each sensing device is connected to only one controller, which reads and distributes the sensor information to the other controllers over the data bus. Also, because each controller on the data bus can access the controller sensor inputs to every other controller on the data bus, more function and feature capabilities are possible.

In addition to reducing wire harness complexity, component sensor current loads and controller hardware, multiplexing offers a diagnostic advantage. A multiplex system allows the information flowing between controllers to be monitored using a diagnostic scan tool. The DaimlerChrysler system allows an

## COMMUNICATION (Continued)

electronic control module to broadcast message data out onto the bus where all other electronic control modules can “hear” the messages that are being sent. When a module hears a message on the data bus that it requires, it relays that message to its microprocessor. Each module ignores the messages on the data bus that are being sent to other electronic control modules.

With a diagnostic scan tool connected into the CCD circuit, a technician is able to observe many of the electronic control module function and message outputs while; at the same time, controlling many of the sensor message inputs. The CCD data bus, along with the use of a diagnostic scan tool and a logic-based approach to test procedures, as found in the Diagnostic Procedures manuals, allows the trained automotive technician to more easily, accurately and efficiently diagnose the many complex and integrated electronic functions and features found on today's vehicles.

## OPERATION - CCD DATA BUS

The CCD data bus system was designed to run at a 7812.5 baud rate (or 7812.5 bits per second). In order to successfully transmit and receive binary messages over the CCD data bus, the system requires the following:

- Bus (+) and Bus (-) Circuits
- CCD Chips in Each Electronic Control Module
- Bus Bias and Termination
- Bus Messaging
- Bus Message Coding

Following are additional details of each of the above system requirements.

## BUS (+) AND BUS (-) CIRCUITS

The two wires (sometimes referred to as the “twisted pair”) that comprise the CCD data bus are the D1 circuit [Bus (+)], and the D2 circuit [Bus (-)]. The “D” in D1 and D2 identify these as diagnostic circuits. Transmission and receipt of binary messages on the CCD data bus is accomplished by cycling the voltage differential between the Bus (+) and Bus (-) circuits.

The two data bus wires are twisted together in order to shield the wires from the effects of any Electro-Magnetic Interference (EMI) from switched voltage sources. An induced EMI voltage can be generated in any wire by a nearby switched voltage or switched ground circuit. By twisting the data bus wires together, the induced voltage spike (either up or down) affects both wires equally. Since both wires are affected equally, a voltage differential still exists between the Bus (+) and Bus (-) circuits, and the data bus messages can still be broadcast or received. The correct specification for data bus wire twisting is

one turn for every 44.45 millimeters (1 ¾ inches) of wire.

## CCD CHIPS

In order for an electronic control module to communicate on the CCD data bus, it must have a CCD chip (Fig. 1). The CCD chip contains a differential transmitter/receiver (or transceiver), which is used to send and receive messages. Each module is wired in parallel to the data bus through its CCD chip.

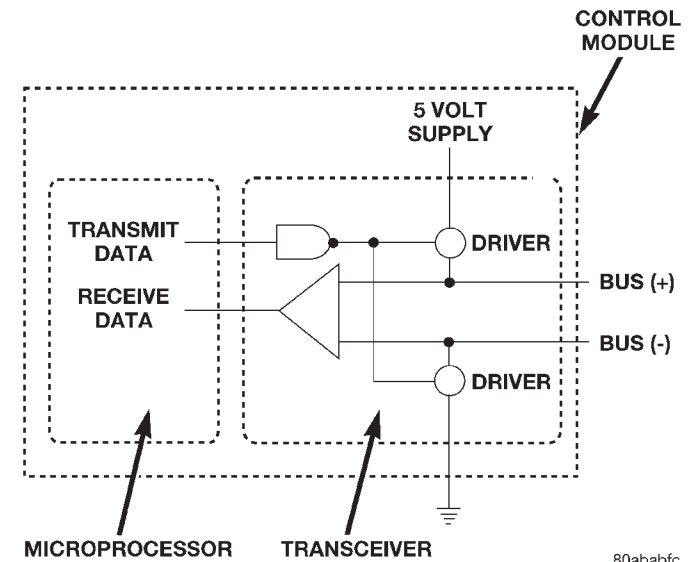


Fig. 1 CCD Chip

The differential transceiver sends messages by using two current drivers: one current source driver, and one current sink driver. The current drivers are matched and allow 0.006 ampere to flow through the data bus circuits. When the transceiver drivers are turned On, the Bus (+) voltage increases slightly, and the Bus (-) voltage decreases slightly. By cycling the drivers On and Off, the CCD chip causes the voltage on the data bus circuit to fluctuate to reflect the message.

Once a message is broadcast over the CCD data bus, all electronic control modules on the data bus have the ability to receive it through their CCD chip. Reception of CCD messages is also carried out by the transceiver in the CCD chip. The transceiver monitors the voltage on the data bus for any fluctuations. When data bus voltage fluctuations are detected, they are interpreted by the transceiver as binary messages and sent to the electronic control module's microprocessor.

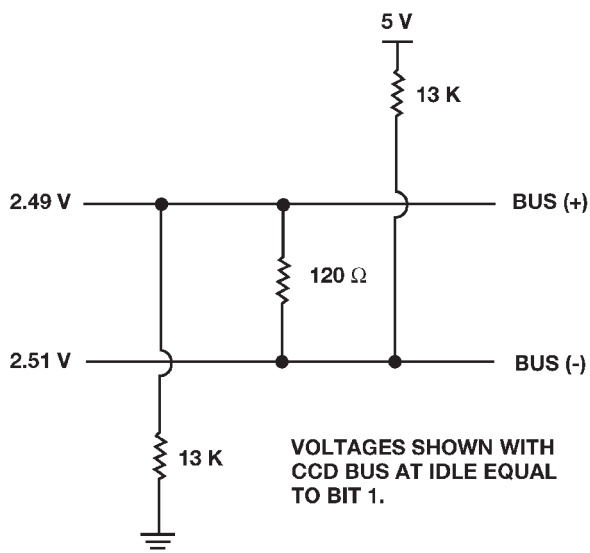
## BUS BIAS AND TERMINATION

The voltage network used by the CCD data bus to transmit messages requires both bias and termination. At least one electronic control module on the data bus must provide a voltage source for the CCD

## COMMUNICATION (Continued)

data bus network known as bus bias, and there must be at least one bus termination point for the data bus circuit to be complete. However, while bias and termination are both required for data bus operation, they both do not have to be within the same electronic control module. The CCD data bus is biased to approximately 2.5 volts. With each of the electronic control modules wired in parallel to the data bus, all modules utilize the same bus bias. Therefore, based upon vehicle options, the data bus can accommodate two or twenty electronic control modules without affecting bus voltage.

The power supplied to the data bus is known as bus biasing. Bus bias is provided through a series circuit. To properly bias the data bus circuits, a 5 volt supply is provided through a 13 kilohm resistor to the Bus (-) circuit (Fig. 2). Voltage from the Bus (-) circuit flows through a 120 ohm termination resistor to the Bus (+) circuit. The Bus (+) circuit is grounded through another 13 kilohm resistor. While at least one termination resistor is required for the system to operate, most Chrysler systems use two. The second termination resistor serves as a backup (Fig. 3). The termination resistor provides a path for the bus bias voltage. Without a termination point, voltage biasing would not occur. Voltage would go to 5 volts on one bus wire and 0 volts on the other bus wire.



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**Fig. 2 Bus Biasing**

The voltage drop through the termination resistor creates 2.51 volts on Bus (-), and 2.49 volts on Bus (+). The voltage difference between the two circuits is 0.02 volts. When the data bus voltage differential is a steady 0.02 volts, the CCD system is considered "idle." When no input is received from any module and the ignition switch is in the Off position for a pre-programmed length of time, the bus data becomes inactive or enters the "sleep mode." Elec-

tronic control modules that provide bus bias can be programmed to "wake up" the data bus and become active upon receiving any predetermined input or when the ignition switch is turned to the On position.

### BUS MESSAGING

The electronic control modules used in the CCD data bus system contain microprocessors. Digital signals are the means by which microprocessors operate internally and communicate messages to other microprocessors. Digital signals are limited to two states, voltage high or voltage low, corresponding to either a one or a zero. Unlike conventional binary code, the CCD data bus systems translate a small voltage difference as a one (1), and a larger voltage difference as a zero (0). The use of the 0 and 1 is referred to as binary coding. Each binary number is called a bit, and eight bits make up a byte. For example: 01011101 represents a message. The controllers in the multiplex system are able to send thousands of these bytes strung together to communicate a variety of messages. Through the use of binary data transmission, all electronic control modules on the data bus can communicate with each other.

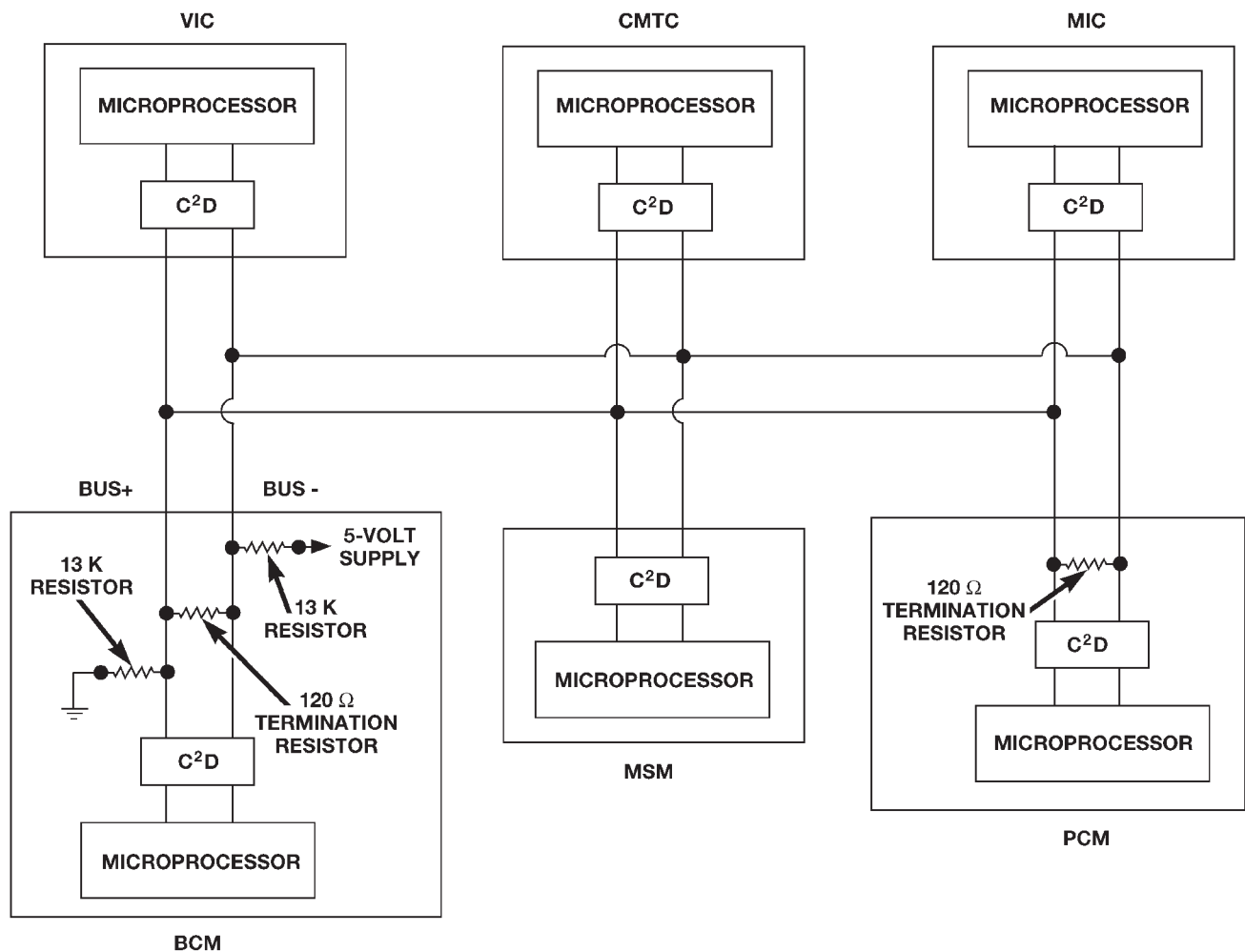
The microprocessors in the CCD data bus system translate the binary messages into Hexadecimal Code (or Hex Code). Hex code is the means by which microprocessors communicate and interpret messages. When fault codes are received by the DRBIII, they are translated into text for display on the DRBIII® screen. Although not displayed by the DRBIII® for Body Systems, hex codes are shown by the DRB III® for Engine System faults.

When the microprocessor signals the transceiver in the CCD chip to broadcast a message, the transceiver turns the current drivers On and Off, which cycles the voltage on the CCD data bus circuits to correspond to the message. At idle, the CCD system recognizes the 0.02 voltage differential as a binary bit 1. When the current drivers are actuated, the voltage differential from idle must increase by 0.02 volt for the CCD system to recognize a binary bit 0 (Fig. 4). The nominal voltage differential for a 0 bit is 0.100 volts. However, data bus voltage differentials can range anywhere between 0.02 and 0.120 volt.

### BUS MESSAGE CODING

The first part of a data bus message has an Identification (ID) byte. The ID byte contains message priority, message identification, message content and message length information. All messages sent over the data bus are coded for both priority and identification.

COMMUNICATION (Continued)



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**Fig. 3 Bus Termination**

**PRIORITY**

Messages can be broadcast almost simultaneously by modules over the CCD data bus. Therefore, all messages are defined and ranked by a predetermined priority. When two CCD chips start a message at exactly the same time, non-destructive arbitration occurs between the two CCD chips. Arbitration will occur based upon the priority code, to determine which message takes priority on the data bus and to prevent data collision. If a CCD chip senses a message of higher priority being transmitted, it stops transmitting its message. The higher priority message is then transmitted in its entirety without interruption. The other CCD chips on the data bus do not allow any other messages to be broadcast.

To determine the winner in an arbitration, all messages start with an ID byte which contains the predetermined priority code. In the digital broadcast, zero is the dominant bit. All ID bytes start with a zero. This is the start of the message. With zeros being the dominant bit, messages starting with more

zeros have a higher priority. For example: of the two messages below, Message #2 loses arbitration at the second bit, where Message #1 has a zero and Message #2 has a one (Fig. 5). After the message is broadcast, an idle period occurs while all microprocessors can queue, if necessary, and attempt to broadcast their messages again.

- Message #1 = 00010110
- Message #2 = 01010101

**MESSAGE IDENTIFICATION**

Because messages are broadcast over the data bus, all modules can receive them, yet not all modules need all messages. In order to enhance microprocessor speed, unneeded messages are filtered out. The ID byte, along with showing message priority, also identifies the data, content and length. The electronic control module, through its CCD chip transceiver, monitors the ID code of the messages. If the message is not for that particular module, the message is simply ignored. Once the module recognizes a message

COMMUNICATION (Continued)

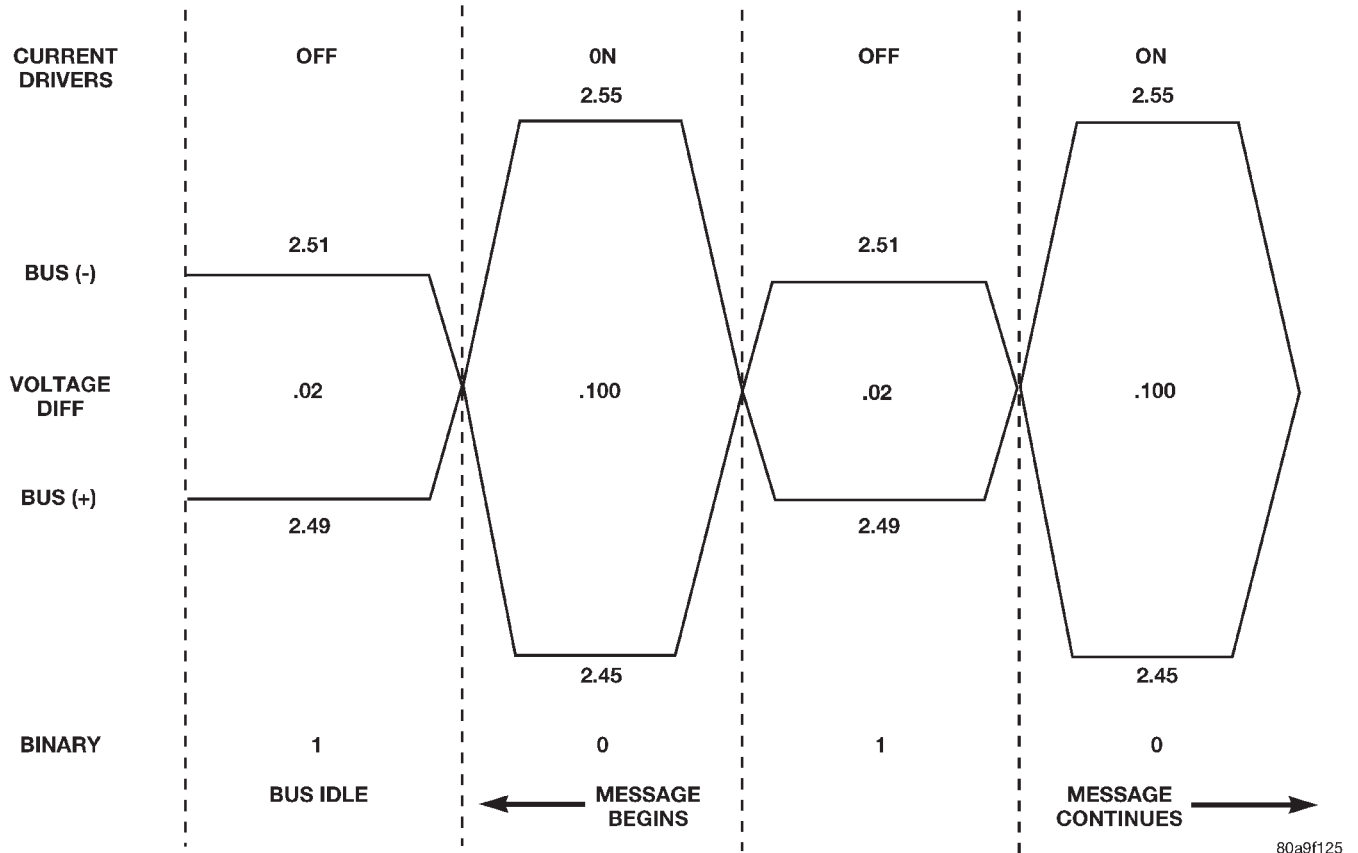
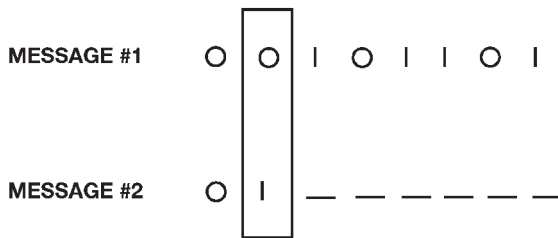


Fig. 4 Voltage Cycling to Correspond to Message



MESSAGE #2 LOSES ARBITRATION AT SECOND BIT AND THE CCD CHIP STOPS TRANSMITTING THE MESSAGE.

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Fig. 5 Message Arbitration

that it requires, the rest of the message is monitored and processed.

TRANSMISSION VERIFICATION

Once a CCD chip transmits a message over the CCD data bus, the message is received by the transmitting module at the same time through the CCD chip differential transceiver. The module knows the message was broadcast correctly when it receives its own message back. If the message received does not

match the message transmitted, the message is said to be corrupt.

Corruption occurs when the message is incorrectly transmitted on the data bus. Corruption can also occur from interference, wiring problems, or other data bus problems. In the case of a corrupt message, the module attempts to have the CCD chip re-send the message.

DIAGNOSIS AND TESTING - CCD DATA BUS

CCD BUS FAILURE

The CCD data bus can be monitored using the DRB III®. However, it is possible for the data bus to pass all tests since the voltage parameters will be in "range" and false signals are being sent. There are essentially 12 "hard failures" that can occur with the CCD data bus:

- Bus Shorted to Battery
- Bus Shorted to 5 Volts
- Bus Shorted to Ground
- Bus (+) Shorted to Bus (-)
- Bus (-) and Bus (+) Open
- Bus (+) Open
- Bus (-) Open
- No Bus Bias
- Bus Bias Level Too High

COMMUNICATION (Continued)

- Bus Bias Level Too Low
  - No Bus Termination
  - Not Receiving Bus Messages Correctly
- Refer to the proper Diagnostic Procedures manual for details on how to diagnose these faults using a DRB III® scan tool.

**BUS FAILURE VISUAL SYMPTOM DIAGNOSIS**

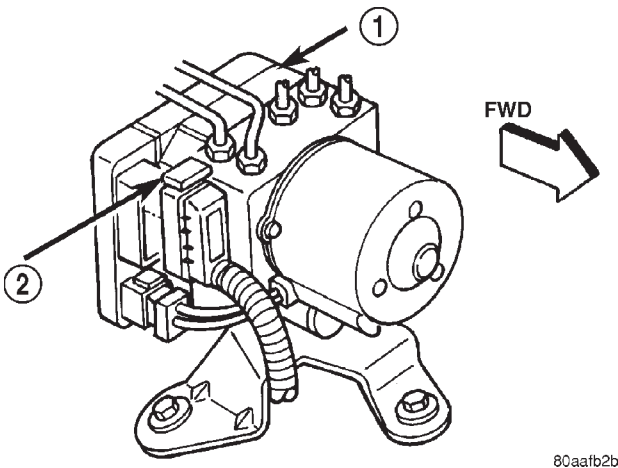
The following visible symptoms or customer complaints, alone or in combination, may indicate a CCD data bus failure:

- Airbag Indicator Lamp and Malfunction Indicator Lamp (MIL) Illuminated
- Instrument Cluster Gauges (All) Inoperative
- No Remote Keyless Entry (RKE) Operation
- No Compass Mini Trip Computer (CMTC) Operation

**CONTROLLER ANTILOCK BRAKE**

**REMOVAL**

- (1) Remove negative battery cable from the battery.
- (2) Pull up on the CAB harness connector release (Fig. 6) and remove connector.



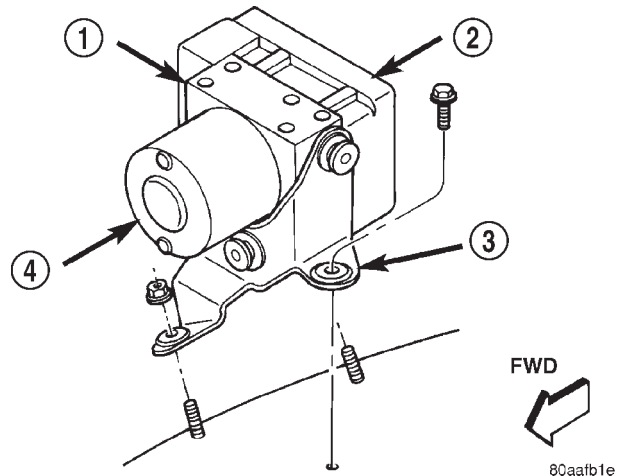
**Fig. 6 CAB Harness Connector Release**

- 1 - CAB
- 2 - CAB HARNESS RELEASE

- (3) Remove brake lines from the HCU.
- (4) Remove HCU/CAB mounting nuts and bolt (Fig. 7) and remove HCU/CAB.

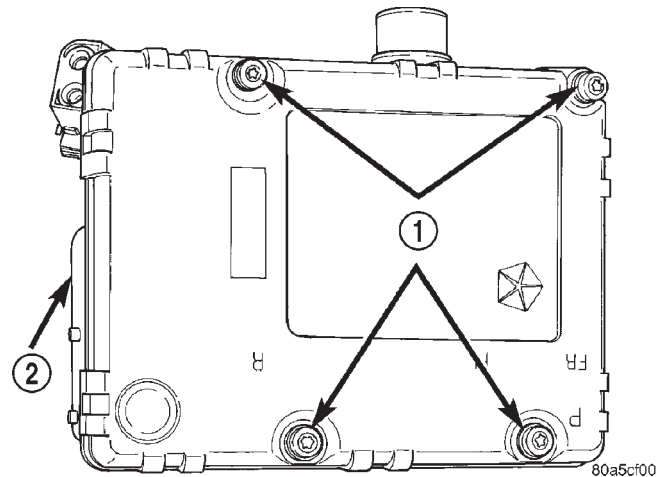
**DISASSEMBLY**

- (1) Remove pump motor connector from the CAB.
- (2) Remove CAB mounting screws from the HCU (Fig. 8).
- (3) Remove CAB from the HCU.



**Fig. 7 HCU/CAB Mounting**

- 1 - HCU
- 2 - CAB
- 3 - HCU/CAB BRACKET
- 4 - MOTOR



**Fig. 8 CAB Mounting**

- 1 - MOUNTING SCREWS
- 2 - CAB

**ASSEMBLY**

- (1) Install the CAB onto the HCU.
- (2) Install the CAB mounting screws and tighten to 1.8 N·m (16 in. lbs.).
- (3) Install pump motor connector to the CAB.

**INSTALLATION**

- (1) Install HCU/CAB on the mounting studs.
- (2) Install mounting nuts and bolt. Tighten to 11.5 N·m (102 in. lbs.).
- (3) Install brake lines to the HCU and tighten to 19 N·m (170 in. lbs.).

## CONTROLLER ANTILOCK BRAKE (Continued)

- (4) Install wiring harness connector to the CAB and push down on the release to secure the connector.
- (5) Install negative battery cable to the battery.
- (6) Bleed ABS brake system.

## DATA LINK CONNECTOR

## DESCRIPTION - DATA LINK CONNECTOR

The data link connector is located at the lower edge of the instrument panel near the steering column.

## OPERATION - DATA LINK CONNECTOR

The 16-way data link connector (diagnostic scan tool connector) links the Diagnostic Readout Box (DRB) scan tool or the Mopar Diagnostic System (MDS) with the Powertrain Control Module (PCM).

## POWERTRAIN CONTROL MODULE

## DESCRIPTION - PCM

The Powertrain Control Module (PCM) is located in the engine compartment (Fig. 9). The PCM is referred to as JTEC.

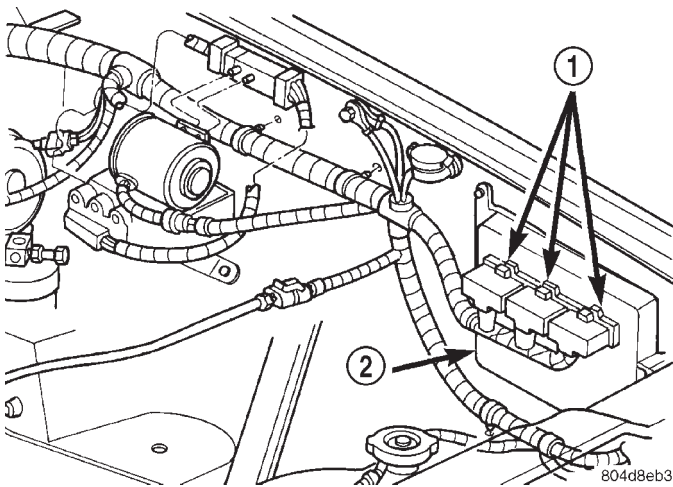


Fig. 9 PCM Location

- 1 - (3) 32-WAY CONNECTORS  
2 - PCM

## MODES OF OPERATION

As input signals to the Powertrain Control Module (PCM) change, the PCM adjusts its response to the output devices. For example, the PCM must calculate different injector pulse width and ignition timing for idle than it does for wide open throttle (WOT).

The PCM will operate in two different modes: **Open Loop and Closed Loop.**

During Open Loop modes, the PCM receives input signals and responds only according to preset PCM programming. Input from the oxygen (O<sub>2</sub>S) sensors is not monitored during Open Loop modes.

During Closed Loop modes, the PCM will monitor the oxygen (O<sub>2</sub>S) sensors input. This input indicates to the PCM whether or not the calculated injector pulse width results in the ideal air-fuel ratio. This ratio is 14.7 parts air-to-1 part fuel. By monitoring the exhaust oxygen content through the O<sub>2</sub>S sensor, the PCM can fine tune the injector pulse width. This is done to achieve optimum fuel economy combined with low emission engine performance.

The fuel injection system has the following modes of operation:

- Ignition switch ON
- Engine start-up (crank)
- Engine warm-up
- Idle
- Cruise
- Acceleration
- Deceleration
- Wide open throttle (WOT)
- Ignition switch OFF

The ignition switch On, engine start-up (crank), engine warm-up, acceleration, deceleration and wide open throttle modes are Open Loop modes. The idle and cruise modes, (with the engine at operating temperature) are Closed Loop modes.

## IGNITION SWITCH (KEY-ON) MODE

This is an Open Loop mode. When the fuel system is activated by the ignition switch, the following actions occur:

- The PCM pre-positions the idle air control (IAC) motor.
- The PCM determines atmospheric air pressure from the MAP sensor input to determine basic fuel strategy.
- The PCM monitors the engine coolant temperature sensor input. The PCM modifies fuel strategy based on this input.
- Intake manifold air temperature sensor input is monitored.
- Throttle position sensor (TPS) is monitored.
- The auto shutdown (ASD) relay is energized by the PCM for approximately three seconds.
- The fuel pump is energized through the fuel pump relay by the PCM. The fuel pump will operate for approximately three seconds unless the engine is operating or the starter motor is engaged.
- The O<sub>2</sub>S sensor heater element is energized via the ASD relay. The O<sub>2</sub>S sensor input is not used by

## POWERTRAIN CONTROL MODULE (Continued)

the PCM to calibrate air-fuel ratio during this mode of operation.

**ENGINE START-UP MODE**

This is an Open Loop mode. The following actions occur when the starter motor is engaged.

The PCM receives inputs from:

- Battery voltage
- Engine coolant temperature sensor
- Crankshaft position sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal

The PCM monitors the crankshaft position sensor. If the PCM does not receive a crankshaft position sensor signal within 3 seconds of cranking the engine, it will shut down the fuel injection system.

The fuel pump is activated by the PCM through the fuel pump relay.

Voltage is applied to the fuel injectors with the ASD relay via the PCM. The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.

The PCM determines the proper ignition timing according to input received from the crankshaft position sensor.

**ENGINE WARM-UP MODE**

This is an Open Loop mode. During engine warm-up, the PCM receives inputs from:

- Battery voltage
- Crankshaft position sensor
- Engine coolant temperature sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)
- Park/neutral switch (gear indicator signal—auto. trans. only)
- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)

Based on these inputs the following occurs:

• Voltage is applied to the fuel injectors with the ASD relay via the PCM. The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.

• The PCM adjusts engine idle speed through the idle air control (IAC) motor and adjusts ignition timing.

• The PCM operates the A/C compressor clutch through the A/C compressor clutch relay. This is done if A/C has been selected by the vehicle operator and

specified pressures are met at the high and low-pressure A/C switches. Refer to Group 24, Heating and Air Conditioning for additional information.

• When engine has reached operating temperature, the PCM will begin monitoring O<sub>2</sub>S sensor input. The system will then leave the warm-up mode and go into closed loop operation.

**IDLE MODE**

When the engine is at operating temperature, this is a Closed Loop mode. At idle speed, the PCM receives inputs from:

- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)
- Battery voltage
- Crankshaft position sensor
- Engine coolant temperature sensor
- Extended idle switch (4.0L engine with police package only)
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)
- Battery voltage
- Park/neutral switch (gear indicator signal—auto. trans. only)
- Oxygen sensors

Based on these inputs, the following occurs:

• Voltage is applied to the fuel injectors with the ASD relay via the PCM. The PCM will then control injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.

• The PCM monitors the O<sub>2</sub>S sensor input and adjusts air-fuel ratio by varying injector pulse width. It also adjusts engine idle speed through the idle air control (IAC) motor.

• The PCM adjusts ignition timing by increasing and decreasing spark advance.

• The PCM operates the A/C compressor clutch through the A/C compressor clutch relay. This is done if A/C has been selected by the vehicle operator and specified pressures are met at the high and low-pressure A/C switches. Refer to Group 24, Heating and Air Conditioning for additional information.

The optional Extended Idle Switch is used to raise and hold the engine idle speed to approximately 1000 rpm. This is when the shifter is in either the Park or Neutral position and throttle pedal is not used. A rocker-type switch (extended idle switch) is mounted to the instrument panel. This switch will supply a ground circuit (input) to the PCM. **The switch is available only with 4.0L engine when supplied with optional police package.**

## POWERTRAIN CONTROL MODULE (Continued)

**CRUISE MODE**

When the engine is at operating temperature, this is a Closed Loop mode. At cruising speed, the PCM receives inputs from:

- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)
- Battery voltage
- Engine coolant temperature sensor
- Crankshaft position sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)
- Park/neutral switch (gear indicator signal—auto, trans. only)

- Oxygen (O<sub>2</sub>S) sensors

Based on these inputs, the following occurs:

- Voltage is applied to the fuel injectors with the ASD relay via the PCM. The PCM will then adjust the injector pulse width by turning the ground circuit to each individual injector on and off.
- The PCM monitors the O<sub>2</sub>S sensor input and adjusts air-fuel ratio. It also adjusts engine idle speed through the idle air control (IAC) motor.
- The PCM adjusts ignition timing by turning the ground path to the coil on and off.
- The PCM operates the A/C compressor clutch through the clutch relay. This happens if A/C has been selected by the vehicle operator and requested by the A/C thermostat.

**ACCELERATION MODE**

This is an Open Loop mode. The PCM recognizes an abrupt increase in throttle position or MAP pressure as a demand for increased engine output and vehicle acceleration. The PCM increases injector pulse width in response to increased throttle opening.

**DECELERATION MODE**

When the engine is at operating temperature, this is an Open Loop mode. During hard deceleration, the PCM receives the following inputs.

- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)
- Battery voltage
- Engine coolant temperature sensor
- Crankshaft position sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)
- Park/neutral switch (gear indicator signal—auto, trans. only)
- Vehicle speed sensor

If the vehicle is under hard deceleration with the proper rpm and closed throttle conditions, the PCM will ignore the oxygen sensor input signal. The PCM will enter a fuel cut-off strategy in which it will not supply a ground to the injectors. If a hard deceleration does not exist, the PCM will determine the proper injector pulse width and continue injection.

Based on the above inputs, the PCM will adjust engine idle speed through the idle air control (IAC) motor.

The PCM adjusts ignition timing by turning the ground path to the coil on and off.

**WIDE OPEN THROTTLE MODE**

This is an Open Loop mode. During wide open throttle operation, the PCM receives the following inputs.

- Battery voltage
- Crankshaft position sensor
- Engine coolant temperature sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)

During wide open throttle conditions, the following occurs:

- Voltage is applied to the fuel injectors with the ASD relay via the PCM. The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off. The PCM ignores the oxygen sensor input signal and provides a predetermined amount of additional fuel. This is done by adjusting injector pulse width.
- The PCM adjusts ignition timing by turning the ground path to the coil on and off.

**IGNITION SWITCH OFF MODE**

When ignition switch is turned to OFF position, the PCM stops operating the injectors, ignition coil, ASD relay and fuel pump relay.

**DESCRIPTION - 5 VOLT SUPPLIES**

Two different Powertrain Control Module (PCM) five volt supply circuits are used; primary and secondary.

**DESCRIPTION - IGNITION CIRCUIT SENSE**

This circuit ties the ignition switch to the Powertrain Control Module (PCM).

**DESCRIPTION - POWER GROUNDS**

The Powertrain Control Module (PCM) has 2 main grounds. Both of these grounds are referred to as power grounds. All of the high-current, noisy, electri-

## POWERTRAIN CONTROL MODULE (Continued)

cal devices are connected to these grounds as well as all of the sensor returns. The sensor return comes into the sensor return circuit, passes through noise suppression, and is then connected to the power ground.

The power ground is used to control ground circuits for the following PCM loads:

- Generator field winding
- Fuel injectors
- Ignition coil(s)
- Certain relays/solenoids
- Certain sensors

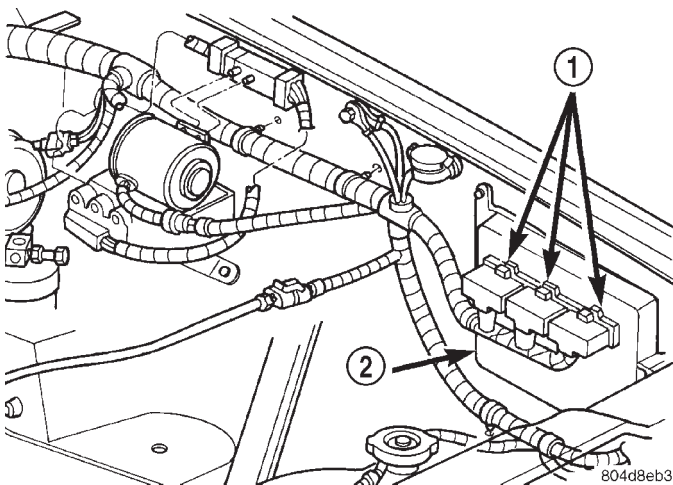
**DESCRIPTION - SENSOR RETURN**

The Sensor Return circuits are internal to the Powertrain Control Module (PCM).

Sensor Return provides a low-noise ground reference for all engine control system sensors. Refer to Power Grounds for more information.

**OPERATION - PCM**

The PCM operates the fuel system. The PCM is a pre-programmed, triple microprocessor digital computer. It regulates ignition timing, air-fuel ratio, emission control devices, charging system, certain transmission features, speed control, air conditioning compressor clutch engagement and idle speed. The PCM can adapt its programming to meet changing operating conditions.



**Fig. 10 PCM Location**

- 1 - (3) 32-WAY CONNECTORS  
2 - PCM

The PCM receives input signals from various switches and sensors. Based on these inputs, the PCM regulates various engine and vehicle operations through different system components. These components are referred to as Powertrain Control Module (PCM) Outputs. The sensors and switches that pro-

vide inputs to the PCM are considered Powertrain Control Module (PCM) Inputs.

The PCM adjusts ignition timing based upon inputs it receives from sensors that react to: engine rpm, manifold absolute pressure, engine coolant temperature, throttle position, transmission gear selection (automatic transmission), vehicle speed, power steering pump pressure (2.5L engine only), and the brake switch.

The PCM adjusts idle speed based on inputs it receives from sensors that react to: throttle position, vehicle speed, transmission gear selection, engine coolant temperature and from inputs it receives from the air conditioning clutch switch and brake switch.

Based on inputs that it receives, the PCM adjusts ignition coil dwell. The PCM also adjusts the generator charge rate through control of the generator field and provides speed control operation.

**NOTE: PCM Inputs:**

- A/C request (if equipped with factory A/C)
- A/C select (if equipped with factory A/C)
- Auto shutdown (ASD) sense
- Battery temperature
- Battery voltage
- Brake switch
- CCD bus (+) circuits
- CCD bus (-) circuits
- Camshaft position sensor signal
- Crankshaft position sensor
- Data link connection for DRB scan tool
- Engine coolant temperature sensor
- Extended idle switch (4.0L engine with police package)
  - Fuel level
  - Generator (battery voltage) output
  - Ignition circuit sense (ignition switch in on/off/crank/run position)
  - Intake manifold air temperature sensor
  - Leak detection pump (switch) sense (if equipped)
  - Manifold absolute pressure (MAP) sensor
  - Oil pressure
  - Oxygen sensors
  - Park/neutral switch (auto. trans. only)
  - Power ground
  - Power steering pressure switch (2.5L engine only)
- Sensor return
- Signal ground
- Speed control multiplexed single wire input
- Throttle position sensor
- Vehicle speed sensor

**NOTE: PCM Outputs:**

- A/C clutch relay

## POWERTRAIN CONTROL MODULE (Continued)

- Auto shutdown (ASD) relay
- CCD bus (+/-) circuits for: speedometer, voltmeter, fuel gauge, oil pressure gauge/lamp, engine temp. gauge and speed control warn. lamp
- Data link connection for DRB scan tool
- EGR valve control solenoid (if equipped)
- EVAP canister purge solenoid
- Five volt sensor supply (primary)
- Five volt sensor supply (secondary)
- Fuel injectors
- Fuel pump relay
- Generator field driver (-)
- Generator field driver (+)
- Idle air control (IAC) motor
- Ignition coil
- Leak detection pump (if equipped)
- Malfunction indicator lamp (Check engine lamp). Driven through CCD circuits.
- Radiator cooling fan relay
- Speed control vacuum solenoid
- Speed control vent solenoid
- Tachometer (if equipped). Driven through CCD circuits.
- Transmission convertor clutch circuit

## OPERATION - 5 VOLT SUPPLIES

Primary 5-volt supply:

- supplies the required 5 volt power source to the Crankshaft Position (CKP) sensor.
- supplies the required 5 volt power source to the Camshaft Position (CMP) sensor.
- supplies a reference voltage for the Manifold Absolute Pressure (MAP) sensor.
- supplies a reference voltage for the Throttle Position Sensor (TPS) sensor.

Secondary 5-volt supply:

- supplies the required 5 volt power source to the oil pressure sensor.
- supplies the required 5 volt power source for the Vehicle Speed Sensor (VSS) (if equipped).
- supplies the 5 volt power source to the transmission pressure sensor (if equipped with an RE automatic transmission).

## OPERATION - IGNITION CIRCUIT SENSE

The ignition circuit sense input tells the PCM the ignition switch has energized the ignition circuit.

Battery voltage is also supplied to the PCM through the ignition switch when the ignition is in the RUN or START position. This is referred to as the "ignition sense" circuit and is used to "wake up" the PCM. Voltage on the ignition input can be as low as 6 volts and the PCM will still function. Voltage is supplied to this circuit to power the PCM's 8-volt regulator and to allow the PCM to perform fuel, ignition and emissions control functions.

## REMOVAL

**USE THE DRB SCAN TOOL TO REPROGRAM THE NEW POWERTRAIN CONTROL MODULE (PCM) WITH THE VEHICLES ORIGINAL IDENTIFICATION NUMBER (VIN) AND THE VEHICLES ORIGINAL MILEAGE. IF THIS STEP IS NOT DONE, A DIAGNOSTIC TROUBLE CODE (DTC) MAY BE SET.**

The PCM is located in the engine compartment next to the air cleaner assembly (Fig. 11).

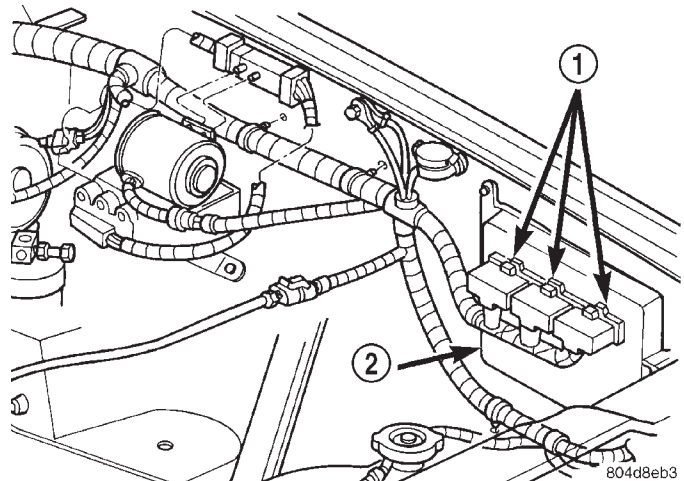


Fig. 11 PCM Location

- 1 - (3) 32-WAY CONNECTORS  
2 - PCM

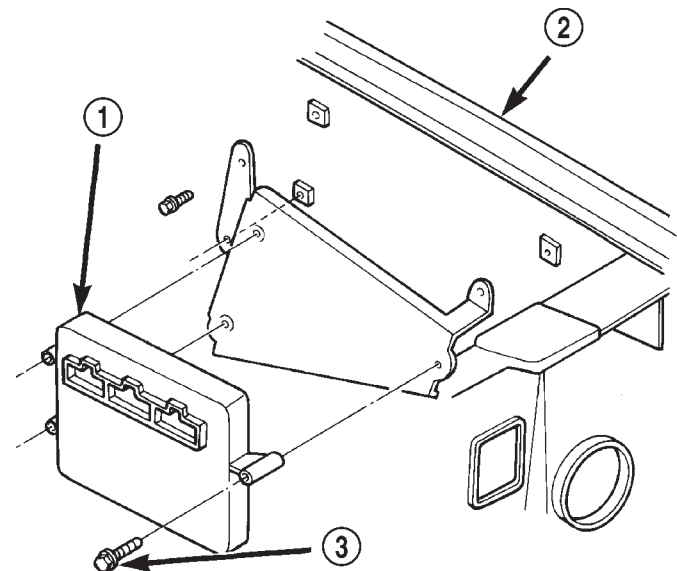


Fig. 12 PCM Mounting

- 1 - PCM  
2 - L.F. FENDER  
3 - PCM MOUNTING BOLTS (3)