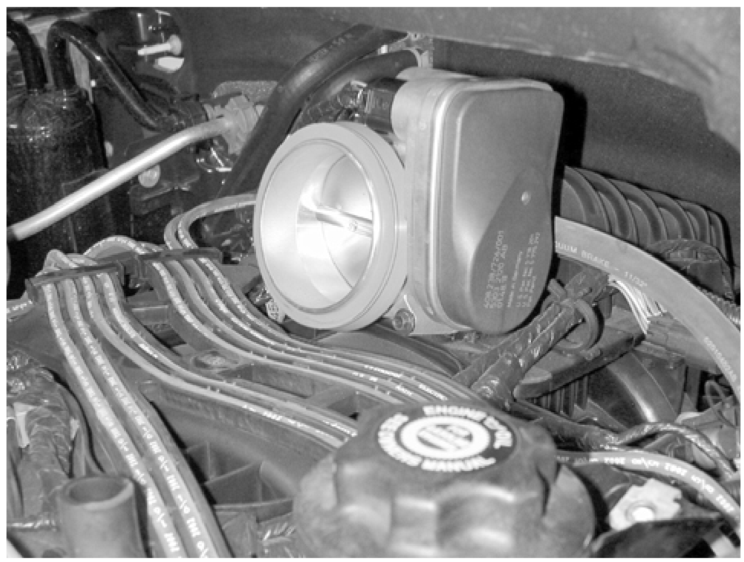
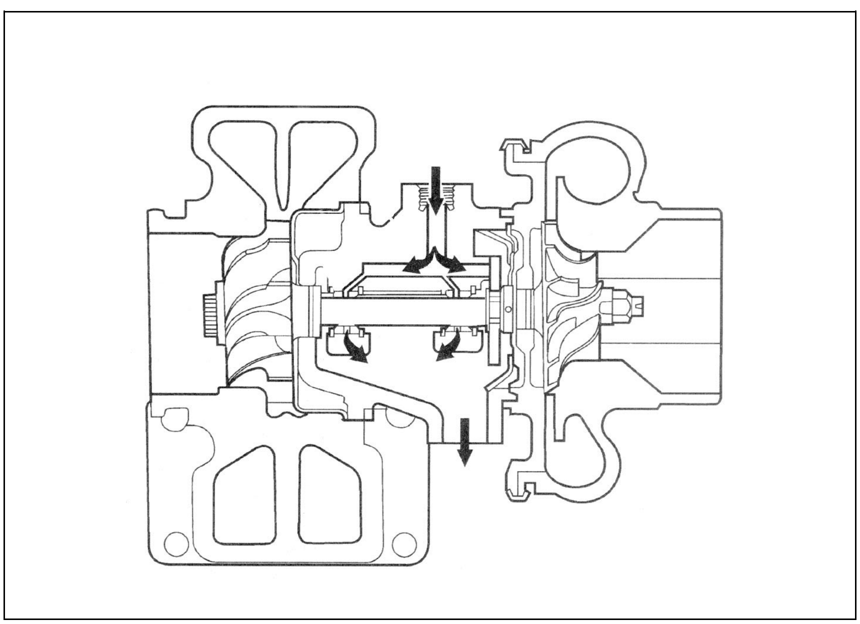
NEXT GENERATION CONTROLLER LEVEL 5 UPDATE

Course Code 0850708



5.7L NGC II Electronic Throttle Body



2.4L Turbo

TABLE OF CONTENTS

INTRODUCTION

The Next Generation Controller II (NGC II) is the new torque-based Powertrain Control Module (PCM) used on 2003 DR models with the 5.7L HEMI engine. The NGC II system features Electronic Throttle Control (ETC) and integrated Speed Control. Transmission control is not integral with the NGC II PCM but is provided by a separate Electronic Automatic Transmission Controller (EATX). This is the only current application for NGC II.

The 5.7L engine is not the first use of ETC on a Chrysler Group vehicle. The 1.6L Neon sold in Europe is already equipped with an electronic throttle. Although slightly different, this system is very similar.

Why Electronic Throttle Control? ETC is a torque management system. The PCM monitors many inputs, only one of which is the driver's accelerator pedal position. The PCM calculates the torque requirement based on those inputs and then commands actuators to vary ignition timing, fuel quantity and intake air volume as needed to supply optimum torque.

Torque management can better match engine performance to vehicle characteristics and can vary with changing operating conditions. These include changes in altitude, temperature, emissions-related activities and loads. The result is smoother vehicle and engine speed limiting, and improved launch in manual transmission applications.

Gasoline powered engines are air-throttled, and the quantity of air admitted has direct control over engine speed and power. With conventional throttle control, the PCM can only react to throttle plate position and the effects of the resultant airflow. The correct amount of fuel is added to achieve the desired air-fuel ratio.

Diesel engines, for comparison, are fuel-throttled. A Diesel engine has no throttle plate and permits unrestricted air intake at all times. Its power and speed are controlled by regulating how much fuel is admitted. The 5.7L with ETC is a gasoline engine and therefore it must control the amount of air admitted.

ETC will make it easier in the future to add new systems that benefit from electronic control of the throttle. These include Multiple Displacement Engines, Stability Control and new transmission designs. NGC III PCMs will appear in 2004 and will incorporate ETC and transmission control functions.

STUDENT LEARNING OBJECTIVES

Upon completion of this course, you should be able to:

- Identify and describe the hardware and operation of the NGC II PCM with Electronic Throttle Control (ETC).
- Describe the operation of the ETC system and Coil On Plug waste spark ignition.
- Describe the operation of the PCV system on the 5.7L HEMI engine.
- Explain the operation of the new speed control system on the 5.7L HEMI engine with ETC.
- Demonstrate how to retrieve DTCs and diagnose components of the ETC system.
- Identify and describe the hardware and operation of the 2.4L turbo engine.
- Demonstrate how to diagnose components of the 2.4L turbo engine.

ACRONYMS

The acronyms listed here are used throughout this course:

- APPS Accelerator Pedal Position Sensor
- ASD Auto Shutdown Relay
- Baro Barometric Pressure Sensor
- CKP Crankshaft Position Sensor
- CMP Camshaft Position Sensor
- COP Coil On Plug Ignition
- CVT Continuously Variable Transmission
- DLC Data Link Connector
- DMM Digital Multimeter
- DRBIII ® Diagnostic Readout Box – 3rd Generation
- DTC Diagnostic Trouble Code
- EATX Electronic Automatic Transmission Controller
- ECT Engine Coolant Temperature Sensor
- EGR Exhaust Gas Recirculation
- ETC Electronic Throttle Control
- IAC Idle Air Control
- IAT Intake Air Temperature Sensor
- JTEC Jeep/Truck Engine Controller
- KOEO Key On Engine Off
- KOER Key On Engine Running
- LTFT Long Term Fuel Trim
- MAP Manifold Absolute Pressure Sensor
- MDS2 ® Mopar Diagnostic System – 2nd Generation
- MIL Malfunction Indicator Lamp

- NGC I Next Generation Controller 1
- NGC II Next Generation Controller 2
- NTC Negative Temperature Coefficient
- OBD II On-Board Diagnostics – 2nd Generation
- ORVR On-Board Refueling Vapor Recovery
- PCM Powertrain Control Module
- PCV Positive Crankcase Ventilation Valve
- PEP Peripheral Expansion Port
- PTC Positive Temperature Coefficient
- PWM Pulse Width Modulated
- RPM Revolutions Per Minute
- SBEC Single Board Engine Controller
- STFT Short Term Fuel Trim
- SVA Surge Valve Actuator
- TCM Transmission Control Module
- TIP Throttle Inlet Pressure Sensor
- TPS Throttle Position Sensor
- VSS Vehicle Speed Signal
- WG Wastegate
- WOT Wide Open Throttle

MODULE 1 NGC II ETC SYSTEM AND COMPONENTS

The NGC II ETC system takes conventional speed density fuel management electronics and adds an electronically controlled throttle. The throttle plate is moved by an electric motor under PCM control and is no longer mechanically connected to the accelerator pedal. Accelerator pedal position is one of several inputs to the PCM.

The PCM receives inputs from sensors, calculates the desired torque request and outputs control signals to the throttle motor, ignition and fuel injectors. In this system, the PCM manages intake airflow, ignition timing and fuel quantity control.

The NGC II PCM also handles the Speed Control function with ECT throttle plate control. No separate speed control unit or processor is required. Also, no separate Idle Air Control (IAC) valve is necessary. Idle speed is also controlled with throttle plate position.

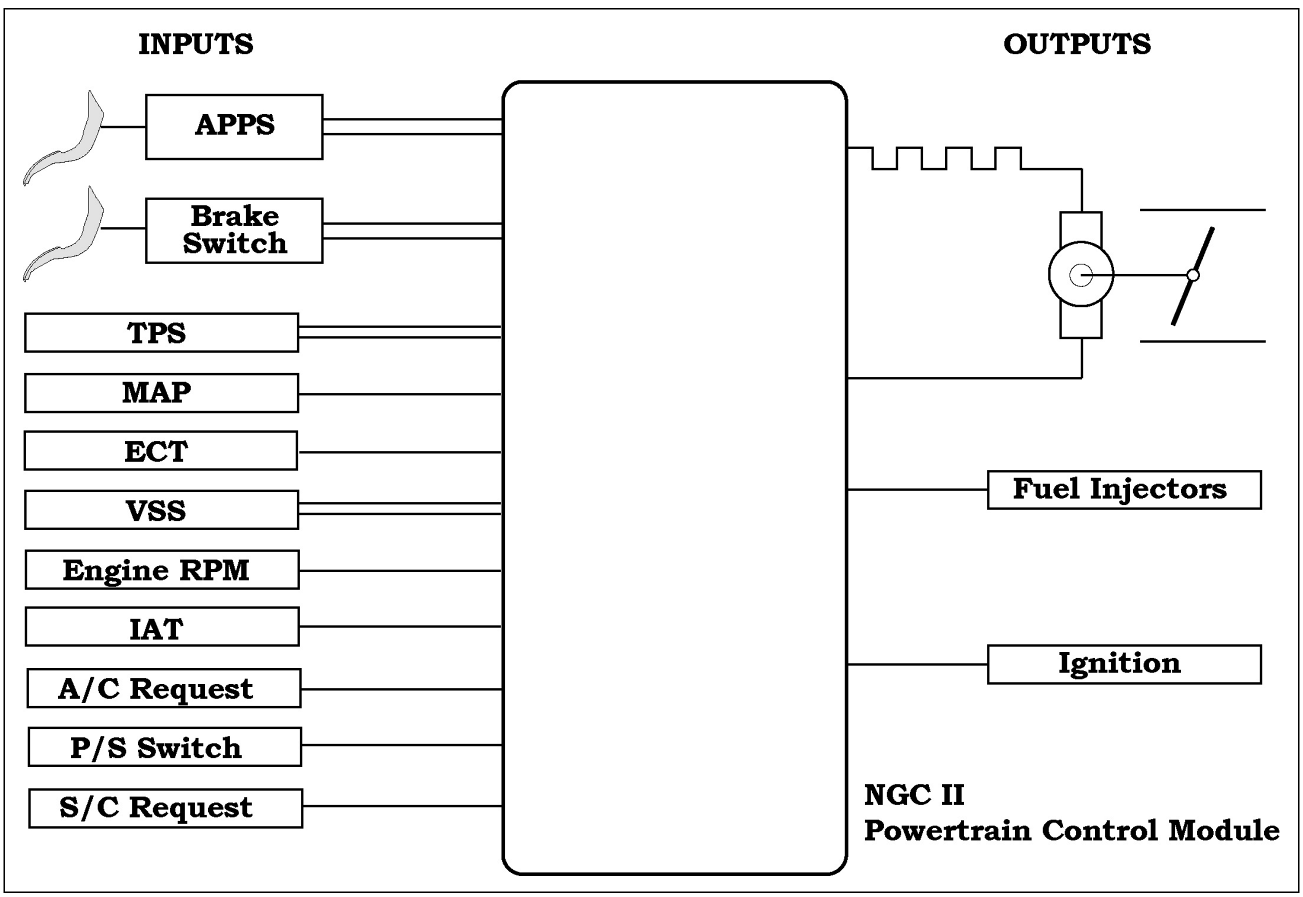


Figure 1 NGC II PCM Inputs and Outputs

SYSTEM BENEFITS

- Maximize the effectiveness of MDS, ESP, CVT, and HEV
- Improved bobble control
- Soft over-rev/over-speed
- Seamless transition into speed control
- Speed control performance not limited by available vacuum
- Potential to reduce emissions during transients
- Potential to reduce cost by eliminating IAC, speed control hardware, throttle cable

SYSTEM COMPONENTS

New or changed components required for Electronic Throttle Control include:

- Powertrain Control Module (PCM)
- Accelerator Pedal Position Sensors (APPS) (2)
- Electronic Throttle Control (ETC) Body
- Throttle Position Sensor (TPS) (2)
- Speed Control Switches
- Brake Switches (2)
- Vehicle Speed Sensors (2)
- Molded Plastic Intake Manifold
- ETC Warning Light

Familiar components that are still important:

- Intake Air Temperature (IAT) Sensor
- Manifold Air Pressure (MAP) Sensor
- Electronic Automatic Transmission Controller (EATX)

POWERTRAIN CONTROL MODULE (PCM)

PCM Manufacturers

The NGC II PCM used in DR models is currently manufactured by Motorola. NGC I PCMs are produced by the DaimlerChrysler Huntsville Electronics plant and also by Motorola.

The different controllers are not interchangeable. To distinguish, Huntsville controllers have cooling fins cast into the housing, while Motorola controllers do not. Always verify that a replacement is the correct part number.

Figure 2 5.7L NGC II PCM

PCM Location

The NGC II PCM location on DR models with the 5.7L HEMI engine is the same as models with other engines. The PCM is mounted in the engine compartment on the right rear, under the cowl. The separate EATX module is mounted near the PCM.

The PCM housing is a special alloy casting and is similar to NGC I housings. The mounting hardware is special to ensure thermal and electrical conductivity. Do not substitute other fasteners.

PCM Connectors

NGC II PCMs have four 38-pin connector sockets with color-coding stripes. The harness connectors are also color-coded. Some PCM sockets may be empty and all four harness connectors may not be used, depending upon the application.

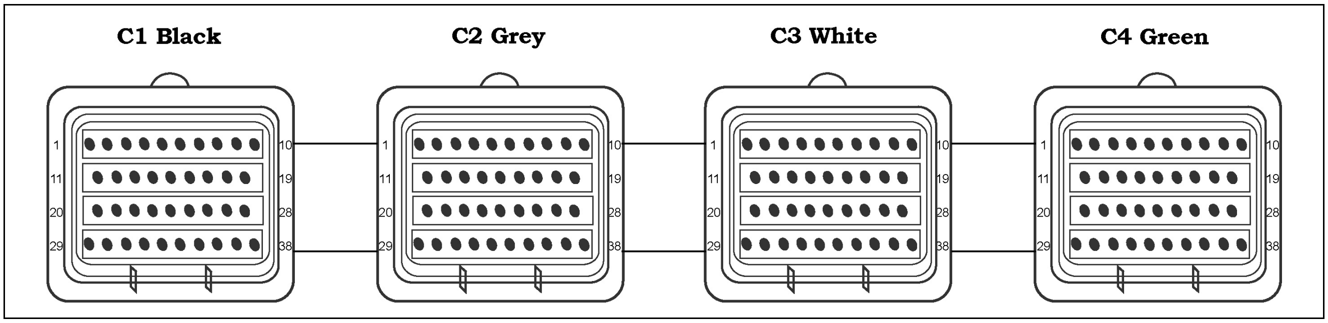


Figure 3 NGC II PCM Connectors

When diagnosing circuits, **DO NOT** probe or backprobe the PCM connectors. Damage to the connector will occur if this procedure is not followed. Two new tools have been introduced for use on all NGC I and NGC II PCM connectors: Miller #3638 Pin Removal Tool and Miller #8815 Pinout Box. Use of both reduces the possibility of connector and pin damage caused by probing or backprobing.

Figure 4 Miller #8638 Pin Removal Tool

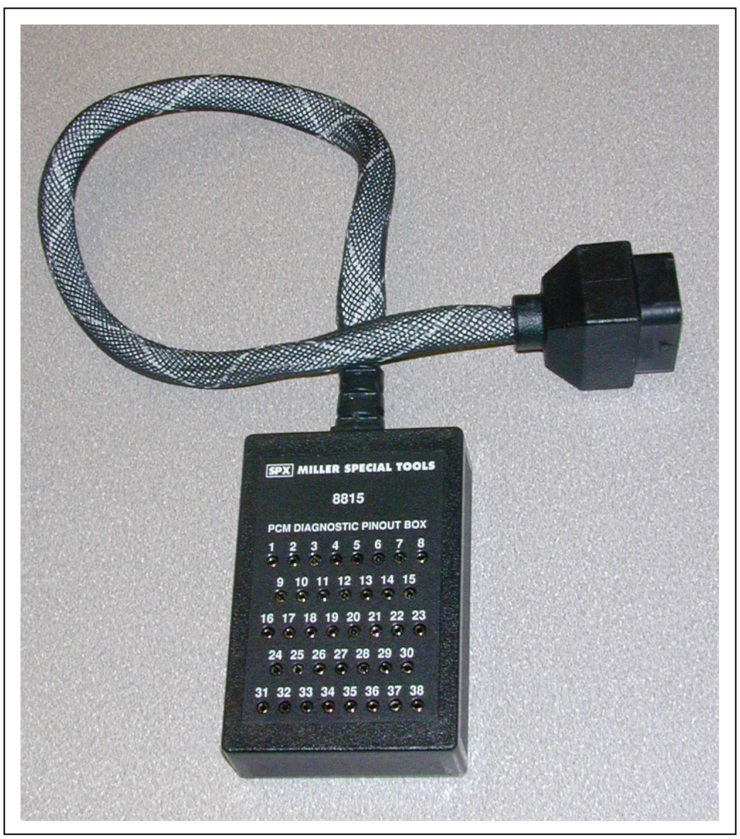


Figure 5 Miller #8815 Pinout Box

ACCELERATOR PEDAL POSITION SENSORS (APPS)

The Accelerator Pedal Position Sensor (APPS) sends a driver torque-request signal to the PCM in response to changes in accelerator pedal position. Two Hall-effect sensors are built into one housing. The sensors are located in the engine compartment on the left side, under the battery. A cable connects the accelerator pedal to a lever on the APPS unit. The cable is pulled when the pedal is depressed and causes the lever to move against a return spring. A plastic hinged cover snaps into place to protect the assembly.

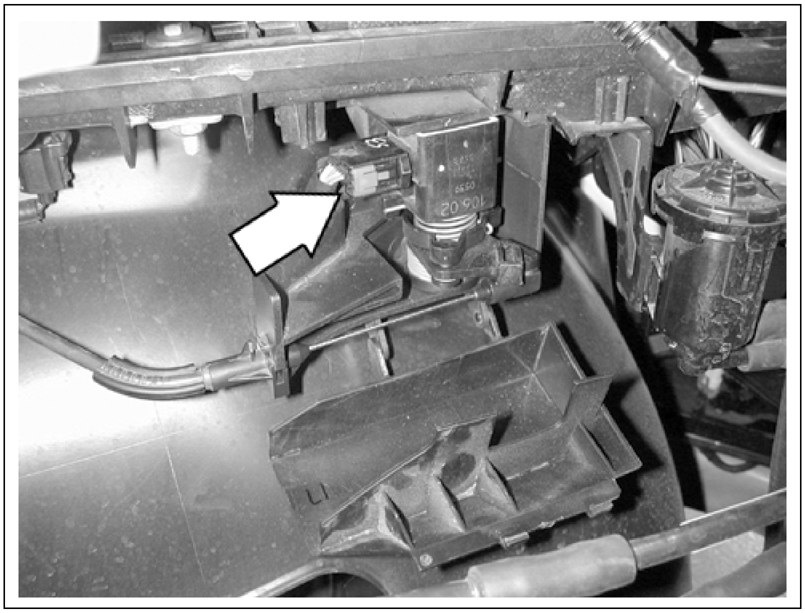


Figure 6 5.7L Accelerator Pedal Position Sensors

ETC THROTTLE BODY

The Electronic Throttle Control Body houses the throttle plate, electric actuator motor, dual throttle position sensors, gears and a spring.

The throttle actuator motor is controlled by a duty-cycle signal from the PCM. A concentric clockspring works to close the throttle plate when it is opened beyond the idle position. If electric power is lost, the spring will close the throttle to the idle position. The spring also tries to open the throttle plate when it is fully closed.

<u>WARNING</u>: KEEP FINGERS AWAY FROM THE THROTTLE PLATE WHEN THE IGNITION IS ON. DO NOT OPEN THE THROTTLE PLATE MANUALLY FOR ANY REASON. ALWAYS USE THE DRB III THROTTLE FOLLOWER TEST TO OPEN THE THROTTLE PLATE.

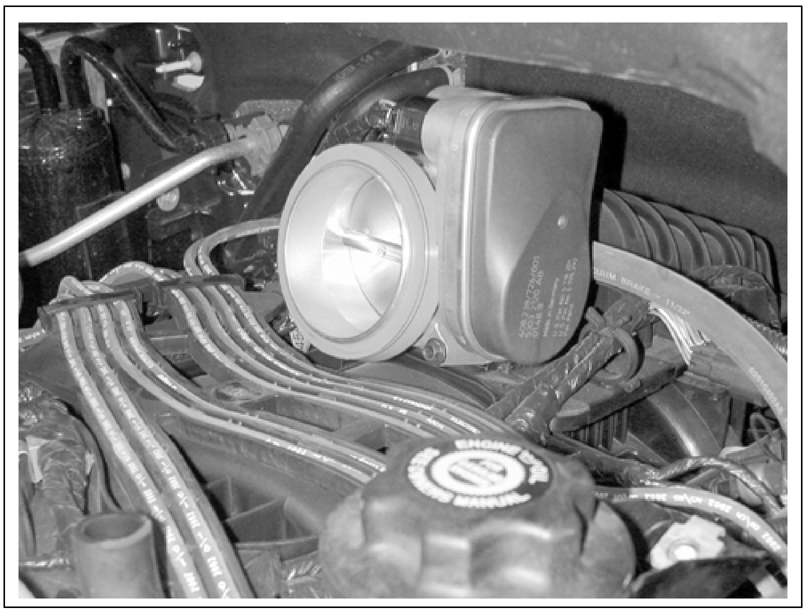
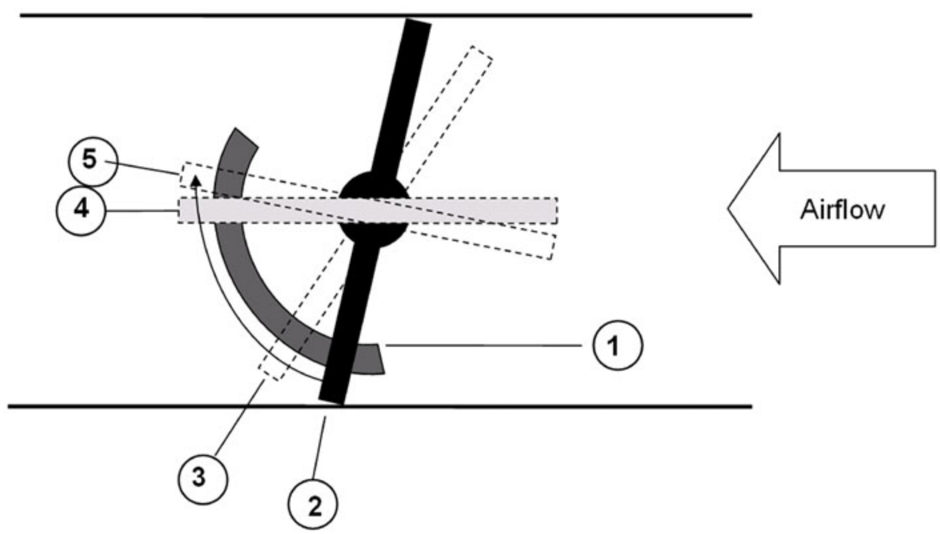


Figure 7 5.7L ETC Throttle Body

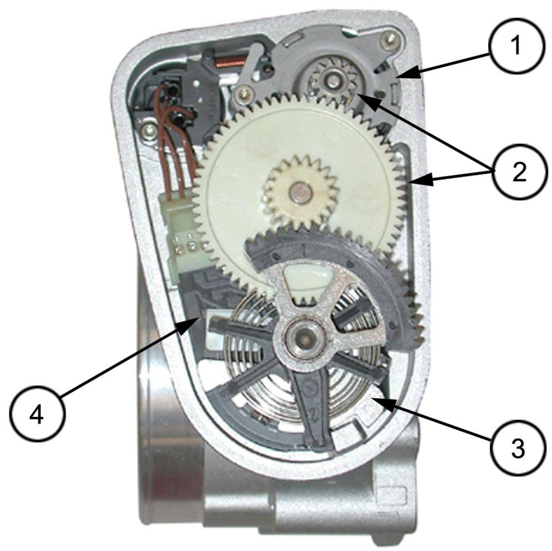


1	Position sensor range (~105°)
2	Lower Mech. Stop (DELTHR = 0.0V)
3	Mechanical Limp-Home (default) position. Defined by platform, adjusted by supplier.
4	Wide Open Throttle
5	Upper Mech. Stop

Figure 8 5.7L ETC Throttle Plate Stops

THROTTLE POSITION SENSOR (TPS)

Two Throttle Position Sensors (TPS) are built into the ETC throttle body and provide two throttle position signals to the PCM. Two sensors are used for fail-safe redundancy and error checking. The sensors output analog signals to inform the PCM that the throttle plate moves as expected.



1	Throttle Actuator Motor
2	Gears
3	Spring
4	Throttle Position Sensors (2)

Figure 9 5.7L ETC Throttle Actuator Motor, TPS, Spring and Gears

MOLDED PLASTIC INTAKE MANIFOLD

A new design molded plastic intake manifold is used on the 5.7L HEMI engine. The manifold provides mounting points for the ETC throttle body, fuel injectors, MAP sensor and PCV valve. A blocked-off port can be used for EGR in the future. Joints between the manifold, the throttle body and intake passages in the heads are sealed with silicone rubber seals.

The number of vacuum lines has been reduced. There are vacuum hose nipples for the power brake booster and EVAP purge lines.

PCV passages are internally molded to eliminate all external hoses except the PCV fresh air inlet. The PCV fresh air inlet hose is located on the left front of the engine. The hose connects the air box plenum to the oil fill tube. When removing the air box plenum, take care when disconnecting and reconnecting this hose.

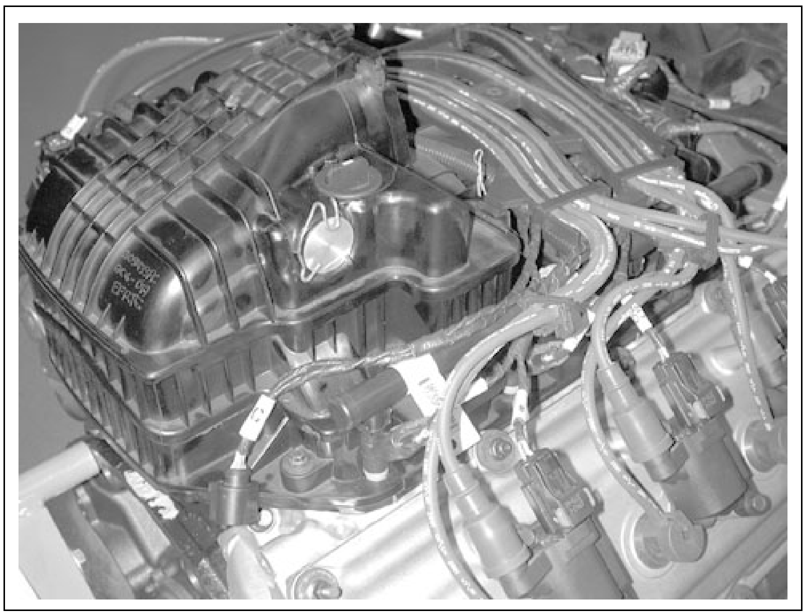


Figure 10 5.7L Plastic Intake Manifold

ETC WARNING LIGHT

The ETC Warning Light is located on the right side of the instrument panel. If a problem is detected, the light will come on while the engine is running. The light remains lit when a fault is detected and the vehicle is usually drivable. A more serious fault will cause the light to flash. A serious fault will also initiate the Limp-In mode, which will be fully described in Module 3.

The light will come on when the ignition is first turned on and will remain on briefly as a bulb check. Also, the light will come on if both the accelerator pedal and brake are depressed for 3-5 sec. This is normal and allows the system to check for a stuck throttle plate.

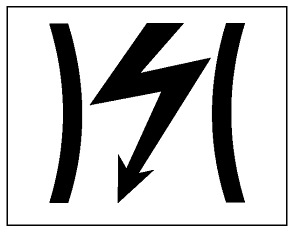


Figure 11 ETC Warning Light

INTAKE AIR TEMPERATURE (IAT) SENSOR

The Intake Air Temperature (IAT) sensor is a 2-wire Negative Thermal Coefficient (NTC) sensor installed in the intake manifold. It twist-locks in the air box plenum at the front where it can sense the temperature of incoming air. Air density is calculated from this temperature measurement.

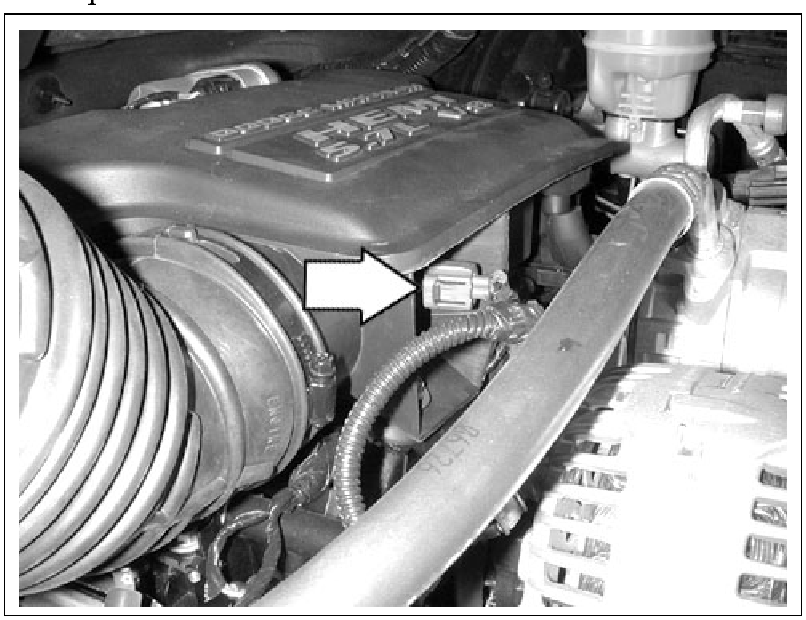


Figure 12 5.7L IAT Sensor

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The Manifold Absolute Pressure (MAP) sensor provides a major input to the PCM for determining fuel injection pulse width. The PCM also knows that the MAP signal represents barometric (atmospheric) pressure with Key On Engine Off (KOEO). The PCM updates this barometric value when the engine is running with the throttle plate commanded wide open. The MAP signal is analog and linear in proportion to manifold pressure.

The sensor twist-locks to the plastic intake manifold. Since it mounts directly to the manifold, no external sensing hose is required.

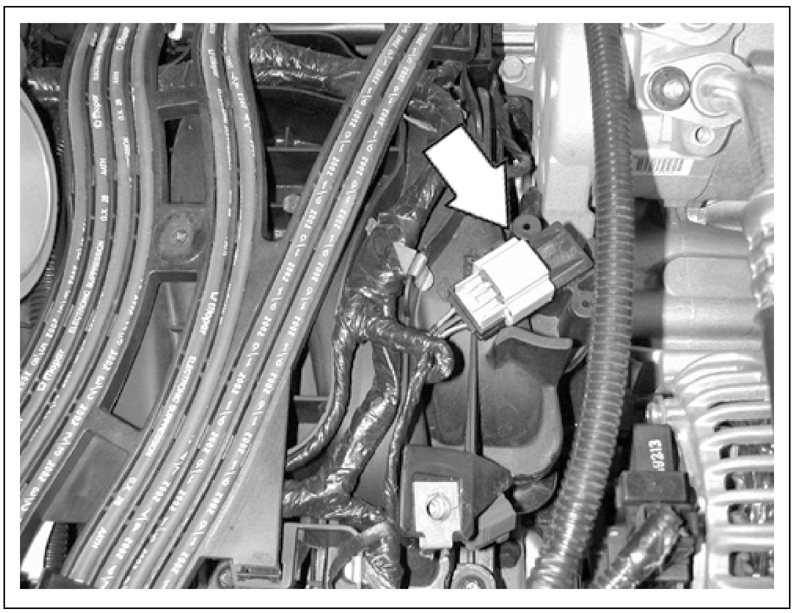


Figure 13 5.7L MAP Sensor

ELECTRONIC AUTOMATIC TRANSMISSION CONTROLLER (EATX)

Automatic transmission control on NGC II systems is provided by a separate EATX module. The NGC II PCM does not have the automatic transmission controller function built-in.

Figure 14 5.7L EATX Transmission Control Module

OTHER INPUTS

Unlike NGC I and SBEC controllers, NGC II receives two vehicle speed inputs. One input is from the rear wheel speed sensor and the other from the front.

Two brake switch inputs are also used. The switches are in a common housing near the brake pedal.

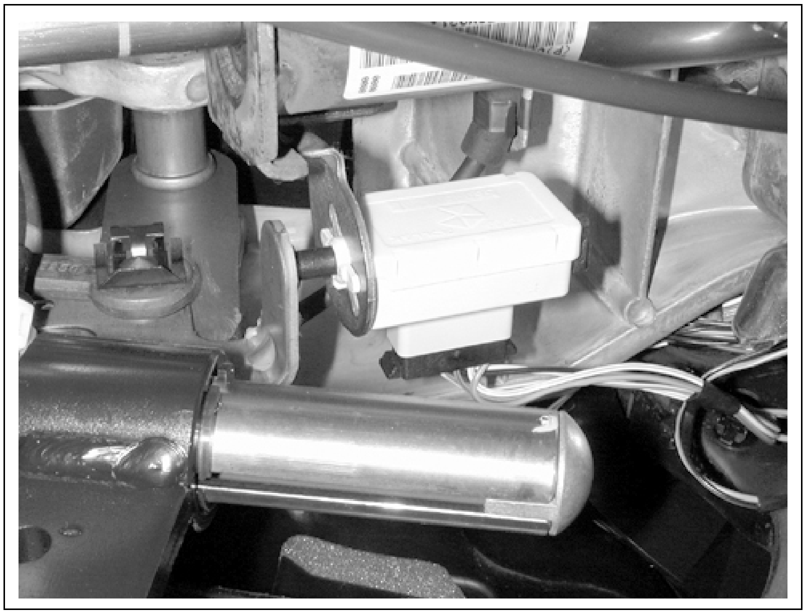


Figure 15 5.7L Brake Switch

Notes:

Notes:

ACTIVITY 1 ETC SYSTEM AND COMPONENTS

1. Locate the following ETC system components on the 5.7L engine. Write the location for each component:
2. Powertrain Control Module (PCM): ____________________
   Electronic Transmission Controller (EATX): ____________________
   Accelerator Pedal Position Sensor (APPS): ____________________
   Brake Switch: ____________________
   Electronic Throttle Control (ETC) Body: ____________________
   Intake Air Temperature (IAT) Sensor: ____________________
   Manifold Absolute Pressure (MAP) Sensor: ____________________
   Throttle Position Sensor (TPS): ____________________
   PCV Valve: ____________________
   EGR port plug: ____________________
3. Does this vehicle have a separate speed control servo?
   YES NO
   If NO, what component or components manage the speed control function?
   ____
4. Does this vehicle have a separate idle air control valve to control idle speed?
   YES NO
   If NO, what component or components manage the idle speed control function?
   ____
5. Remove the air box plenum from the classroom engine to expose the ETC throttle body assembly. Remove the IAT sensor from the air box plenum and reconnect it to the engine wiring harness.
6. Crank the engine and closely observe the throttle plate. Be sure to observe all events as the key is turned from OFF to the START position.

WARNING: KEEP FINGERS AWAY FROM THE THROTTLE PLATE WHEN THE IGNITION IS ON. DO NOT OPEN THE THROTTLE PLATE MANUALLY FOR ANY REASON. ALWAYS USE THE DRB III THROTTLE FOLLOWER TEST TO OPEN THE THROTTLE PLATE.

7. Describe throttle plate action during the start sequence: ____________________
   ____
   ____
8. Did the engine begin to crank immediately when the key was turned to the START position? Explain: ____________________

Notes:

MODULE 2 ETC CIRCUITS

The ETC system adds electronic throttle management to electronic control of other important engine systems: ignition spark timing and fuel quantity. Electronic throttle control becomes the direct responsibility of the PCM. The PCM controls the throttle plate position by actuating an electric motor. Throttle plate opening is no longer a direct input from the driver, but is determined by the PCM after evaluating various inputs.

The ETC system uses redundant sensor inputs to the NGC II controller in critical areas to allow checks and backups. Two throttle position sensors, two accelerator pedal position sensors, two brake switch inputs and two vehicle speed inputs are used.

Whether a single or redundant sensor is used, the PCM performs rationality checks by comparing sensor inputs against stored, calculated or modeled values. The type of check and how often it is done depends on the type of sensor.

ACCELERATOR PEDAL POSITION SENSORS (APPS)

Two Accelerator Pedal Position Sensors (APPS) input the driver's torque-demand signal to the PCM. The sensors are two Hall-effect sensors that provide the PCM with two voltage signals in proportion to accelerator pedal position. Redundant sensors are used because of their critical function. Failure modes will be discussed in Module 3.

The signals from the two sensors are not identical. As the throttle opens, the signal from one sensor increases at about twice the rate of the signal from the other sensor. The two sensors have completely separate circuits, with separate 5V references, signals and Grounds. See Figures 16 and 17.

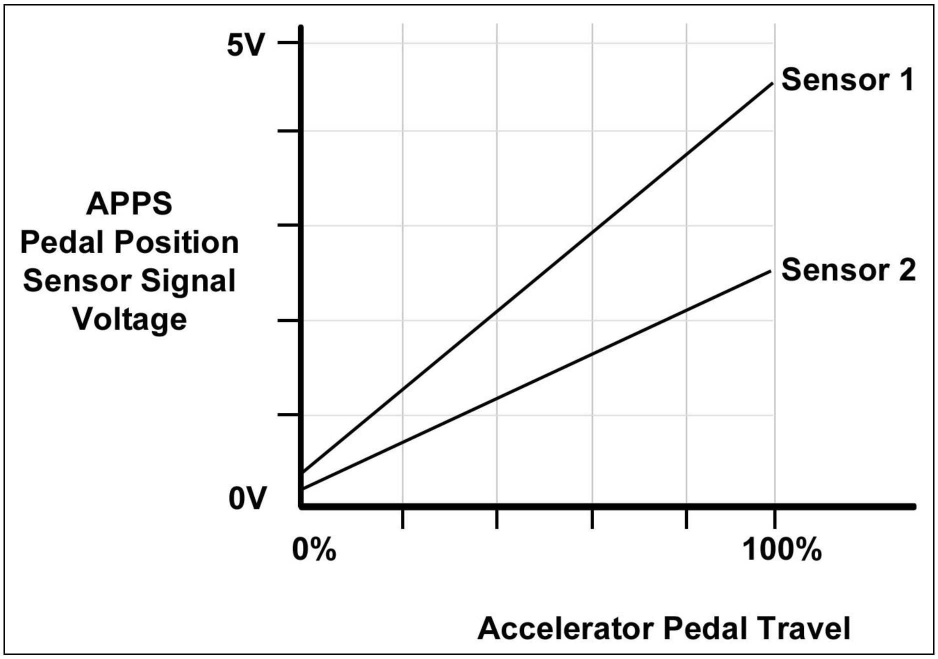


Figure 16 APPS Signal Voltages vs Accelerator Pedal Travel

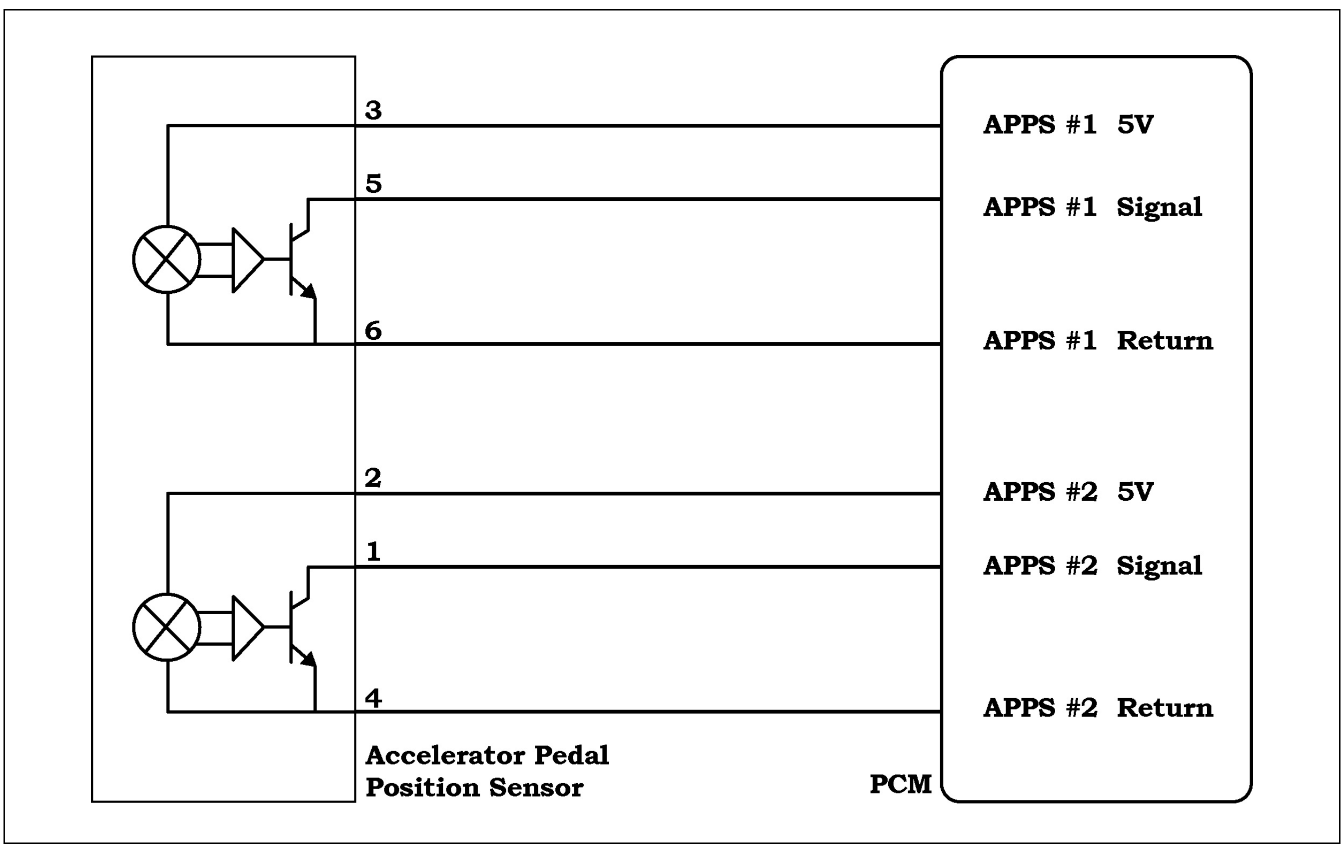


Figure 17 5.7L APPS Circuit

ETC THROTTLE BODY

The ETC throttle body has a six-pin connector for the throttle plate actuator motor and the two TPS. See Figure 18 for the pinout schematic.

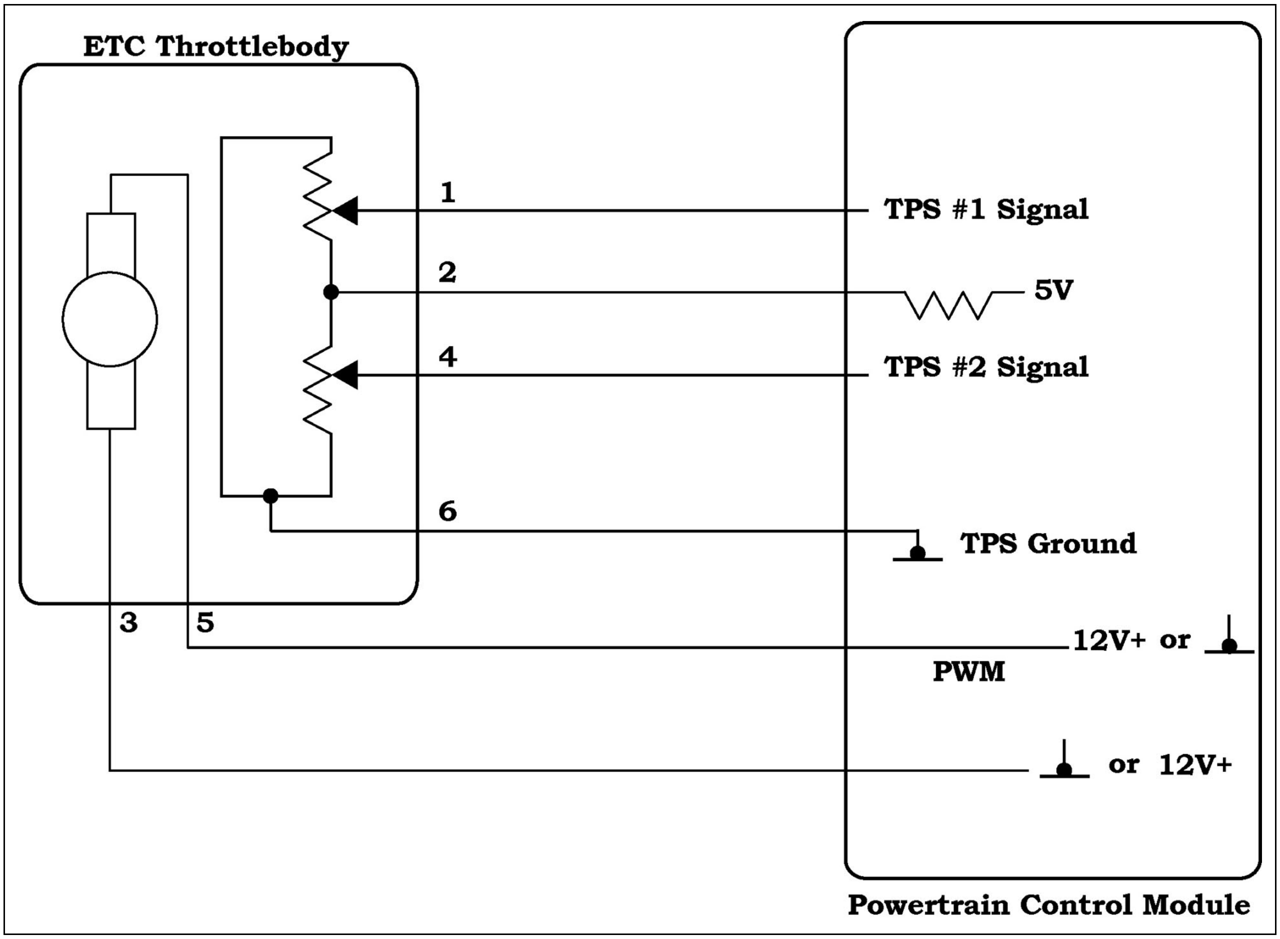


Figure 18 Electronic Throttle Control Circuit

THROTTLE PLATE MOTOR CIRCUIT

The motor circuit reverses polarity to drive the throttle plate either open or closed. ETC connector Pin 5 is the Pulse Width Modulated (PWM) side of the motor circuit. The motor circuit is completed through Pin 3. Most of the time, circuit polarity causes the actuator motor to either open the throttle plate or hold the throttle plate open against spring tension. To do this, Pin 3 is grounded and Pin 5 is powered. To reverse the motor and rapidly close the throttle, the circuit reverses polarity. Pin 3 supplies 12V and Pin 5 is grounded. Regardless of polarity, the motor circuit is always PWM on Pin 5. See Figures 19 and 20:

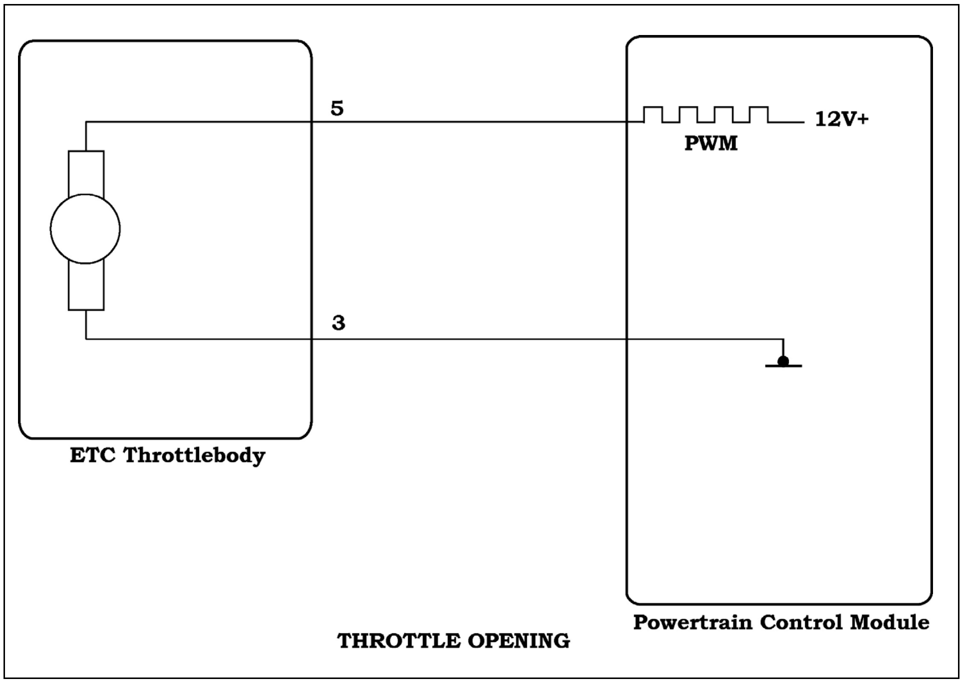


Figure 19 ETC Motor Polarity with Throttle Opening

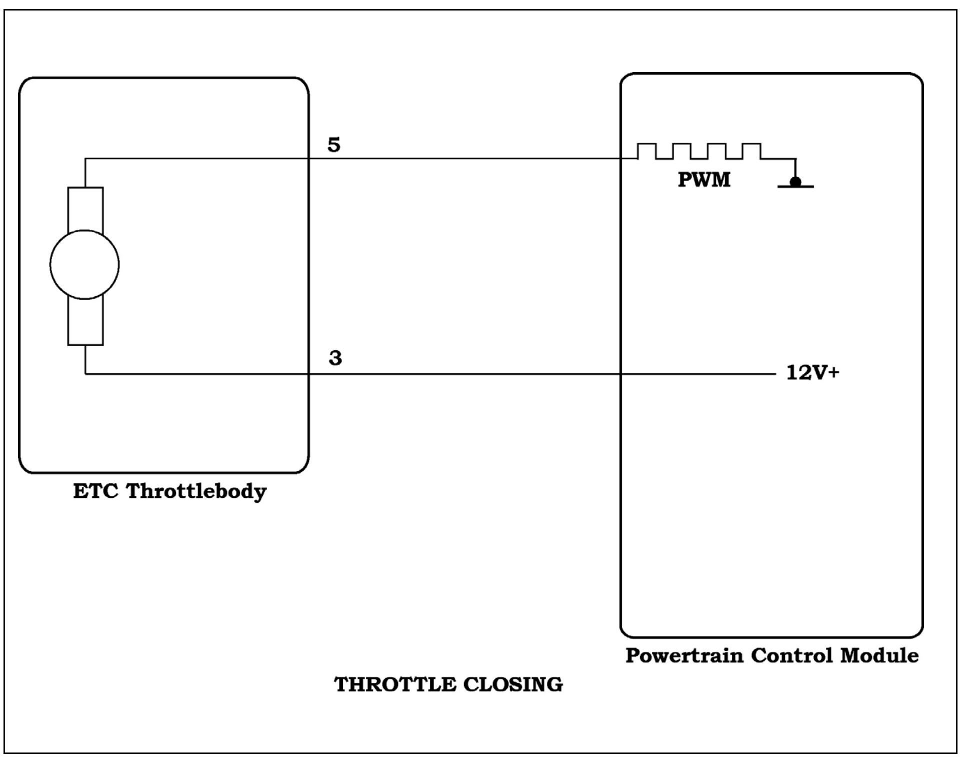


Figure 20 ETC Motor Polarity with Throttle Closing

THROTTLE POSITION SENSORS (TPS)

Two TPS are built into the ETC throttle body. Two potentiometer sensors are used for fail-safe redundancy. Each sensor outputs an analog signal voltage in proportion to throttle plate position, but one sensor uses reverse logic. As the throttle plate opens, the signal voltage from TPS#1 increases, and the signal voltage from TPS#2 decreases. The sum of the two TPS signal voltages should always equal approx. 5V. The PCM monitors this value to check system integrity. Failure modes will be discussed in Module 3.

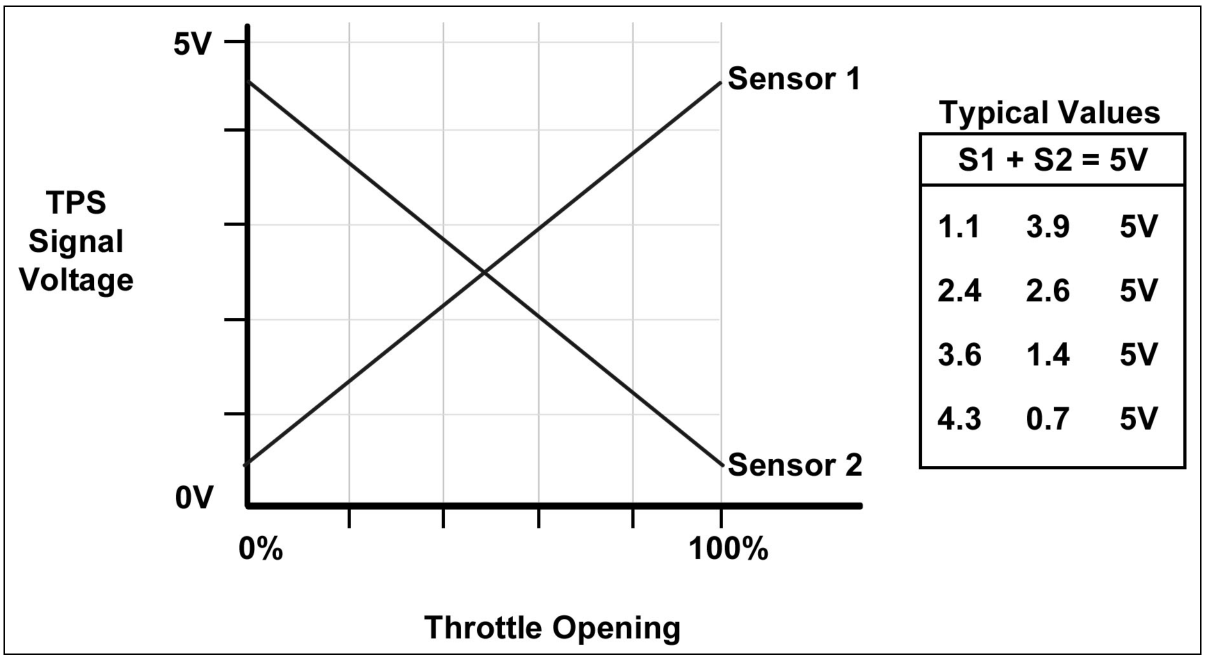


Figure 21 TPS Signal Voltages vs Throttle Plate Position

Notes:

ACTIVITY 2 ETC CIRCUITS

1. Using service information, locate the wiring schematic for the ETC throttle body connector.
2. In the chart below, fill in the circuit numbers and wire colors.
3. Also fill in the circuit type or circuit function (examples: analog signal, digital signal, pull-up circuit, NTC resistor, TPS #1 signal, ground, 5V reference, input, output):

ETC Connector Pins	Circuit Number/Color	Circuit Function
1		
2		
3		
4		
5		
6		

4. Prepare to backprobe the ETC throttle body connector on the classroom vehicle. Use a DMM, T-pins and jumpers.
5. With KOEO, measure the signal at each of the six pins on the ETC connector.
6. Fill in the measured values in the second column in the chart below.
7. Start the engine and allow it to idle. Again backprobe the ETC throttle body assembly connector.
8. With KOER at idle, measure each signal again.
9. Fill in the measured values in the third column in the chart below:

ETC Connector Pin	KOEO Measurements	KOER Measurements
1		
2		
3		
4		
5		
6		

10. Stop the engine.
11. Answer the following questions based on your measurements:

    Which wire supplies the 5V reference to the TPS? ____________________________

    Which wires provide the two TPS signals to the PCM? ________________________

    Add together the two TPS signal values measured with KOEO: _______________

    Add together the two TPS signal values measured with KOER: _______________

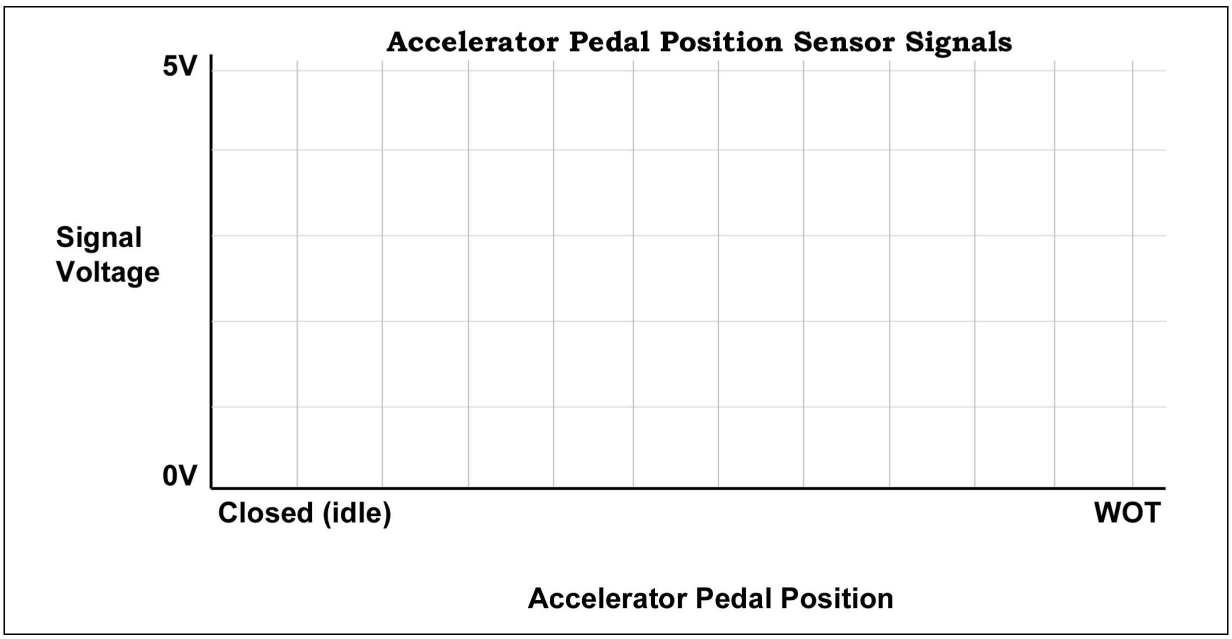
    In both cases, the sum of the two TPS signals equals approx.: ________________

    Which wire is the TPS circuit ground or return? _____________________________

    Which two wires control the throttle plate actuator motor? ___________________

ACTIVITY 3 APPS AND ETC MOTOR OSCILLOSCOPE PATTERNS

1. Consult service information and locate the APPS.
2. Configure the DRBIII® with PEP Module oscilloscope leads for both channels 1 and 2.
3. Backprobe the correct APPS connector pins at the sensors to view oscilloscope patterns for both APPS signals.
4. With KOEO, slowly depress the accelerator pedal and observe the two AAPS signals on the oscilloscope. Sketch what you see in the graph below as the pedal moves full travel. Label the traces and include units:



5. Observed voltage range for APPS 1: MIN __________ MAX __________
6. Observed voltage range for APPS 2: MIN __________ MAX __________
7. Explain any differences you see between the two signals: ______________________
____
8. Why are two accelerator pedal position sensors used? __________________________
____
9. Backprobe ETC throttle body connector Pins 3 and 5 with the DRBIII® PEP Module oscilloscope leads to view both sides of the throttle plate motor circuit. Use channels 1 and 2.
10. With KOER at idle, view the oscilloscope patterns.

11. At idle, which Pin is the PWM side of the throttle plate motor circuit? __________

12. At idle, which Pin is the positive side and which pin is the Ground side of the throttle plate motor circuit?

    Positive Pin: ________________________ Ground Pin: ________________________

13. Depress the throttle quickly to WOT and release. Carefully watch the patterns change. Watch for differences as the throttle plate opens and then closes.

14. Describe how the oscilloscope patterns change: ______________________________
    ____

15. Allow the engine to idle.

16. Introduce a large vacuum leak by removing the power brake booster hose.

17. Observe how the engine runs, and watch the throttle plate motor circuit oscilloscope patterns. Run the engine at idle and also at higher speeds.

18. Describe how the engine runs with a large vacuum leak: _____________________
    ____
    ____

19. Describe how the oscilloscope patterns change with a vacuum leak: __________
    ____

20. On the DRBIII®, go to the SENSORS list and view the engine torque value.

21. Torque value at idle: ____

22. For part of this exercise, the vehicle will be operated briefly at WOT and in gear. This will create a stall condition and a load on the engine.

Note: Observe all safety precautions when running the vehicle in gear in the classroom. Set the parking brake and foot brake firmly. Be sure no persons are in front of the vehicle. Run the engine at WOT for only a few seconds and record data as quickly as possible. Allow sufficient time for cool-down.

23. Set the parking brake and foot brake and be sure no persons are in front of the vehicle. Select drive gear. Observe all cautions as stated above.

24. Depress the accelerator pedal fully, run the engine at WOT for a few seconds.

25. Torque value at WOT: ____

26. Stop the engine.

27. Check for DTCs. Record stored DTCs if set: _________________________________

28. Clear any DTCs.

MODULE 3
ETC RESPONSE TO NORMAL AND ABNORMAL CONDITIONS

You will need to study some new concepts to understand the new ETC system with NCG II. The PCM controls throttle plate position, not driver input. The PCM looks at the accelerator pedal sensor signals (and many other inputs) and then determines throttle plate position. If all is OK, then the driver will get the torque he/she is requesting. If not, then the PCM will take some other course of action (reduced power, power-free, zero RPM, etc.)

With NGC II, the PCM now has responsibility for air flow, spark timing and fuel quantity.

STARTING A VEHICLE WITH ETC

When a start-up attempt is made on a vehicle with ETC, several new events take place. On every start-up, starter engagement is delayed briefly while the PCM conducts an ETC Spring Test. The throttle plate is quickly driven open, then completely closed. The delay is approx. 0.2 sec. and the driver may not notice this delay. Throttle plate movement can make noises that are unfamiliar to the driver. Be prepared to explain that these noises are normal.

This start-up delay may be noticed only if the driver goes directly from the Lock position to the Crank position. If the driver goes from Lock to Run, and pauses (for whatever reason), the delay will NOT be noticed. The ETC Spring Test is done as soon as the key is in the Run position, and the test will be completed before the driver goes to the Crank position.

In rare cases, the delay can be up to 2 sec. before starter engagement is allowed. This will only happen if all of the following are true:

- The Battery has been disconnected.
- Both engine coolant and ambient temperature sensors indicate that no ice may be present.
- The ETC Throttle learned Limp-In values don't match the actual Limp-In values (this would most likely happen if the entire Throttle Body Assembly is replaced).

If the above conditions are all true, then NGC II will do an entire throttle plate range sweep (min. to WOT and closed again) which must take place before starter engagement is allowed. This may last up to 2 sec. and may cause a customer complaint. The DRBIII® displays when the starter was last disabled with "ETC STARTER INHIBIT: Miles".

NORMAL OPERATION

The PCM enters closed loop operation quickly: usually within 30 sec. Short Term Fuel Trim becomes active as soon as the engine is started. When engine coolant temperature exceeds 71°C (160°F), Long Term Fuel Trim becomes active. In closed loop, both fuel adaptations respond very quickly.

Note: The throttle plate will not open with accelerator pedal input if the engine is not running, even with the key ON.

NGC controllers have built-in logic to compare inputs from suspect sensors with stored values. NGC controllers can also use the inputs from a combination of sensors to calculate a value to validate a sensor.

With the accelerator pedal fully depressed, the In-Neutral WOT Rev Limiter is less abrupt and holds RPM to a lower value, approx. 3,500 rpm. In gear, max. rpm at WOT is approx. 5900. If WOT is maintained, max. rpm drops to approx. 5600.

FAILURE MODES

Fail-Safe Mode

The first response of the ETC system to a fault is to limit throttle opening, slow the response to the accelerator pedal, drop engine speed to idle with brake application and disable the speed control function. This is the Fail-Safe mode. A DTC will be set and the ETC warning light will illuminate.

Limp-In Mode

More serious faults will cause the system to enter the Limp-In mode. In this mode, the ETC light flashes, and the engine will run roughly but the vehicle can be driven with severe restrictions. In the Limp-In mode, accelerator pedal position has no effect on throttle plate opening or engine speed. The engine runs at two different RPMs, with engine speed controlled by the action of the brake pedal. When the brakes are applied, engine speed is controlled at approx. 800 RPM. With brakes released, engine speed is 1200-1500 RPM. The PCM controls engine speed by controlling spark timing and fuel.

Below are reasons for the NGC II ETC system to remove power to the throttle actuator motor and to enter the Limp-In mode:

- Low Battery Voltage
- ASD Relay OFF
- ETC throttle adaption routine Limp-In learning
- Level 2 error (software) or Level 3 failure (operating system or PCM failure)
- Auxiliary 5 Volt supply failed (Not Primary)

- One TPS and the MAP sensor have failed
- Both TPS have failed
- ETC actuator motor failure
- Spring test open or close failure
- APPS A2D converter failure

VACUUM LEAKS

The ETC system can compensate for some vacuum leaks. The NGC II fuel injection system is a speed density type and there is no mass airflow sensor. Manifold pressure and engine rpm are two signals with the greatest influence.

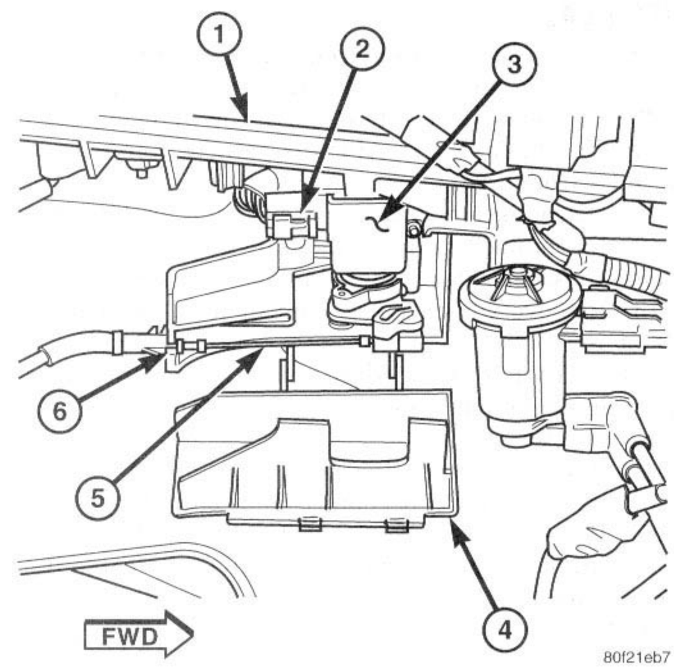
A vacuum leak in the intake manifold will allow air into the manifold that has not come through the throttle body, but this air is not unmeasured air, since there is no mass airflow sensor. The ETC system will simply adjust throttle plate opening to compensate for the leak. There is no Idle Air Control system, so PCM control of the ETC throttle plate can compensate for some vacuum leaks.

APPS SENSOR FAILURE

Two Accelerator Pedal Position Sensors (APPS) provide a driver-torque demand signal to the PCM. Loss of one sensor signal will initiate the Fail-Safe mode which slows the response to the good APPS, reduces maximum throttle opening, drops engine rpm to idle with brake application, sets a DTC and causes the ETC warning light to illuminate. The MIL does not illuminate. Speed control operation is not permitted.

Loss of both APPS signals will cause the system to enter the Limp-In mode. In this mode, the ETC warning light flashes, and the engine will run roughly but the vehicle can be driven with severe restrictions. Without both APPS, the accelerator pedal cannot provide input and has no effect on engine speed. The engine runs at two different RPMs, with engine speed controlled by the action of the brake pedal. When the brakes are applied, engine speed is controlled at approx. 800 RPM. With brakes released, engine speed is 1200-1500 RPM. The PCM controls engine speed by controlling spark timing and fuel.

The APPS are replaced as a unit which includes both sensors, the plastic housing and the accelerator pedal cable. See Figure 22:



1	Bottom of Battery Tray
2	Electrical Connector
3	APPS (2)
4	Swing-Down Door
5	Cable (to Pedal)
6	Cable Release Tab

Figure 22 APPS Installation

BRAKE SWITCH FAILURE

The brake pedal switches are another redundant circuit. Two switches are located in one housing near the brake pedal. Both switches actuate in parallel when the brake pedal is depressed. Like APPS faults, loss of one brake switch signal will initiate the Fail-Safe mode. Loss of both brake switch signals will cause the system to enter the Limp-In mode.

THROTTLE BODY AND TPS FAILURES

A blocked or sticking throttle plate will cause an out-of-range duty cycle response in the ETC motor circuit. The PCM compares TPS signals and actuator motor circuit duty cycle, and if it senses a disparity, it will remove power to the motor and enter the Limp-In mode.

Failure of one TPS will initiate the Fail-Safe mode. Loss of both TPS signals will cause the system to enter the Limp-In mode.

During the start sequence, the throttle plate closes completely.

Note: The throttle body cannot be cleaned. Do not use spray (carburetor) cleaners or silicone lubricants on any part of the throttle body.

The throttle body has no serviceable components and is replaced as a unit. Disconnect the battery before replacing the throttle body. After the throttle body is replaced, these steps must be performed to adapt the new throttle body. Refer to the latest service information for specific procedures.

- Disconnect the battery negative cable and leave disconnected for at least 90 seconds.
- Reconnect the negative cable.
- Turn the ignition key to the KOEO position, do not crank.
- Leave the ignition switch ON for at least ten seconds. The PCM will adapt to the new throttle body.

DIAGNOSTIC PROCEDURES

New diagnostic procedures have been created to help diagnose and repair this new technology. Several P2100 series DTCs have been added specifically for ETC-equipped vehicles. There are new Verification Tests and module replacement procedures for the new PCM.

The throttle plate will not open with accelerator pedal input if the engine is not running, even with the key ON. To assist in diagnosis, use the Throttle Follower Test on the DRBIII®. In this mode, depressing the accelerator pedal will cause the PCM to actuate the throttle plate motor. With this test, you can verify throttle plate movement with accelerator pedal input. This Throttle Follower Test must be performed with KOEO.

ETC System Test allows you to actuate the throttle plate directly with the DRBIII®. See service information for complete testing information.

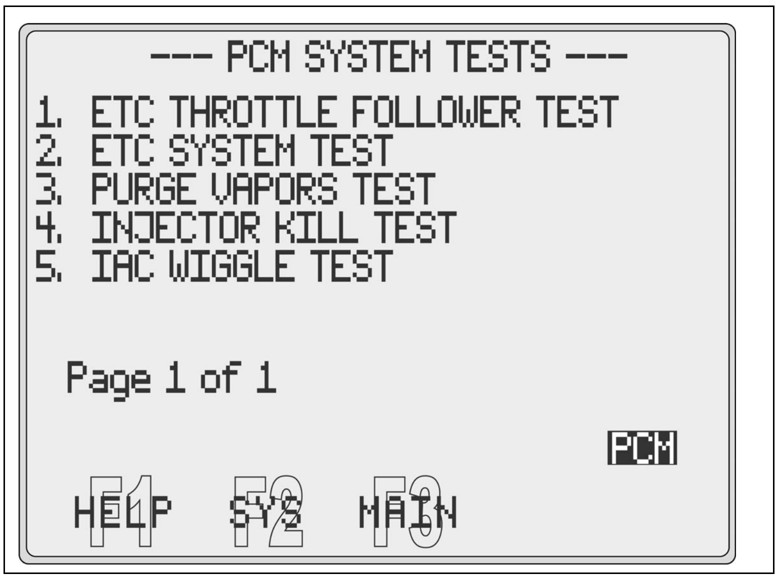


Figure 23 ETC Tests on the DRBIII

Notes:

Notes:

ACTIVITY 4
ETC RESPONSE TO NORMAL AND ABNORMAL CONDITIONS

1. Connect the DRBIII® to the DLC in the classroom vehicle.
2. Start the engine and allow it to idle. Be sure that the PCM enters closed loop control and LTFT values are updating.
3. View the Adaptive Monitor screen on the DRBIII®.
4. Look at both Short Term Fuel Trim and Long Term Fuel Trim values with the engine idling normally. Then create a large vacuum leak by disconnecting the power brake booster hose. Connect and disconnect the hose several times and note how STFT and LTFT react.
5. Describe how fast STFT and LTFT respond to the vacuum leak: _______________
   ____
6. Reconnect the power brake booster hose.
7. Monitor the MAP sensor voltage with the DRBIII®. Snap the accelerator pedal to WOT several times.
8. Describe the change in MAP sensor voltage as you do this: ____________________
   ____
9. If a MAP/TPS correlation problem is detected, DTC P0068 will set. Locate this DTC in the Powertrain Diagnostic Procedures manual. What MAP sensor voltage range is acceptable when the accelerator pedal is snapped?
   ____
10. Does the MAP meet the specification? ____
11. Stop the engine. Turn the key to the KOEO position.
12. With the DRBIII®, perform the Throttle Follower Test.
13. Describe the change in TPS #1 sensor voltage as you open and close the throttle: ____
14. Consult the service information. What TPS #1 sensor voltage range is acceptable for this test? ____
15. Does the TPS #1 meet the specification? ______________________________________
16. Describe the change in TPS #2 sensor voltage as you open and close the throttle: ____
17. Consult the service information. What TPS #2 sensor voltage range is acceptable for this test? ____

18. Does the TPS #2 meet the specification? ______________________________

19. Turn the key OFF.

20. If MAP and TPS sensors pass the above tests, but the vehicle has set DTC P0068, list what items you would check next: ______________________________
____

21. Turn the key to the KOEO position.

22. With KOEO, disconnect the APPS connector. This will force the Limp-In mode.

23. With the APPS sensors still disconnected, start the engine.

24. What is the state of the ETC Warning Light? OFF ON FLASHING

25. What is the engine RPM with the brake pedal depressed? ________________

26. What is the engine RPM with the brake pedal not depressed? ______________

27. Does engine RPM change when the accelerator pedal is depressed?
YES NO

28. Stop the engine and reconnect the APPS sensor connector.

29. With the DRBIII®, retrieve any DTCs: ______________________________

30. Clear any DTCs.

31. The ETC system has a Clear Flood mode, similar to other vehicles.

32. Use the DRBIII® to monitor the fuel injectors.

33. Depress the accelerator pedal to WOT and crank the engine for a few seconds.

34. Does the engine start? YES NO

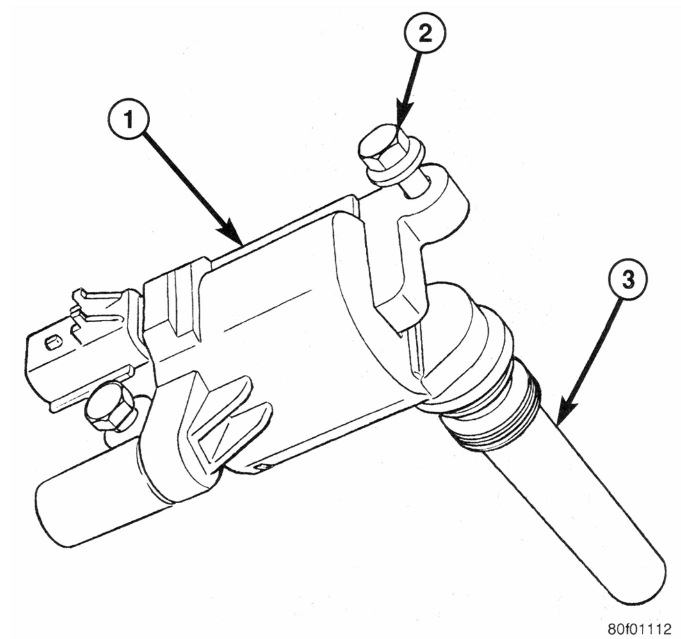
35. Were the fuel injectors pulsed while cranking with WOT? ________________

36. Explain your answer: ____
____

MODULE 4 COP DUAL WASTE SPARK IGNITION

IGNITION SYSTEM LAYOUT

The 5.7L HEMI engine uses a dual Coil On Plug (COP) Waste Spark ignition system with two spark plugs per cylinder. There are eight individually fired coils. Each cylinder has a COP fired spark plug, and a remote fired spark plug, with the coil mounted directly on top of the COP fired spark plug. A high-voltage secondary cable runs in a plastic cable tray from each coil to the remote fired spark plug in the companion (running-mate) cylinder on the opposite cylinder bank.



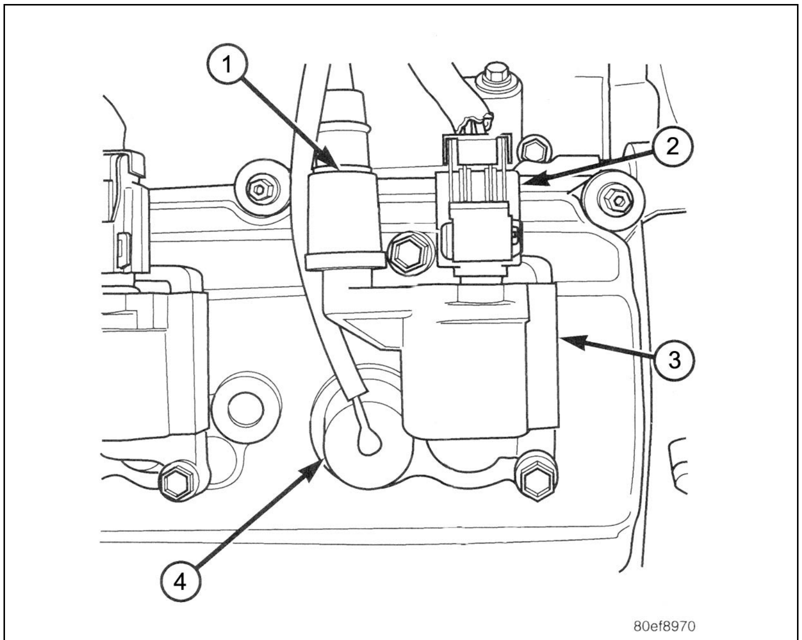
1	Ignition Coil
2	Mounting Bolts (2)
3	Boot to Spark Plug

Figure 24 5.7L Ignition Coil

IGNITION SYSTEM OPERATION

Ignition spark timing and cylinder selection for spark are controlled by the PCM. This is typical in today's OBD II engine management systems. The firing order is 1-8-4-3-6-5-7-2. The companion cylinder pairs or running mates are numbers 1-6, 5-8, 4-7 and 2-3.

Every coil and every spark plug fires with every revolution of the crankshaft. When a coil is firing its COP fired spark plug on the compression stroke to begin the power stroke event, at the same time it fires the remote fired spark plug in the companion cylinder on the exhaust stroke for the waste spark event. During the next revolution of the crankshaft, the same coil fires again, but this time it fires its remote fired spark plug on the compression stroke and the COP fired spark plug on the exhaust stroke. Both spark plugs in a cylinder fire at the same time, but they are fired by different coils.



1	Spark Plug Cable (to remote fired spark plug in companion cylinder)
2	Electrical Connector
3	Ignition Coil
4	Spark Plug Cable (from ignition coil in companion cylinder)

Figure 25 5.7L Ignition Coil Installation

Why are the ignition coils not configured to fire both spark plugs in the same cylinder? It takes less energy to fire a spark plug during the exhaust stroke than during the compression stroke. If the coil had to fire both spark plugs on the compression stroke, it would need to develop much higher power. The waste spark system requires less total coil energy.

IGNITION SYSTEM SERVICE

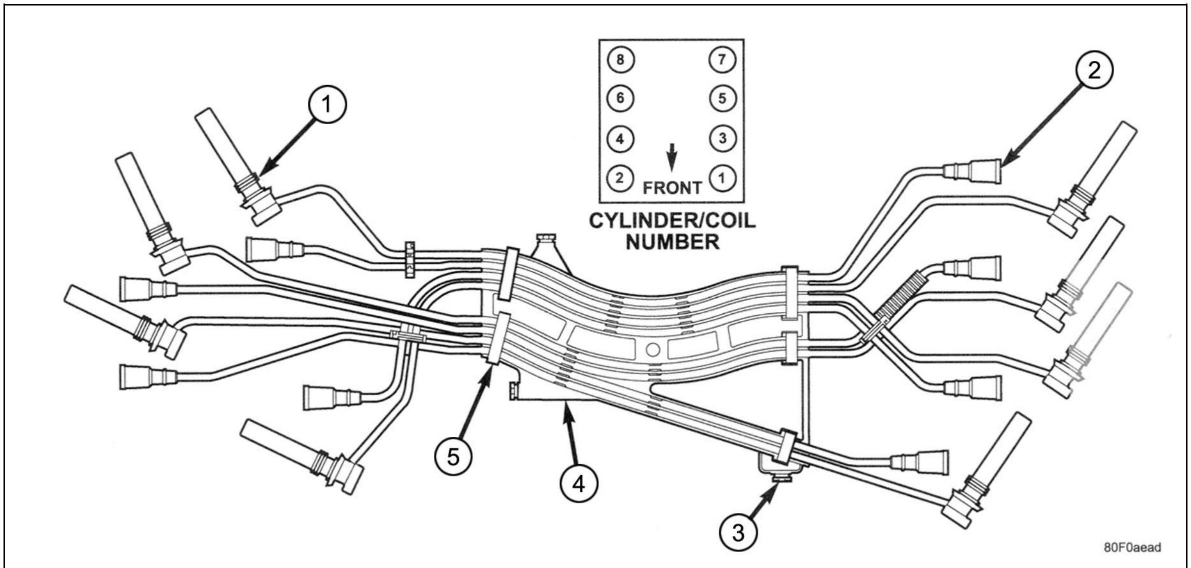
A plastic cable tray holds the secondary cables in position to prevent crossfire. Before removing any spark plug cables, note their original position. Remove cables one at a time.

Both the secondary cables and the cable tray are marked with cylinder numbers to help routing. The cables and the cable tray are replaced as an assembly. At this time, the cables are not available separately.

Note: The cables MUST be properly positioned in the tray to prevent crossfire. Cable retention clips must also be securely locked.

Before installing spark plug cables, apply dielectric grease to the inside of the terminal boots.

The PCM monitors spark plug ionization and will set a DTC if an out-or-range condition is detected.



1	Secondary Cable Spark Plug Connector (typical)
2	Secondary Cable Coil Connector (typical)
3	Clips (tray–to–manifold retention)
4	Cable Tray
5	Clips (Spark Plug Cable–to–tray retention)

Figure 26 5.7L Spark Plug Cable Routing

Notes:

Notes:

ACTIVITY 5 COP DUAL WASTE SPARK IGNITION

1. List the firing order for the classroom 5.7L engine with ETC: ____________________
   ____
2. List the companion pairs of cylinders (running mates): ____________________
   ____
3. Trace the secondary high-voltage cables from each coil. What spark plugs are fired by each coil? Refer to companion pairs of cylinders when you describe:
   ____
   Identify the location of cylinder #1: ________________________________
4. Locate the ignition coil on cylinder #1. The COP fired spark plug for cylinder #1 is directly under this coil. The secondary high-voltage cable on this coil connects to which other spark plug? ________________________________
5. When the coil on cylinder #1 fires, one spark plug of the coil pair fires on the ____________________ stroke and the other spark plug of the coil pair fires on the ____________________ stroke.
6. Describe how often each coil fires in terms of crankshaft revolutions: __________
   ____
7. Why does each coil fire a pair of spark plugs in companion cylinders rather than both spark plugs in the same cylinder? ____________________________
   ____
8. What is the purpose of the molded plastic loom which holds the secondary high-voltage cables? ____
   ____
9. On a classroom vehicle, disconnect the secondary high-voltage cable from the coil on cylinder #1.
10. Ground the high-voltage cable with a spare spark plug and jumper wire.
11. Attempt to start the vehicle. Does the vehicle start? ____________________
12. If NO, explain: ____
13. Was a DTC set? YES NO
14. Reconnect the secondary high-voltage cable.
15. Configure the DRBIII® with PEP Module oscilloscope leads. Use both channels 1 and 2.
16. Backprobe the correct connector pins on coils #1 and #6 to view both primary ignition signals.
17. Start the engine and allow to idle.
18. Do both ignition coils fire at the same time at idle? YES NO
19. Run the engine at 2500 RPM and again view the two primary patterns.
20. Do both ignition coils fire at the same time at 2500 RPM? YES NO
21. Stop the engine.

Notes:

MODULE 5 PCV SYSTEM

PCV SYSTEM DESIGN

The 5.7L engine is equipped with a closed PCV system of new design. The PCV valve is located on top of the intake manifold on the right side behind the throttle body. The valve is molded plastic and seals with two o-rings.

To remove the PCV valve, rotate it counterclockwise. Beyond 90 degrees of rotation, arrows molded into the PCV valve ride up ramps on the intake manifold to help valve removal. When installing the valve, be sure that it is turned fully clockwise to the stops.

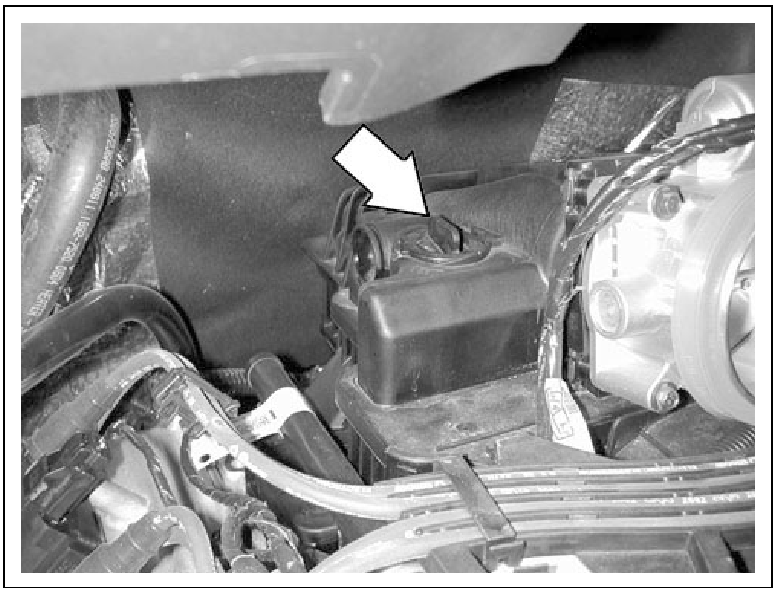


Figure 27 5.7L PCV Valve Location

The PCV system uses molded passages in the plastic intake manifold. A rubber hose for fresh air inlet connects the air box plenum and oil fill tube. Filtered air enters the crankcase through this hose. A leak in the hose or its connections allows unfiltered air to enter the crankcase. This does not create a vacuum leak.

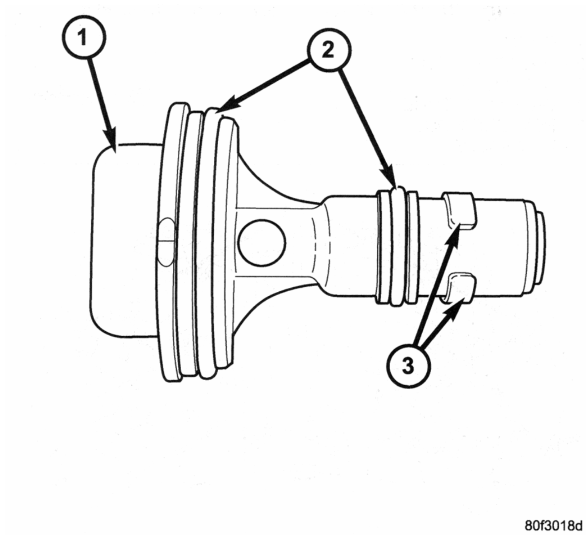
PCV SYSTEM TESTING

Shake the PVC valve to test it. The metering plunger should be free and should rattle. Always inspect the condition of the o-rings whenever the valve is removed. Defective o-rings can cause a vacuum leak.

Note: Replace the PCV valve if necessary. Do not attempt to clean it.

Crankcase blowby gases can sometimes exceed the PCV valve flow rate under some conditions. When the PCV valve flow is insufficient, excess blowby gases go back up the fresh air inlet hose and enter the air inlet system and throttle body. Excessive amounts of oil collected in the air box plenum can indicate an engine problem causing too much blowby. Worn or stuck piston rings or a plugged PCV valve may cause this condition.

Figure 28 5.7L PCV Fresh Air Inlet Hose



1	PCV Valve
2	O–Rings
3	Alignment Tabs

Figure 29 5.7L PCV Valve

Notes:

ACTIVITY 6 PCV SYSTEM

1. Remove the air box plenum from the 5.7L classroom engine. Locate and remove the PCV valve.
2. Describe the procedure for PCV valve removal: ________________________________
____
3. What is the condition of the two o-ring seals on the PCV valve? ________________
____
4. If o-rings were damaged, could a vacuum leak result? ________________________
5. Explain how damaged o-rings could affect drivability: _________________________
____
6. Shake the PCV valve. Does the internal metering plunger rattle? ______________
7. Locate the PCV hose allowing filtered air into the crankcase.
8. If this hose were damaged, would it create an intake manifold vacuum leak?
YES NO
9. If this hose were damaged, what problems could result? ______________________
____
10. If you observed an unusual quantity of oil in the air box plenum, list two possible causes: ____
____
11. Remove the small o-ring from the PCV valve and reinstall the valve.
12. Start the engine.
13. Describe how the engine runs with the small o-ring removed: _________________
____
14. Stop the engine.
15. Replace the small o-ring and remove the large o-ring from the PCV valve.
16. Start the engine.
17. Describe how the engine runs with the large o-ring removed: _________________
____
18. Stop the engine.
19. Replace the large o-ring on the PCV valve and reinstall the valve.

Notes:

MODULE 6 SPEED CONTROL SYSTEM

SPEED CONTROL SYSTEM OPERATION

Speed control with ETC functions the same as previous systems, and the driver should not notice any differences. It does, however, work differently. Speed control is now integrated into ETC and no longer requires a separate actuator. The PCM can manage the speed control function through ETC directly with existing inputs and outputs.

The PCM receives the speed control ON signal and the desired-speed input from the speed control switches. The controller compares this request with the vehicle speed inputs and varies the throttle plate opening to achieve and maintain the desired speed.

After speed control is engaged, the driver can remove his foot from the accelerator pedal. Therefore, the accelerator pedal position signal from the APPS does not indicate torque demand from the driver. To avoid an input rationality conflict, the PCM ignores input from the APPS when speed control is requested. As always, the driver can depress the accelerator pedal and override the programmed speed.

The speed control switches on the steering wheel are connected to the PCM via a single input bus. These switches provide multiplexed (MUX) inputs to the PCM. With speed control integrated with ETC, each steering wheel button actuates a double pole single throw normally open momentary switch (DPST NO Momentary). Each button switch has two parallel pull down resistor circuits. Previous systems had single pole switches with a single pull down resistor circuit for each switch.

When a button is pushed, the PCM reads the voltage drop across the two parallel circuits. The resistor values in the circuits for each button are different. Therefore, every button when depressed sends a different signal voltage.

The minimum speed control Enable Speed has been set at 40 kph (25 mph) for 2003 5.7L DR models. On most other current models, the speed control Enable Speed is 56 kph (35 mph).

The Tap-Up feature is changed from 3 kph (2 mph) per Tap-Up, to 1.5 kph (1 mph) per Tap-Up.

Any failure detected in the electronic throttle control system will deny operation of speed control.

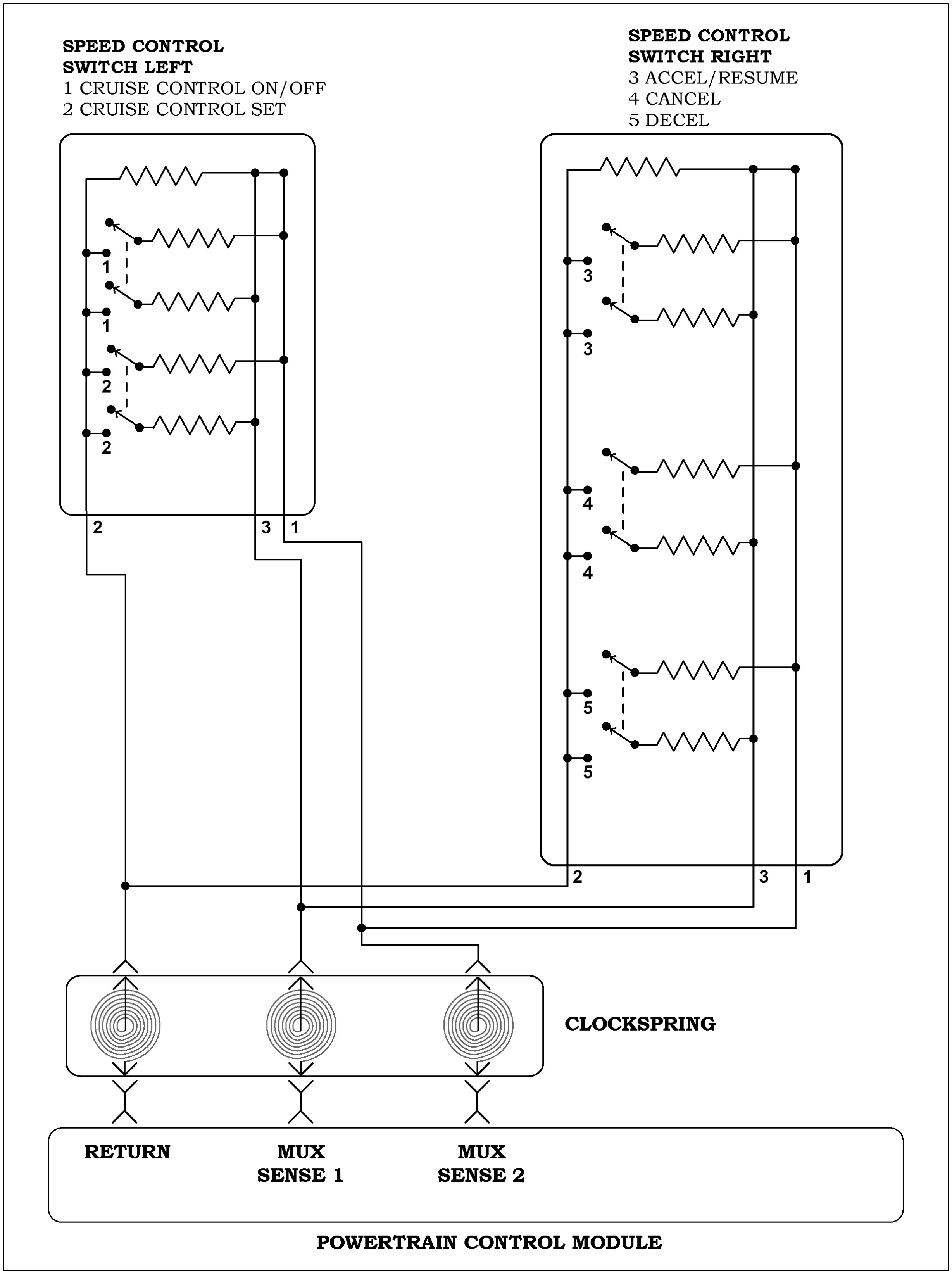


Figure 30 Speed Control Circuit

Notes:

Notes:

ACTIVITY 7 SPEED CONTROL SYSTEM

1. The 5.7L engine with the NGC II controller does not use a separate speed control actuator. List two system components that have main responsibility for managing the speed control function: ____

2. Using the service information, locate the speed control circuits at the PCM.

3. Fill in the connector numbers, pin numbers and wire color in the chart:

PCM Circuit	PCM Connector Pin	Circuit Number
Speed Control MUX Sense 1		
Speed Control MUX Sense 2		
Speed Control MUX Return		

4. Inputs from the brake lamp switch are sensed on which of these circuits?
____

5. Inputs from the speed control switches are sensed on which of these circuits?
____

6. Connect the DRBIII® to the DLC in the classroom vehicle.

7. Locate testing information for P0579 Speed Control Switch #1 Performance in the service information.

8. Fill in the specified resistance values for MUX Switch #1 and MUX Switch #2 in the following chart:

9. With KOEO, depress each speed control button, one at a time.

10. Using the DRBIII®, read the MUX voltages. Fill in the values in the following chart:

S/C Button	MUX Switch #1		MUX Switch #2	
	Specified Ω	**Measured V**	**Specified Ω**	**Measured V**
On/Off				
Set				
Resume/Accel				
Cancel				
Decel				
Rest Position (no buttons depressed)				

11. Now determine how failure of both brake switches affects speed control.
12. With the ignition still ON, turn speed control ON.
13. Unplug the connector on the brake switch.
14. Is the cruise indicator on the instrument panel illuminated? YES NO
15. The DRBIII® indicates that speed control is: ENABLED DISABLED
16. Was a DTC set? YES NO
17. Clear any DTCs and turn the ignition OFF. Restore the vehicle to its original condition.

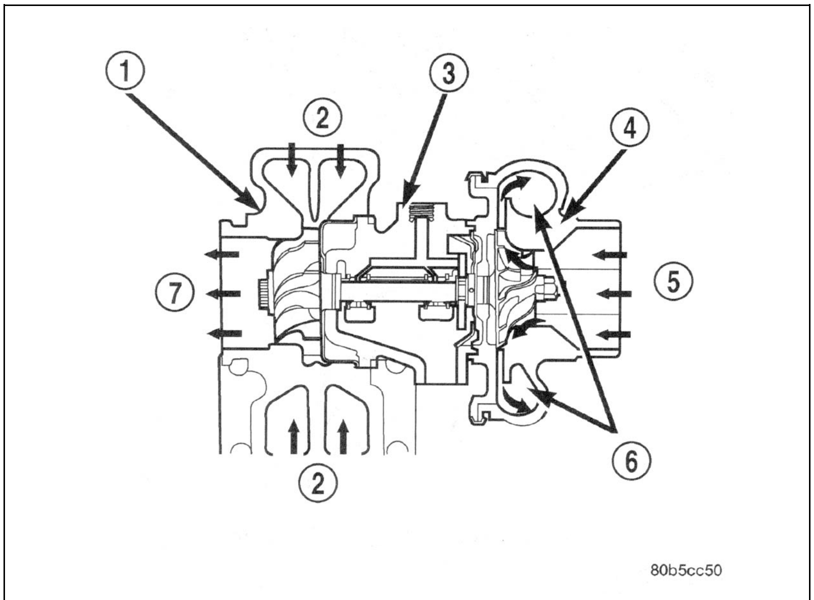
Notes:

Notes:

MODULE 7 2.4L TURBO SYSTEM AND COMPONENTS

TURBO OVERVIEW

For 2003, a turbocharged 2.4L engine is available on some models. Increased horsepower and torque improve performance and drivability for the customer.



1	Turbine Section
2	Exhaust Gas
3	Bearing Housing
4	Compressor Section
5	Inlet Air
6	Compressed Air to Engine
7	Exhaust Gas to Exhaust Pipe

Figure 31 2.4L Turbocharger

The turbocharger is integral with the engine exhaust manifold. A turbo wastegate valve regulates the amount of turbo boost and prevents overboost. An NGC I PCM controls engine management functions.

The air intake path is typical for a turbo installation. Incoming air enters the air cleaner housing, then flows through the turbo, the charge air cooler, throttle body and into the intake manifold.

Figure 32 2.4L Turbo Engine

SOLENOIDS

Three vacuum control solenoids have been added to control turbo functions. All three solenoids are located on the right inner fender. Use caution when servicing, as it is possible to mix up the vacuum hose connections. The wiring connectors are keyed and color-coded and cannot be mixed.

Throttle Inlet Pressure/Baro Sensor and Solenoid

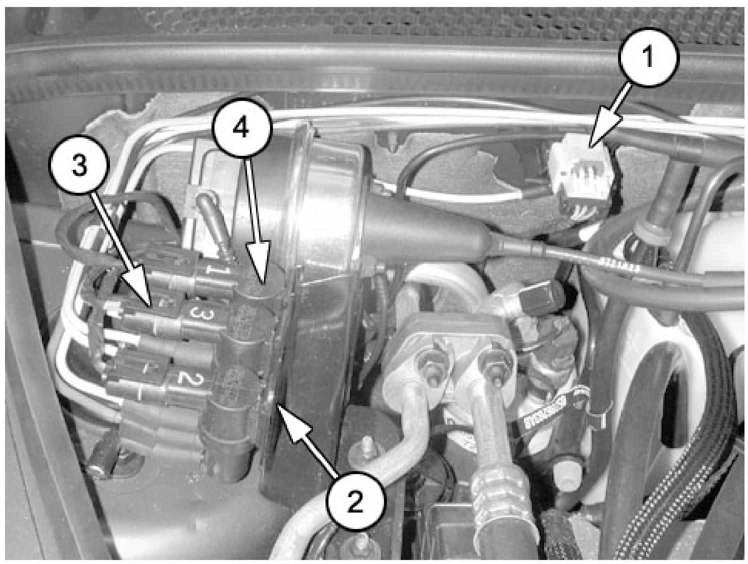
The Throttle Inlet Pressure/Baro Sensor is just like a MAP sensor and measures two different conditions: barometric (atmospheric) pressure and inlet boost pressure. Inlet boost pressure is sensed in the pipe after the charge air cooler and before the throttle body.

The Throttle Inlet Pressure/Baro Solenoid is the rearmost solenoid and is marked #1. It is an ON-OFF device which is switched by the PCM to allow the TIP/Baro Sensor to sense throttle inlet pressure 95% of the time, and barometric pressure 5% of the time. See Figure 33.

Wastegate and Solenoid

The Wastegate Solenoid is the front solenoid of the three and is marked #2. It controls the operation of the Wastegate Valve by regulating boost pressure to it. This solenoid is the only one that is duty-cycle controlled by the PCM. See Figures 33 and 34.

Applying boost pressure opens the wastegate valve which bypasses exhaust gases around the turbocharger turbine to reduce turbine speed and boost. The wastegate valve opens in proportion to the amount of pressure it receives. 100% duty cycle = maximum boost, and 0% duty cycle = minimum boost.



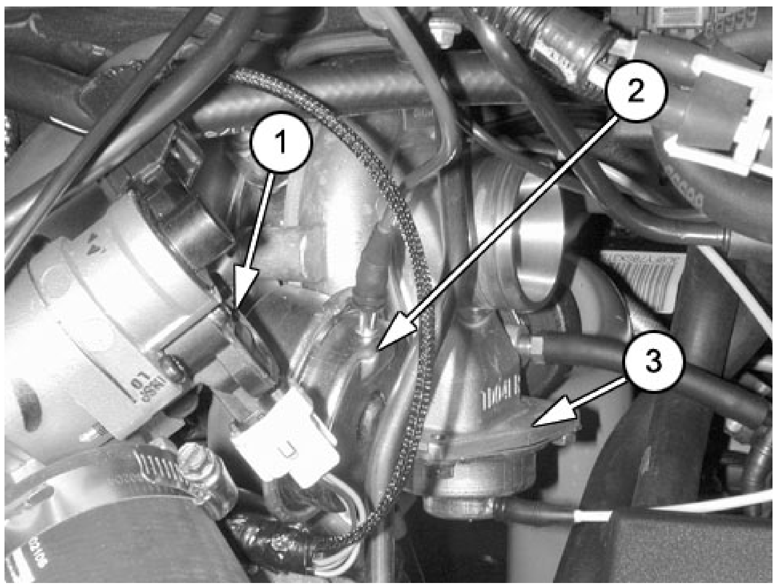
1	Throttle Inlet Pressure/Baro Sensor
2	Wastegate Solenoid (marked #2)
3	Surge Valve Solenoid (marked #3)
4	TIP/Baro Solenoid (marked #1)

Figure 33 2.4L Turbo Solenoids and Throttle Inlet Pressure (TIP) Sensor

Surge Valve Actuator and Solenoid

The Surge Valve improves vehicle drivability. It is controlled by the Surge Valve Actuator Solenoid. This solenoid is an ON-OFF device switched by the PCM. It is the middle solenoid on the right inner fender and is marked #3. See Figures 33 and 34.

The Surge Valve Actuator Solenoid is energized only after boosted throttle tip-outs. This allows the high pressure between the turbo compressor and the throttle body to vent, reducing surge and noise on deceleration.



1	Throttle Position Sensor
2	Wastegate
3	Surge Valve

Figure 34 2.4L Turbo with Wastegate Actuator and Surge Valve Actuator

Vacuum Ejectors

The vacuum ejectors are pneumatic devices that generate vacuum even during boost. This allows speed control and EVAP purge to function at all times. There are no moving parts or electrical connections. If the turbo is creating boost, air pressure blows across a venturi in the vacuum ejectors. This creates a pressure drop and sufficient vacuum to operate speed control and EVAP purge.

Find the vacuum ejectors on the vacuum hose schematic shown in Figure 38. In the vehicle, they are located near the fresh air inlet hose and power brake booster. The ejectors must be clean to function.

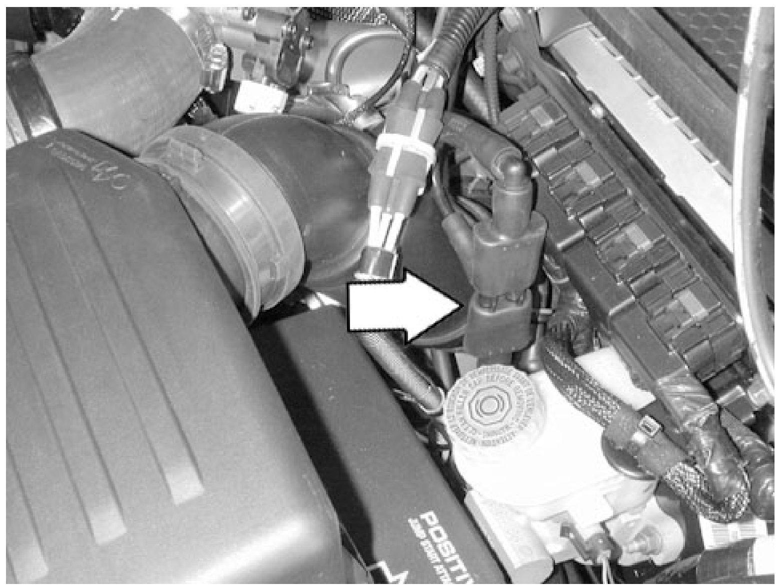


Figure 35 2.4L Turbo Vacuum Ejectors

TEMPERATURE SENSORS

PT turbo models have two ambient temperature sensors located in front of the radiator. On non-turbo models, the PCM uses the IAT sensor for the ambient temperature signal. On turbo models, the ambient temperature sensor for the PCM is the one mounted in front of the radiator on the driver's side. The sensor on the passenger's side provides an ambient temperature signal to the overhead console.

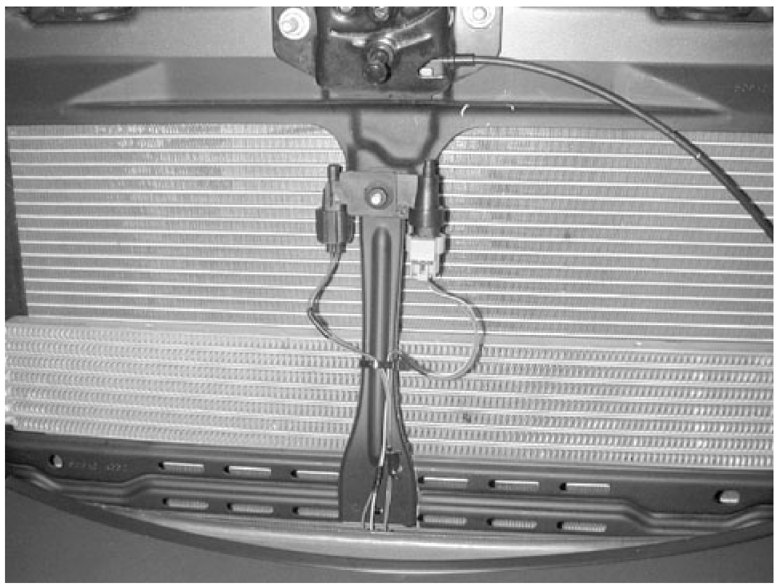


Figure 36 2.4L Ambient Air Temperature Sensors

The Air Charge Temperature (ACT) sensor is the same as an IAT sensor. It measures charge air temperature in the hose after the charge air cooler and before the throttle body. The PCM compares the values from both the ACT sensor and the ambient temperature sensor when determining fuel quantity.

CHARGE AIR COOLER

Compressing a gas causes its temperature to rise. Engine intake air is heated as it is compressed by the turbo impeller. This heating reduces the density of the air and also reduces engine efficiency. A Charge Air Cooler is an air-to-air heat exchanger that is used to remove heat from the incoming air after it leaves the turbo. The cooler is mounted in front of the lower part of the engine coolant radiator. Two large diameter air hoses connect the charge air cooler to the turbo and throttle body.

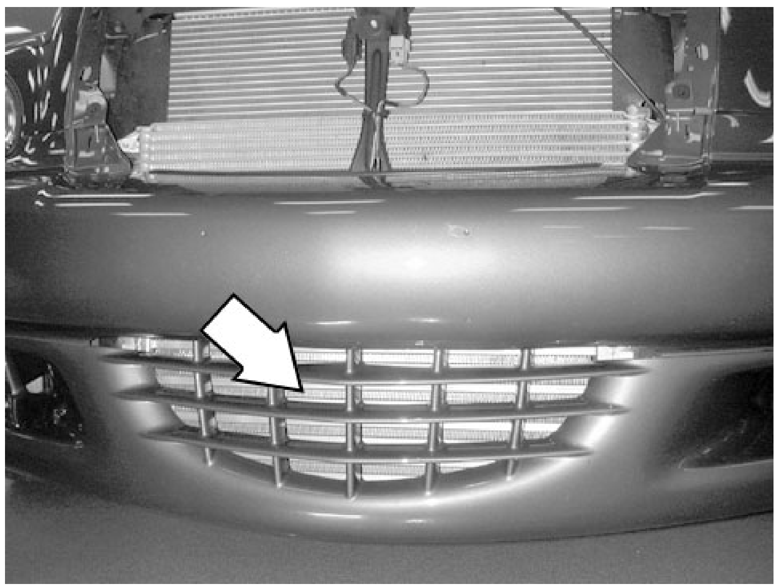


Figure 37 2.4L Charge Air Cooler

TURBO INSPECTION

The turbocharger shaft bearings are plain bushings pressure fed with oil. There is always some play in these bushings. Turbos have been incorrectly diagnosed as faulty when this play is noted. A small amount of radial play in the turbo shaft is normal. There is no published specification, use your judgment when evaluating turbo condition.

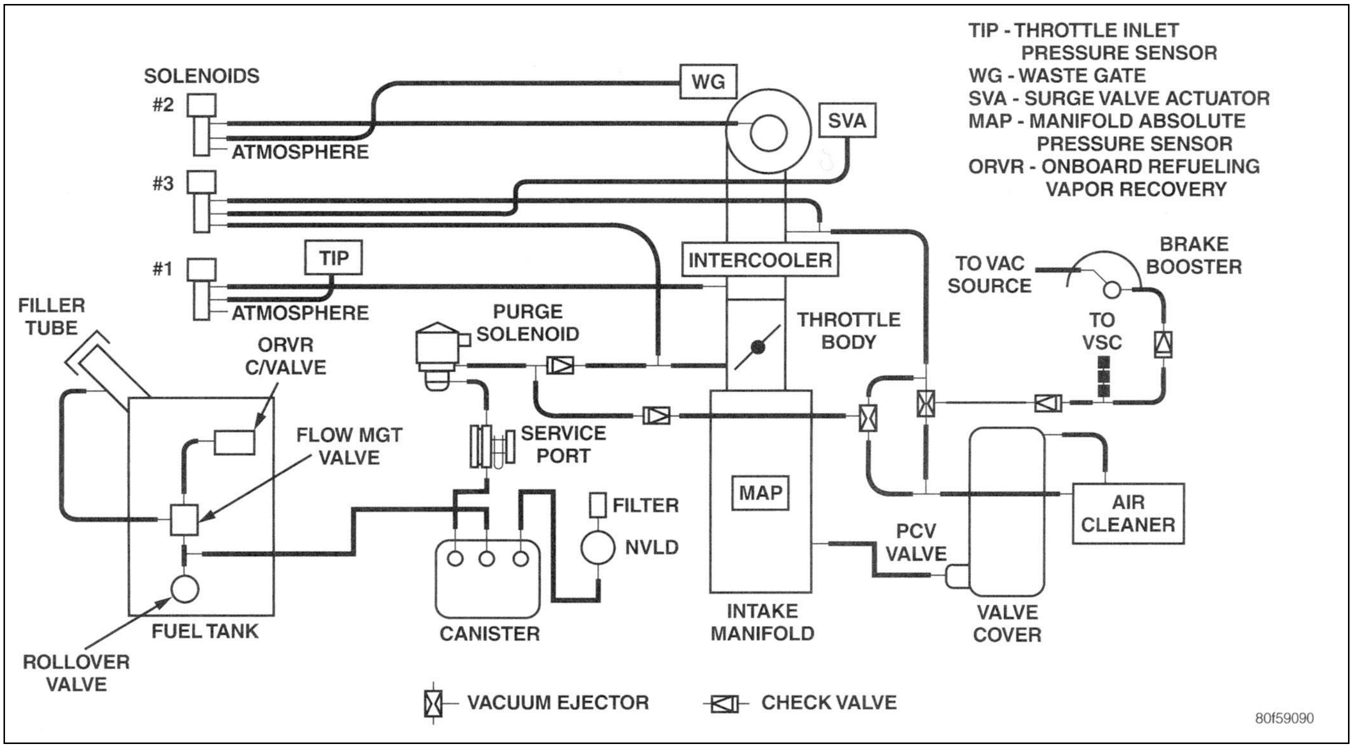


Figure 38 2.4L Turbo Vacuum Harness Schematic

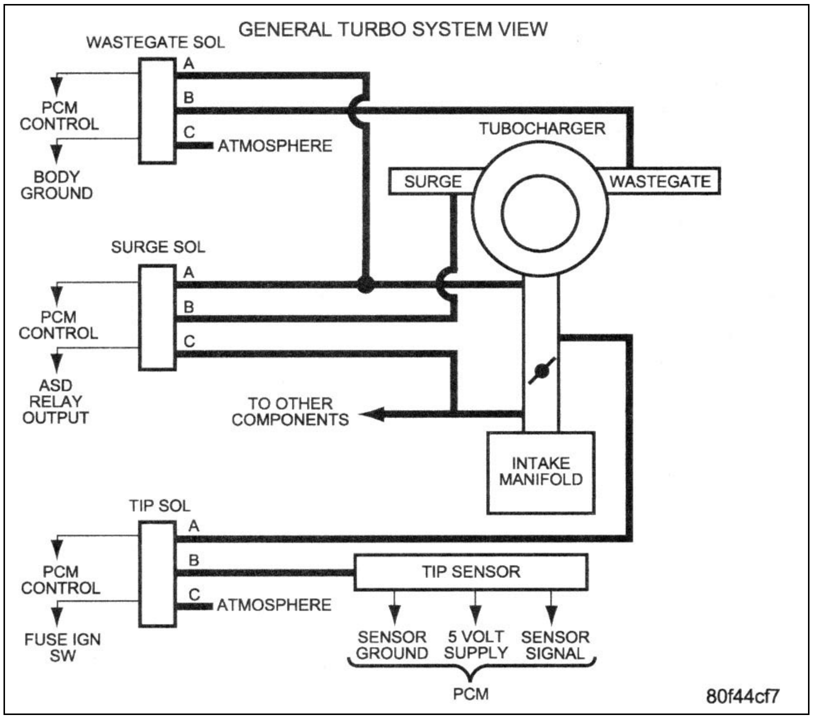


Figure 39 2.4L Turbo Solenoids

SOLENOID DIAGNOSIS

The three turbo control solenoids are similar, but they are controlled differently. The Surge Valve Actuator solenoid and Throttle Inlet Pressure solenoid are ON-OFF devices controlled by the PCM. The Wastegate solenoid is duty-cycle controlled by the PCM.

The DRBIII® INPUT/OUTPUT screen displays the ON-OFF state for the SVA and TIP solenoids.

TURBO BARO and SENSED TIP data are both obtained from the TIP sensor. The TIP solenoid switches state to permit the TIP sensor to alternately measure both barometric pressure and turbo inlet pressure.

The DRBIII® displays a P-RATIO, which is an indication of boost level. Any value greater than one indicates positive boost from the turbo.

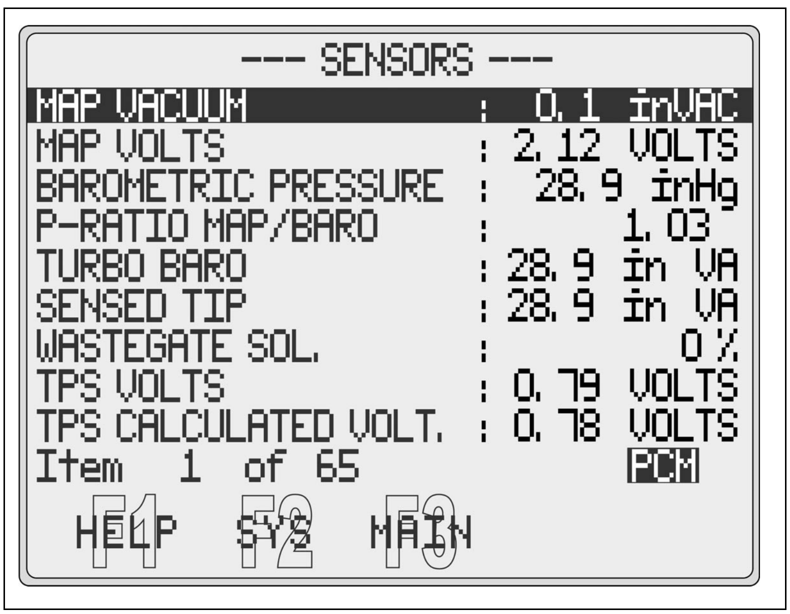


Figure 40 DRBIII Screen

CHARGE AIR COOLER HOSES

As the engine heats and cools, thermal cycling will loosen the charge air cooler hose clamps. The clamps should be inspected during service.

Check clamp tightness when cold and torque fasteners to the correct value. See the latest service information.

Notes:

Notes:

ACTIVITY 8 2.4L TURBO COMPONENTS

1. Locate the following 2.4L turbo components on the classroom vehicle. Write the location for each component in the chart below:

Component	Location
Wastegate Solenoid	
Surge Valve Actuator Solenoid	
TIP/Baro Solenoid	
TIP/Baro Sensor	
MAP Sensor	
Vacuum Ejectors (2)	
Ambient Temperature Sensor for PCM	
Ambient Temperature Sensor for Console	
Charge Air Cooler	
Wastegate	

2. Remove the clean air hose between the air cleaner housing and the turbo inlet.
3. Inspect the turbo impeller shaft by hand for axial and radial movement.
4. Is the shaft axial play acceptable? YES NO
5. Is the shaft radial play acceptable? YES NO

Notes:

ACTIVITY 9
2.4L TURBO VACUUM EJECTORS AND AIR INLET COMPONENTS

1. Locate the vacuum ejectors on the engine.
2. Study the vacuum hose schematic and compare it to the actual components.
3. Install a vacuum gauge on the vacuum line teed at the vacuum ejector.
4. A rubber hose runs from the turbo to the vacuum ejector. Remove the rubber hose from the turbo and prepare to apply regulated shop air to the hose.
5. Apply 83 kPa (12 psi) max. regulated shop air to the rubber hose and watch the vacuum gauge.
6. Describe what you observe on the vacuum gauge: ____________________________
____
7. Reinstall the clean air inlet hose.
8. Locate and inspect the integrity of all charge air cooler hoses, clamps and joints.
9. See service information for torque valves and check clamp torque.
10. Charge air cooler hose clamp torque specification: ____________________________
11. How many connections should be checked? ____________________________
12. Explain how the engine would run with a leaking charge air cooler hose or joint: ____
____
13. Turbo system components are listed in the chart below in alphabetical order. Number them 1-5 in the order in which air flows through them, from the air intake to the engine:

Component	Airflow Order 1-5
Air Cleaner Housing	
Charge Air Cooler	
Intake Manifold	
Throttle Body	
Turbo	

14. Test the wastegate actuator. Follow the procedure in the service information.
15. Describe your observations: ____
    ____

Notes:

Notes:

ACTIVITY 10
2.4L TURBO DRB III SENSOR AND SOLENOID DATA

1. For part of this exercise, the vehicle will be operated briefly at WOT and in gear. This will create a stall condition and a load on the engine to increase boost.

Note: Observe all safety precautions when running the vehicle in gear in the classroom. Set the parking brake and foot brake firmly. Be sure no persons are in front of the vehicle. Run the engine at WOT for only a few seconds and record data as quickly as possible. Allow sufficient idle time for cool-down.

2. Connect the DRBIII® to the classroom vehicle and prepare to observe TURBO BARO, MAP, TURBO TIP and P-RATIO values.

3. Start the engine and allow it to idle. Record the values displayed on the DRBIII® in the chart below:

Sensor	DRB III Values at IDLE in NEUTRAL
TURBO BARO	
MAP	
TURBO TIP	
P-RATIO	

4. Set the parking brake and foot brake and be sure no persons are in front of the vehicle. Select drive gear. Observe all cautions as stated above.

5. Depress the accelerator pedal fully, run the engine at WOT for a few seconds and take one reading on the DRBIII®. Release the throttle and locate the next sensor on the DRBIII®. Repeat for all four sensors.

6. Record the values in the chart below:

Sensor	DRB III Values at WOT in DRIVE (STALL)
TURBO BARO	
MAP	
TURBO TIP	
P-RATIO	

7. Compare the TURBO BARO values at idle and WOT. Explain any difference: ____________________

8. Compare the MAP values at idle and WOT. Explain any difference: ____________________

9. Compare the TURBO TIP values at idle and WOT. Explain any difference: ____________________

10. What does the P-RATIO indicate? ____________________

11. Use the DRBIII® to view the wastegate solenoid duty cycle percentage.

12. Allow the engine to idle and read the DRBIII®.

13. What is the wastegate solenoid % at idle? ____________________

14. Set the parking brake and foot brake and be sure no persons are in front of the vehicle. Select drive gear. Observe all cautions as stated above.

15. Depress the throttle fully for several seconds and read the DRBIII®.

16. What is the wastegate solenoid % at WOT in drive? ____________________

17. Use the DRBIII® to view the surge valve state on the INPUT/OUTPUT screen.

18. Allow the engine to idle and read the DRBIII®.

19. What is the state of the surge valve at idle? ____________________

20. Set the parking brake and foot brake and be sure no persons are in front of the vehicle. Select drive gear. Observe all cautions as stated above.

21. Depress the throttle fully for several seconds, release and read the DRBIII®.

22. What is the state of the surge valve when the accelerator pedal is released after WOT? ____________________

23. Describe your observations: ____________________

24. Allow turbo to cool at idle before turning engine OFF.

Notes:

Notes:

ACTIVITY 11 2.4L TURBO SOLENOID TESTS

1. Perform the following tests on one of the three solenoids as assigned by the instructor. The test procedures are the same for all three solenoids.
2. For specifications and procedures in detail, see diagnostic procedures for P0234, P1106 and P1188 in the service information.
3. Be sure the ignition is OFF. Disconnect the hoses from the solenoid to be tested.
4. Plug solenoid Port B and connect a vacuum pump to Port A.
5. Apply 20 inches of vacuum to Port A.
6. Vacuum reading should not drop below ________ in. within _______ sec.
7. Does the solenoid pass this test? YES NO
8. Now plug solenoid Port C and connect a vacuum pump to Port A.
9. Attempt to apply 20 inches of vacuum to Port A.
10. Vacuum should escape through Port B.
11. Does the solenoid pass this test? YES NO
12. With solenoid Port C plugged, now connect a vacuum pump to Port B.
13. Disconnect the wiring harness connector from the solenoid. Apply 12 V and Ground to the solenoid terminals to energize the solenoid.
14. Apply 20 inches of vacuum to Port B.
15. Vacuum reading should not drop below ________ in. within _______ sec.
16. Does the solenoid pass this test? YES NO
17. Now plug solenoid Port A and connect a vacuum pump to Port B.
18. Again apply 12 V and Ground to the solenoid terminals to energize the solenoid.
19. Attempt to apply 20 inches of vacuum to Port B.
20. Vacuum should escape through Port C.
21. Does the solenoid pass this test? YES NO
22. Reconnect the wiring harness and vacuum hoses to the solenoid.

23. Test the surge valve solenoid circuit. For specifications and procedures in detail, see diagnostic procedures for P0033 in the service information.
24. Be sure the ignition is OFF.
25. Disconnect the wiring harness connector from the surge valve solenoid. Jumper across the surge valve harness connector with a 12 V test light.
26. Turn the ignition ON.
27. Use the DRBIII® to actuate the surge valve solenoid.
28. Does the test light flash ON and OFF? YES NO
29. Disconnect the PCM harness connector with the surge valve solenoid control circuit K150.
30. Which PCM connector has circuit K150? ______________________________
31. Measure the resistance of the surge valve solenoid control circuit K150 from the surge valve solenoid connector to the appropriate terminal of Miller tool #8815.
32. Measured resistance of circuit K150: ______________________________
33. Is the resistance of circuit K150 OK? YES NO

GLOSSARY

Accelerator Pedal Position Sensor	A Hall-effect sensor which outputs an analog signal to the PCM for accelerator pedal position in vehicles with ETC.
Actuator	Devices controlled by the PCM. The PCM provides outputs to actuators.
Air-throttled	An engine whose speed and power are regulated by controlling the amount of air admitted. Gasoline-powered engines are air-throttled. See also Diesel and fuel-throttled.
Analog	A signal that can continuously vary over a range. Also see Digital.
Backprobe	Inserting a test probe into a connector from the wire-side to contact a circuit without disconnecting the terminal connector.
Blowby	Unburned fuel vapors which collect in the engine crankcase.
Clear Flood Mode	A mode of operation in which fuel injectors are not pulsed. Cranking the engine while the accelerator pedal is fully depressed initiates this mode.
Diagnostic Trouble Code (DTC)	A set of unique five-digit alphanumeric identification codes which identify fault conditions in the On-Board Diagnostic system.
Diesel	Compression-ignition engine. An engine type in which the high compression alone is sufficient to ignite the fuel mixture.
Digital	A signal that has only two values or a small number of discrete values.
Duty-Cycle	A measurement of the On-Time in a Pulse Width Modulated digital circuit. A percentage based on comparing the On-Time with the Total-Time for a cycle.
Electronic Throttle Control (ETC) System	A drive-by-wire system with no mechanical connection between the accelerator pedal and the throttle plate. The PCM determines throttle plate position based on inputs from numerous sensors.
Fuel-throttled	An engine whose speed and power are regulated by controlling the amount of fuel admitted. Diesel engines are fuel-throttled. See also air-throttled.

Hall-Effect Sensor	A type of electronic sensor which is capable of producing an accurate and stable signal. In vehicles with ETC, the Accelerator Pedal Position Sensor is a Hall-effect sensor.
Intake Air Temperature (IAT) Sensor	An NTC thermistor which outputs an analog signal to the PCM for intake air temperature.
Manifold Absolute Pressure (MAP) Sensor	A sensor which outputs an analog signal to the PCM for intake manifold vacuum. Under some conditions it can also provide barometric pressure information to the PCM.
Multiplexing (MUX)	Use of one circuit to provide signals from multiple components.
Positive Crankcase Ventilation (PCV) System	A system which purges crankcase blowby gases and controls the flow of these gases into the intake manifold.
Pulse Width Modulated	A digital circuit in which the On-Time changes. See Duty-Cycle.
Sensor	A device that responds to changes in some physical condition such as temperature, speed, pressure or position. It sends a signal to the PCM that varies with changes in the condition sensed. Sensors provide inputs to the PCM.
Thermistor	A resistor that changes resistance with changes in temperature.
Throttle Position Sensor (TPS)	A sensor which outputs an analog signal to the PCM for throttle plate position.
Torque	A measure of the engine crankshaft twisting force.
Turbocharger	Assembly consisting of a turbine wheel driven by engine exhaust connected to a compressor wheel which draws in and compresses the intake air.
Vacuum	A pressure lower than atmospheric pressure.
Waste Spark	An ignition system in which one ignition coil fires two spark plugs simultaneously. The spark plugs are in companion cylinders. One spark plug fires during the compression stroke and the other spark plug “wastes” its spark firing during the exhaust stroke.

TOOL APPENDIX

Miller #8638 Pin Removal Tool

Miller #8815 Pinout Box