

EMISSION CONTROL SYSTEMS

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ON-BOARD DIAGNOSTICS

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DESCRIPTION AND OPERATION

DIAGNOSTIC TROUBLE CODES

A Diagnostic Trouble Code (DTC) indicates the PCM has recognized an abnormal condition in the system.

The technician can display DTC's in two ways. The first way is to cycle the ignition switch and count the number of times the malfunction indicator (Check Engine) lamp on the instrument panel flashes on and off. The DRB scan tool provides the second method of displaying DTC's. Diagnostic trouble codes are the results of a system or circuit failure, but do not directly identify the failed component or components.

NOTE: For a list of DTC's, refer to the charts in this section.

OBTAINING DIAGNOSTIC TROUBLE CODES

USING DRB SCAN TOOL

WARNING: APPLY PARKING BRAKE AND/OR BLOCK WHEELS BEFORE PERFORMING ANY TEST ON AN OPERATING ENGINE.

(1) Connect DRB scan tool to the data link (diagnostic) connector located in the passengers compartment, below the center of instrument cluster on the drivers side (Fig. 1).

(2) Turn the ignition switch on, access Read Fault Screen. Record all the DTC's shown on the DRB scan tool. Observe the malfunction indicator (check engine) lamp on the instrument panel. The lamp should light for 2 seconds then go out (bulb check).

(3) To erase DTC's, use the Erase Trouble Code data screen on the DRB scan tool.

USING THE MALFUNCTION INDICATOR LAMP (MIL)

(1) Cycle the ignition key On - Off - On - Off - On within 5 seconds.

(2) Count the number of times the MIL (check engine lamp) on the instrument panel flashes on and off. The number of flashes represents the trouble code. There is a slight pause between the flashes representing the first and second digits of the code. Longer pauses separate individual two digit trouble codes.

DESCRIPTION AND OPERATION (Continued)

DIAGNOSTIC TROUBLE CODE DESCRIPTIONS

HEX CODE	MIL CODE	GENERIC SCAN TOOL CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
11		28	No Crank Reference Signal at PCM	No crank reference signal detected during engine cranking
12*			Battery Disconnect	Direct battery input to PCM was disconnected within the last 50 key-on cycles
13**	1297	26 27	MAP Pneumatic Signal No Change in MAP From Start to Run	No difference recognized between the engine MAP reading and the barometric (atmospheric) pressure reading from start-up
14**	P0107 or P0108	24 25	MAP Sensor Voltage Too Low MAP Sensor Voltage Too High	MAP sensor input below minimum acceptable voltage. MAP sensor input above maximum acceptable voltage.
15**	P0500	23	No Vehicle Speed Sensor Signal	No vehicle speed sensor signal detected during road load conditions
17		21	Engine too Cold too Long	Engine did not reach operating temperature within acceptable limits
22**	P0117 or P0118	1E 1F	ECT Sensor Voltage Too Low ECT Sensor Voltage Too High	Engine coolant temperature sensor input below minimum acceptable voltage. Engine coolant temperature sensor input above maximum acceptable voltage.
23**	P0112	39	Intake Air Temp Sensor Voltage Low	Intake air temperature sensor input below the maximum acceptable voltage.
24	P0122 or P0123	1A 1B	Throttle Position Sensor Voltage Low Throttle Position Sensor Voltage High	Throttle position sensor input below the minimum acceptable voltage Throttle position sensor input above the maximum acceptable voltage.
25**	P0505	19	Idle Air Control Motor Circuits	A shorted or open condition detected in one or more of the idle air control motor circuits.
27**	P0201 or P0202 or P0203	15 14 13	Injector #1 Control Circuit Injector #2 Control Circuit Injector #3 Control Circuit	Injector #1 output driver does not respond properly to the control signal. Injector #2 output driver does not respond properly to the control signal. Injector #3 output driver does not respond properly to the control signal.
31*	P0443	12	EVAP Purge Solenoid Circuit	An open or shorted condition detected in the duty cycle purge solenoid circuit.
33*		10	A/C Clutch Relay Circuit	An open or shorted condition detected in the A/C clutch relay circuit.

DESCRIPTION AND OPERATION (Continued)

HEX CODE	MIL CODE	GENERIC SCAN TOOL CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
34*		0F	Speed Control Solenoid Circuits	An open or shorted condition detected in the Speed Control vacuum or vent solenoid circuits.
35**	P1489	5D	High Spd Fan Relay Circuit Check	An open or shorted condition detected in the high speed radiator fan relay control circuit.
	or P1490	5C	Low Spd Fan Relay Circuit Check	An open or shorted condition detected in the low speed radiator fan relay control circuit.
41***		0B	Generator Field Not Switching Properly	An open or shorted condition detected in the generator field control circuit.
42*		0A	Auto Shutdown Relay Control Circuit	An open or shorted condition detected in the auto shutdown relay circuit.
43**	P0351	2B	Ignition Coil #1 Primary Circuit	Peak primary circuit current not achieved with maximum dwell time.
44**	P1492	9A	Battery Temp Sensor Voltage Too High	Battery temperature sensor input voltage above an acceptable range.
	or P1493	99	Battery Temp Sensor Voltage Too Low	Battery temperature sensor input voltage below an acceptable range.
46***		06	Charging System Voltage Too High	Battery voltage sense input above target charging voltage during engine operation.
47***		05	Charging System Voltage Too Low	Battery voltage sense input below target charging during engine operation. Also, no significant change detected in battery voltage during active test of generator output circuit.
53**	P0601	02	Internal Controller Failure	PCM Internal fault condition detected.
54**	P0340	01	No Cam Signal at PCM	No camshaft signal detected during engine cranking.
62	P1697	30	PCM Failure SRI Mile Not Stored	Unsuccessful attempt to update EMR mileage in the PCM EEPROM.
63**	P1696	31	PCM Failure EEPROM Write Denied	Unsuccessful attempt to write to an EEPROM location by the PCM.
66		61	No Body CCD Message.	No communication from body control module.
71**	P1496	92	5 Volts Output Low	Internal PCM check for 5 volts.
77		52	S/C Power Relay Circuit.	Malfunction detected with power feed to speed control servo solenoids.

* Check Engine Lamp (MIL) will not illuminate if this Diagnostic Trouble Code was recorded. Cycle Ignition key as described in manual and observe code flashed by Check Engine lamp.

** Check Engine Lamp (MIL) will illuminate during engine operation if this Diagnostic Trouble Code was recorded.

*** Generator Lamp illuminated

MONITORED SYSTEMS

There are new electronic circuit monitors that check fuel, emission, engine and ignition performance. These monitors use information from various

sensor circuits to indicate the overall operation of the fuel, engine, ignition and emission systems and thus the emissions performance of the vehicle. Note that vehicle fuel systems calibrated to run on leaded fuel

DESCRIPTION AND OPERATION (Continued)

do not use the EGR, Misfire, Catalyst, and Oxygen sensor monitors.

The fuel, engine, ignition and emission systems monitors do not indicate a specific component problem. They do indicate that there is an implied problem within one of the systems and that a specific problem must be diagnosed.

If any of these monitors detect a problem affecting vehicle emissions, the Malfunction Indicator (Check Engine) Lamp will be illuminated. These monitors generate Diagnostic Trouble Codes that can be displayed with the check engine lamp or a scan tool.

The following is a list of the system monitors:

- EGR Monitor
- Misfire Monitor
- Fuel System Monitor
- Oxygen Sensor Monitor
- Oxygen Sensor Heater Monitor
- Catalyst Monitor

Following is a description of each system monitor, and its DTC.

Refer to the appropriate Powertrain Diagnostics Procedures manual for diagnostic procedures.

DTC 21—HEX 67, and 69—OXYGEN SENSOR (O2S) MONITOR

Effective control of exhaust emissions is achieved by an oxygen feedback system. The most important element of the feedback system is the O2S. The O2S is located in the exhaust path. Once it reaches operating temperature 300° to 350°C (572° to 662°F), the sensor generates a voltage that is inversely proportional to the amount of oxygen in the exhaust. The information obtained by the sensor is used to calculate the fuel injector pulse width. This maintains a 14.7 to 1 air fuel (A/F) ratio. At this mixture ratio, the catalyst works best to remove hydrocarbons (HC), carbon monoxide (CO) and nitrous oxide (NOx) from the exhaust.

The O2S is also the main sensing element for the EGR, Catalyst and Fuel Monitors.

The O2S may fail in any or all of the following manners:

- Slow response rate
- Reduced output voltage
- Dynamic shift
- Shorted or open circuits

Response rate is the time required for the sensor to switch from lean to rich once it is exposed to a richer than optimum A/F mixture or vice versa. As the sensor starts malfunctioning, it could take longer to detect the changes in the oxygen content of the exhaust gas.

The output voltage of the O2S ranges from 0 to 1 volt. A good sensor can easily generate any output voltage in this range as it is exposed to different con-

centrations of oxygen. To detect a shift in the A/F mixture (lean or rich), the output voltage has to change beyond a threshold value. A malfunctioning sensor could have difficulty changing beyond the threshold value.

DTC 21—HEX 67, and 69—OXYGEN SENSOR HEATER MONITOR

If there is an oxygen sensor (O2S) DTC as well as a O2S heater DTC, the O2S fault **MUST** be repaired first. After the O2S fault is repaired, verify that the heater circuit is operating correctly.

Effective control of exhaust emissions is achieved by an oxygen feedback system. The most important element of the feedback system is the O2S. The O2S is located in the exhaust path. Once it reaches operating temperature 300° to 350°C (572° to 662°F), the sensor generates a voltage that is inversely proportional to the amount of oxygen in the exhaust. The information obtained by the sensor is used to calculate the fuel injector pulse width. This maintains a 14.7 to 1 Air Fuel (A/F) ratio. At this mixture ratio, the catalyst works best to remove hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxide (NOx) from the exhaust.

The voltage readings taken from the O2S are very temperature sensitive. The readings are not accurate below 300°C. Heating of the O2S is done to allow the engine controller to shift to closed loop control as soon as possible. The heating element used to heat the O2S must be tested to ensure that it is heating the sensor properly.

The O2S circuit is monitored for a drop in voltage. The sensor output is used to test the heater by isolating the effect of the heater element on the O2S output voltage from the other effects.

DTC 32—HEX 11—EGR MONITOR

The Powertrain Control Module (PCM) performs an on-board diagnostic check of the EGR system.

The EGR system consists of two main components: a vacuum solenoid and a vacuum operated valve with a back pressure transducer. The EGR monitor is used to test whether the EGR system is operating within specifications. The diagnostic check activates only during selected engine/driving conditions. When the conditions are met, the EGR is turned off (solenoid energized) and the O2S compensation control is monitored. Turning off the EGR shifts the air fuel (A/F) ratio in the lean direction. The O2S data should indicate an increase in the O2 concentration in the combustion chamber when the exhaust gases are no longer recirculated. While this test does not directly measure the operation of the EGR system, it can be inferred from the shift in the O2S data whether the EGR system is operating correctly. Because the O2S

DESCRIPTION AND OPERATION (Continued)

is being used, the O₂S test must pass its test before the EGR test.

DTC 43—HEX 6A, 6B, 6C, 6D, 6E, AE, and AF—MISFIRE MONITOR

Excessive engine misfire results in increased catalyst temperature and causes an increase in HC emissions. Severe misfires could cause catalyst damage. To prevent catalytic converter damage, the PCM monitors engine misfire.

The Powertrain Control Module (PCM) monitors for misfire during most engine operating conditions (positive torque) by looking at changes in the crankshaft speed. If a misfire occurs the speed of the crankshaft will vary more than normal.

DTC 51/52—HEX 76, and 77—FUEL SYSTEM MONITOR

To comply with clean air regulations, vehicles are equipped with catalytic converters. These converters reduce the emission of hydrocarbons, oxides of nitrogen and carbon monoxide. The catalyst works best when the air fuel (A/F) ratio is at or near the optimum of 14.7 to 1.

The PCM is programmed to maintain the optimum air/fuel ratio of 14.7 to 1. This is done by making short term corrections in the fuel injector pulse width based on the O₂S output. The programmed memory acts as a self calibration tool that the engine controller uses to compensate for variations in engine specifications, sensor tolerances and engine fatigue over the life span of the engine. By monitoring the actual air-fuel ratio with the O₂S (short term) and multiplying that with the program long-term (adaptive) memory and comparing that to the limit, it can be determined whether it will pass an emissions test. If a malfunction occurs such that the PCM cannot maintain the optimum A/F ratio, then the MIL will be illuminated.

DTC 64—HEX 70—CATALYST MONITOR

To comply with clean air regulations, vehicles are equipped with catalytic converters. These converters reduce the emission of hydrocarbons, oxides of nitrogen and carbon monoxide.

Normal vehicle miles or engine misfire can cause a catalyst to decay. A meltdown of the ceramic core can cause a reduction of the exhaust passage. This can increase vehicle emissions and deteriorate engine performance, driveability and fuel economy.

The catalyst monitor uses dual oxygen sensors (O₂S's) to monitor the efficiency of the converter. The dual O₂Ss strategy is based on the fact that as a catalyst deteriorates, its oxygen storage capacity and its efficiency are both reduced. By monitoring the oxygen storage capacity of a catalyst, its efficiency can be indirectly calculated. The upstream O₂S is used to

detect the amount of oxygen in the exhaust gas before the gas enters the catalytic converter. The PCM calculates the A/F mixture from the output of the O₂S. A low voltage indicates high oxygen content (lean mixture). A high voltage indicates a low content of oxygen (rich mixture).

When the upstream O₂S detects a lean condition, there is an abundance of oxygen in the exhaust gas. A functioning converter would store this oxygen so it can use it for the oxidation of HC and CO. As the converter absorbs the oxygen, there will be a lack of oxygen downstream of the converter. The output of the downstream O₂S will indicate limited activity in this condition.

As the converter loses the ability to store oxygen, the condition can be detected from the behavior of the downstream O₂S. When the efficiency drops, no chemical reaction takes place. This means the concentration of oxygen will be the same downstream as upstream. The output voltage of the downstream O₂S copies the voltage of the upstream sensor. The only difference is a time lag (seen by the PCM) between the switching of the O₂S's.

To monitor the system, the number of lean-to-rich switches of upstream and downstream O₂S's is counted. The ratio of downstream switches to upstream switches is used to determine whether the catalyst is operating properly. An effective catalyst will have fewer downstream switches than it has upstream switches i.e., a ratio closer to zero. For a totally ineffective catalyst, this ratio will be one-to-one, indicating that no oxidation occurs in the device.

The system must be monitored so that when catalyst efficiency deteriorates and exhaust emissions increase to over the legal limit, the MIL (check engine lamp) will be illuminated.

DTC 31—LEAK DETECTION PUMP MONITOR — IF EQUIPPED

The leak detection assembly incorporates two primary functions: it must detect a leak in the evaporative system and seal the evaporative system so the leak detection test can be run. Note that some vehicle systems do not use a leak detection pump, and therefore, do not have a leak detection pump monitor.

The primary components within the assembly are: A three port solenoid that activates both of the functions listed above; a pump which contains a switch, two check valves and a spring/diaphragm, a canister vent valve (CVV) seal which contains a spring loaded vent seal valve.

Immediately after a cold start, between predetermined threshold limits, the three port solenoid is briefly energized. This initializes the pump by drawing air into the pump cavity and also closes the vent seal. During non test conditions, the vent seal is held open by the pump diaphragm assembly which pushes

DESCRIPTION AND OPERATION (Continued)

it open at the full travel position. The vent seal will remain closed while the pump is cycling due to the reed switch triggering of the three port solenoid that prevents the diaphragm assembly from reaching full travel. After the brief initialization period, the solenoid is de-energized allowing atmospheric pressure to enter the pump cavity, thus permitting the spring to drive the diaphragm which forces air out of the pump cavity and into the vent system. When the solenoid is energized and de-energized, the cycle is repeated, creating flow in typical diaphragm pump fashion. The pump is controlled in 2 modes:

Pump Mode: The pump is cycled at a fixed rate to achieve a rapid pressure build in order to shorten the overall test length.

Test Mode: The solenoid is energized with a fixed duration pulse. Subsequent fixed pulses occur when the diaphragm reaches the Switch closure point.

The spring in the pump is set so that the system will achieve an equalized pressure of about 7.5"/H₂O. The cycle rate of pump strokes is quite rapid, as the system begins to pump up to this pressure. As the pressure increases, the cycle rate starts to drop off. If there is no leak in the system, the pump would eventually stop pumping at the equalized pressure. If there is a leak, it will continue to pump at a rate representative of the flow characteristic of the size of the

leak. From this information, we can determine if the leak is larger than the required detection limit (currently set at .040" orifice by CARB). If a leak is revealed during the leak test portion of the test, the test is terminated at the end of the test mode, and no further system checks will be performed.

After passing the leak detection phase of the test, system pressure is maintained by turning on the LDP's solenoid until the purge system is activated. Purge activation in effect creates a leak. The cycle rate is again interrogated, and when it increases due to the flow through the purge system, the leak check portion of the diagnostic is complete.

The canister vent valve will unseal the system after completion of the test sequence as the pump diaphragm assembly moves to the full travel position.

Evaporative system functionality will be verified by using the stricter evap purge flow monitor. At an appropriate warm idle, the LDP will be energized to seal the canister vent. The purge flow will be clocked up from some small value in and attempt to see a shift in the in the O₂ control system. If fuel vapor, indicated by a shift in the O₂ control, is present, the test is passed. If not, it is assumed that the purge system is not functioning in some respect. The LDP is again turned off and the test is ended.

EXHAUST GAS RECIRCULATION SYSTEM

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DESCRIPTION AND OPERATION

EXHAUST GAS RECIRCULATION (EGR) SYSTEM— UNLEADED FUEL SYSTEMS ONLY

Vehicles with fuel systems calibrated to run on leaded fuel do not use Exhaust Gas Recirculation.

Refer to Monitored Systems - EGR Monitor in this group for more information.

The EGR system reduces oxides of nitrogen (NO_x) in engine exhaust and helps prevent detonation (engine knock). Under normal operating conditions, engine cylinder temperature can reach more than 3000°F. Formation of NO_x increases proportionally with combustion temperature. To reduce the emission of these oxides, the cylinder temperature must be lowered. The system allows a predetermined amount of hot exhaust gas to recirculate and dilute the incoming air/fuel mixture. The diluted air/fuel mixture reduces peak flame temperature during combustion.

The EGR system consists of (Fig. 1), and (Fig. 2):

- EGR tube
- EGR valve
- Electric EGR Transducer
- Connecting hoses

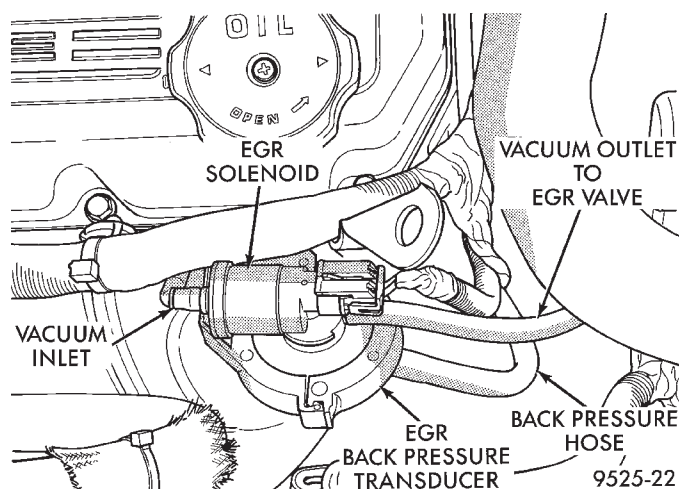


Fig. 1 EGR Control Valve—2.5L

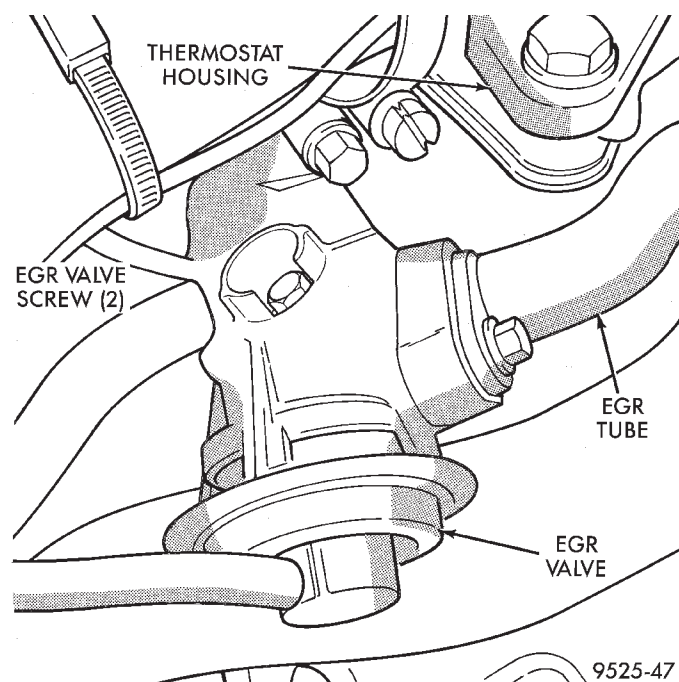


Fig. 2 EGR Valve—2.5L

DESCRIPTION AND OPERATION (Continued)

The electric EGR transducer contains an electrically operated solenoid and a back-pressure transducer (Fig. 3). The Powertrain Control Module (PCM) operates the solenoid. The PCM determines when to energize the solenoid. Exhaust system back-pressure controls the transducer.

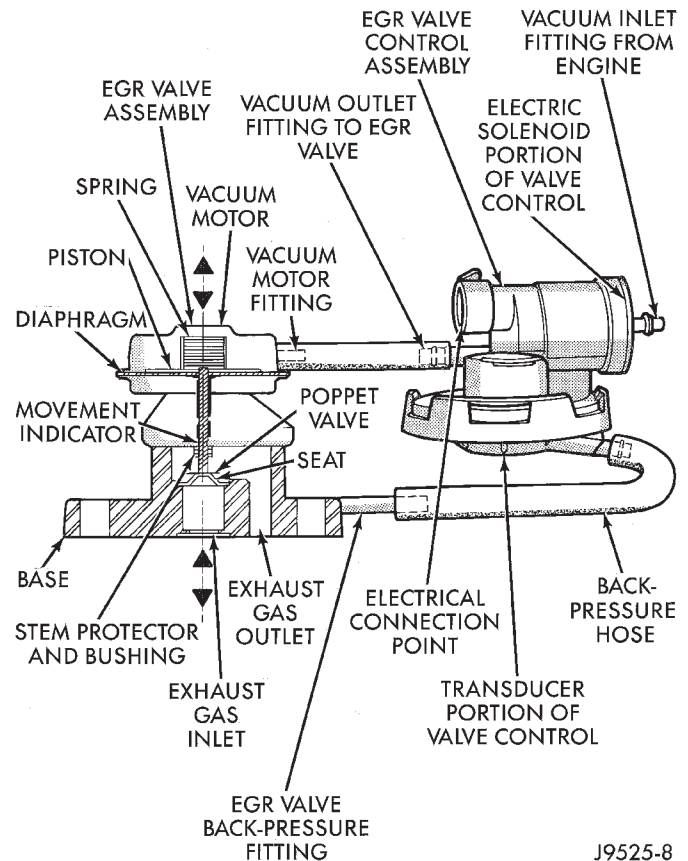
When the PCM energizes the solenoid, vacuum does not reach the transducer. Vacuum flows to the transducer when the PCM de-energizes the solenoid.

When exhaust system back-pressure becomes high enough, it fully closes a bleed valve in the transducer. When the PCM de-energizes the solenoid and back-pressure closes the transducer bleed valve, vacuum flows through the transducer to operate the EGR valve.

De-energizing the solenoid, but not fully closing the transducer bleed hole (because of low back-pressure), varies the strength of vacuum applied to the EGR valve. Varying the strength of the vacuum changes the amount of EGR supplied to the engine. This provides the correct amount of exhaust gas recirculation for different operating conditions.

This system does not allow EGR at idle.

A failed or malfunctioning EGR system can cause engine spark knock, sags or hesitation, rough idle, engine stalling and increased emissions.



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Fig. 3 Electric EGR Transducer