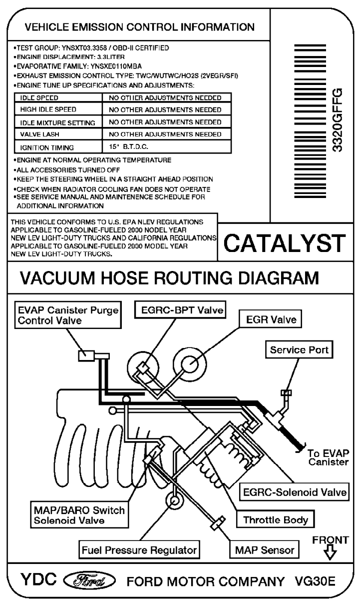
Vehicle Emission Control Information

Vehicle Emission Control Information

Vehicle Emission Control Information (VECI) Decal

Each vehicle is equipped with a Vehicle Emission Control Information (VECI) Decal (Figure 1) containing emission control data that applies specifically to that vehicle and engine. The specifications provided on the decal are critical to servicing systems. The VECI decal is located under the hood next to the prop rod slot (Figure 2).

Figure 1: Typical Vehicle Emission Control Information (VECI) Decal



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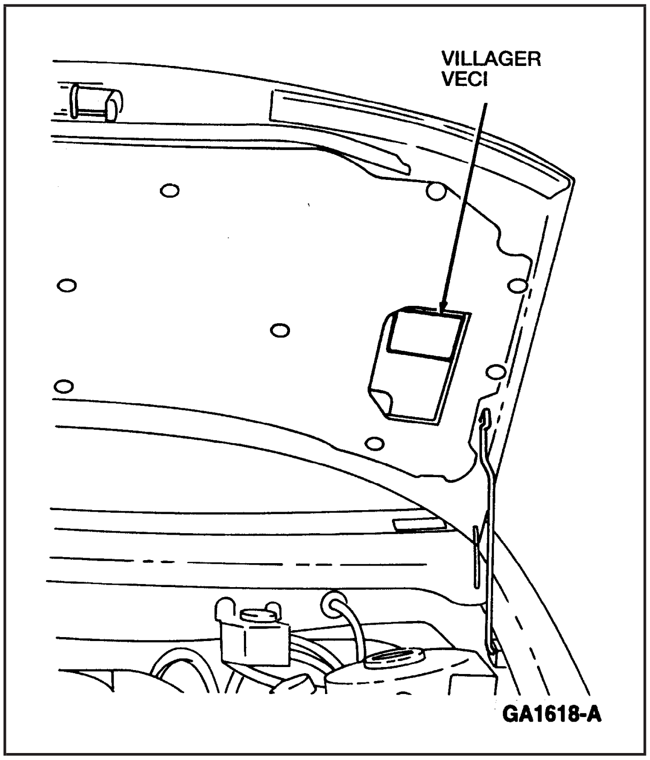
In addition to the tune-up specifications and procedures, the emission decal shows a schematic of the engine vacuum system.

Vehicle Emission Control Information

Figure 2: Vehicle Emission Control Information (VECI) Decal Location



Emission Control System Information

Manufacturers must use a standardized system for identifying their individual engine families. The system described below was developed by the Environmental Protection Agency (EPA) in 1991 to meet new regulatory requirements for 1994 and later model years.

The ENGINE FAMILY name and EVAPORATIVE FAMILY name consists of 12 characters each.

Both the engine family name and the evaporative family names are listed in the box on the emission decal in the area marked as engine/evaporative family information. The lines contain the engine size and the evaporative family name (12 characters).

EVAPORATIVE FAMILY NAMES (12 CHARACTERS)

1 FM 1 120 A Y M E B	
Letter	**Description**
1	Model Year (See Table 1)
FM	Manufacturer (See Table 2)
1	Vapor Storage System (See Table 3)
120	Canister Work Capacity (See Table 4)

(Continued)

Vehicle Emission Control Information

EVAPORATIVE FAMILY NAMES (12 CHARACTERS)

1 FM 1 120 A Y M E B	
Letter	**Description**
A	Canister Configuration and Purge Control (See Table 5)
Y	Fuel System (See Table 6)
M	Fuel Tank Material (See Table 7)
E	Standards (See Table 8)
B	Suffix (Any Letter)

EPA STANDARD ENGINE FAMILY NAME (12 CHARACTERS)

1 FM 3.3 V J G 1 E K	
Letter	**Description**
1	Model Year (See Table 1)
FM	Manufacturer (See Table 2)
3.3	Displacement in Letters-Decimal Point Counts as a Digit (See Table 9)
V	Vehicle Class (See Table 10)
J	Fuel Metering and Number of Valves Per Cylinder (See Table 11)
G	Combustion Cycle and Fuel Type (See Table 12)
1	Standards (See Table 13)
E	Catalyst/Trap (See Table 14)
K	OBD

Table 1

SUBCODES FOR MODEL YEARS

Code	Model Year
S	1995
T	1996
V	1997
W	1998
X	1999
Y	2000
1	2001

Table 2

SUBCODES FOR MANUFACTURERS

Subcode	Code	Manufacturer
FM	30	Ford Motor Company

Vehicle Emission Control Information

Table 3

VAPOR STORAGE SYSTEM

Code	System Type
1	Canister
2	Crankcase
3	Air Cleaner
4	Canister & Crankcase
5	Crankcase & Air Cleaner
6	Canister & Air Cleaner
7	Canister & Crankcase & Air Cleaner

Table 4

CANISTER WORK CAPACITY

Total Grams (All Canisters)

Table 5

CANISTER CONFIGURATION AND PURGE CONTROL

A	Plastic Housing	Closed Bottom	Purge controlled
B	Plastic Housing	Open Bottom	Purge controlled
C	Metal Housing	Closed Bottom	Purge controlled
D	Metal Housing	Open Bottom	Purge controlled
W	Plastic Housing	Closed Bottom	Purge **not** controlled
X	Plastic Housing	Open Bottom	Purge **not** controlled
Y	Metal Housing	Closed Bottom	Purge **not** controlled
Z	Metal Housing	Open Bottom	Purge **not** controlled

Table 6

FUEL SYSTEM

N	Carburetor (any type)
Y	Fuel Injection (any type)

Table 7

FUEL TANK MATERIAL

M	Metal
P	Plastic
C	Both metal and plastic tanks

Table 8

Vehicle Emission Control Information

STANDARDS

0	Tier 0
1	Tier 1

Table 9—Engine Displacement Characters 4, 5 and 6

Displacement in liters (e.g., 5.7 -- the decimal point counts as a digit) or cubic inches (e.g., 350). For dual displacement families, enter the larger displacement. For large displacement engines, the displacement may be entered as XX. format (e.g., 12.). Small motorcycle engines may be entered in a .XX format (e.g.,.07). In all cases the displacement will be read in liters if a decimal point is entered, and it will be read in cubic inches if there is no decimal point.

Table 10—Vehicle Class

LIGHT DUTY

Code	Description			Tier 1	Tier 0
	LVW	**ALVW**	**GVWR**		
V	LDV or California ARB's PC, any Tier, any Fuel				
			LDV	LDV	
Codes for LDTs in Tier 1					
1	All Fuels: ≤3750	Any	<6000	LDT_1	N/A
2	All Fuels: >3750	Any	<6000	LDT_2	N/A
3	Non-diesel: Any Diesel: ≤3750	3751-5750	>6000	LDT_3 $LDDT_3$	N/A
4	Non-diesel: Any Diesel: <3750	≤5750	>6000	LDT_4 $LDDT_4$	N/A
Diesel Tier 1 LDTs Only					
5	Diesel: >3750	3751-5750	>6000	$LDDT_3$	N/A
6	Diesel: >3750	>5750	>6000	$LDDT_4$	N/A
Codes for LDTs in Tier 0—All Fuels					
7	≤3750	Any	Any	—	LDT-A NOx=1.2
8	>3750	Any	Any	—	LDT-B NOx=1.7

CALIFORNIA ARB's MEDIUM DUTY (ONLY USE FOR CALIFORNIA-ONLY VEHICLES)

Code	Designation	GVWR	ALVW
G	MDT-1	<6000	0.3750
H	MDT-2	<6000	3751-5750
J	MDT-3	<6000	5751-8500
K	MDT-4	<6000	8501-10,000
L	MDT-5	<6000	10,001-14,000

Vehicle Emission Control Information

HEAVY DUTY

Code	Useful Life	Standard	Description
A	LHDE	Light Duty	OPTION for <10,000 GVWR
B	LHDE	>14K GVWR	Typically GVWR <19.5K, HP 70-170
C	LHDE	>14K GVWR[a]	Typically GVWR <19.5K, HP 70-170
D	MHDE	>14K GVWR	Typically GVWR 19.5K-33K, HP 170-250
E	HHDE	>14K GVWR	Typically GVWR >33K HP > 250
F	HHDE	Urban Bus	HHDDE Bus

a Also use this code for families containing both <14K and >14K GVWR

Table 11

FUEL METERING AND NUMBER OF VALVES PER CYLINDER

Code	Fuel System	Valves per Cylinder
0	Mult. Carb	2 Valves/Cylinder
1	1 BBL	2 Valves/Cylinder
2	2 BBL	2 Valves/Cylinder
3	3 BBL	2 Valves/Cylinder
4	4 BBL	2 Valves/Cylinder
5	Throttle Body Injection (TBI)	2 Valves/Cylinder
6	Mechanical MFI	2 Valves/Cylinder
7	Electrical MFI-simultaneous	2 Valves/Cylinder
8	Electrical MFI-sequential	2 Valves/Cylinder
9	Central Port Injection	2 Valves/Cylinder
A	Mult. Carb	3 or more Valves/Cylinder
B	1 BBL	3 or more Valves/Cylinder
C	2 BBL	3 or more Valves/Cylinder
D	3 BBL	3 or more Valves/Cylinder
E	4 BBL	3 or more Valves/Cylinder
F	Throttle Body Injection (TBI)	3 or more Valves/Cylinder
G	Mechanical MFI	3 or more Valves/Cylinder

(Continued)

Vehicle Emission Control Information

FUEL METERING AND NUMBER OF VALVES PER CYLINDER

Code	Fuel System	Valves per Cylinder
H	Electrical MFI-simultaneous	3 or more Valves/Cylinder
J	Electrical MFI-sequential	3 or more Valves/Cylinder
K	Central Port Injection	3 or more Valves/Cylinder
Y	None (Electric)	
Z	Other	

Table 12

COMBUSTION CYCLE AND FUEL TYPE

Code	Cycle	Fuel	
G	Otto Cycle (SI)	Gasoline	Piston
M	Otto Cycle (SI)	Methanol	Piston
E	Otto Cycle (SI)	Ethanol	Piston
F	Otto Cycle (SI)	Flexible Fuel—Methanol-Gasoline	Piston
N	Otto Cycle (SI)	Other Flexible Fuel	Piston
C	Otto Cycle (SI)	CNG	Piston
L	Otto Cycle (SI)	LPG	Piston
R	Otto Cycle (SI)	Gasoline	Rotary
X	Otto Cycle (SI)	Other Fuels	Rotary
D	Diesel Cycle (CI)	Diesel Fuel	
A	Diesel Cycle (CI)	Methanol	
B	Diesel Cycle (CI)	Ethanol	
H	Diesel Cycle (CI)	Flexible Fuel Methanol-Diesel	
J	Diesel Cycle (CI)	Other Flexible Fuel	
K	Diesel Cycle (CI)	CNG	
P	Diesel Cycle (CI)	LPG	
2	Two Stroke Cycle	Gasoline	
3	Two Stroke Cycle	Methanol/Ethanol	
4	Two Stroke Cycle	Diesel	
5	Two Stroke Cycle	CNG	
6	Two Stroke Cycle	LPG	
7	Two Stroke Cycle	Flexible Fuel	
T	Turbine	Gasoline	
Q	Turbine	Diesel	
S	Turbine	Methanol/Ethanol	
U	Turbine	CNG	
V	Turbine	LPG	
W	Turbine	Flexible Fuel	
Y	Hybrid Electric	—	
Z	Electric	—	

Vehicle Emission Control Information

Table 13

STANDARDS

49-State and 50-State Families			
Code	Sales Class	HC, CO & NOx	PM
A	49 or 50 States	Tier 0	Any
B	49 or 50 States	Tier 0	Any
C	49 or 50 States	Tier 1	Tier 0
D	49 or 50 States	Tier 1	Tier 0
E	49 or 50 States	Tier 1	Tier 1
F	49 or 50 States	Tier 1	Tier 1
G	49 or 50 States	Tier 1	Tier 0
H	49 or 50 States	Tier 1	Tier 0
J	49 or 50 States	Tier 1	Tier 1
K	49 or 50 States	Tier 1	Tier 1
L-Z	(Reserved)		
California Only Families			
0	California ARB Tier 0	—	—
1	California ARB Tier 1	—	—
2	California ARB TLEV	—	—
3	California ARB LEV	—	—
4	California ARB ULEV	—	—
5	California ARB ZEV (Electric)	—	—

Table 14

CATALYST/TRAP

Codes[a]	Description
Catalyst Type	
A, B	Ox Cat Only
C, D	Reduction Cat
E, F, G, H	3-Way Cat
J, K, L, M	3-Way + Ox Cat
N, P, Q	Heated Cat
R, S, T	No Cat
Trap Type	
1, 2	Trap-Active Regeneration
3, 4	Trap-Continuous Regeneration
5, 6	Trap-Continuous Regeneration + Fuel Add.
Description	
Y, Z	Other

a First code listed is preferred code, other codes may be used if necessary to separate engine families that would otherwise be named the same.

Vehicle Emission Control Information

Acronym Definitions

ALVW—Adjusted Loaded Vehicle Weight, (Curb Weight + GVWR) /2.

CALIFORNIA ARB—California Air Resource Board.

LEV—Low Emission Vehicle.

TLEV—Transitional Low Emission Vehicle.

ULEV—Ultra Low Emission Vehicle.

ZEV—Zero Emission Vehicle.

CI—Cylinder Injection.

GVWR—Gross Vehicle Weight Rating, Curb weight plus payload.

HHDDE—Heavy Heavy Duty Diesel Engine.

MHDE—Medium Heavy Duty Diesel Engine.

LDDT—Light Duty Diesel Truck categories.

LDT—Light Duty Truck (gasoline) categories based on weight as defined in the table.

LDV—Light Duty Vehicle, generally passenger cars and light trucks under 6000 pounds GVWR.

LHDE—Light Heavy Duty Engine (several weight categories).

LVW—Loaded Vehicle Weight, curb weight plus 300 pounds.

MDT—Medium Duty Truck categories based on weight as defined in the table.

MHDE—Medium Heavy Duty Engine.

PC—Passenger Car.

SFI—Sequential Multiport Fuel Injection.

Tier 0—California and Federal regulations effective prior to Tier 1 phase in dates.

Tier 1—California regulations beginning in 1993 model year and Federal regulations beginning in 1994 model year.

Abbreviations:

CONV - Conventional Systems

EVAP - Evaporative Emission

EVAP Canister - Evaporative Emissions Canister

ISC - Idle Speed Control Valve

IAC - Idle Air Control Valve

PCV - Positive Crankcase Ventilation

WU- TWC - Warm Up Three Way Catalytic Converter

TWC - Three Way Catalytic Converter

Engine/Vehicle Applications and VIN Location

Application Chart

APPLICATION CHART

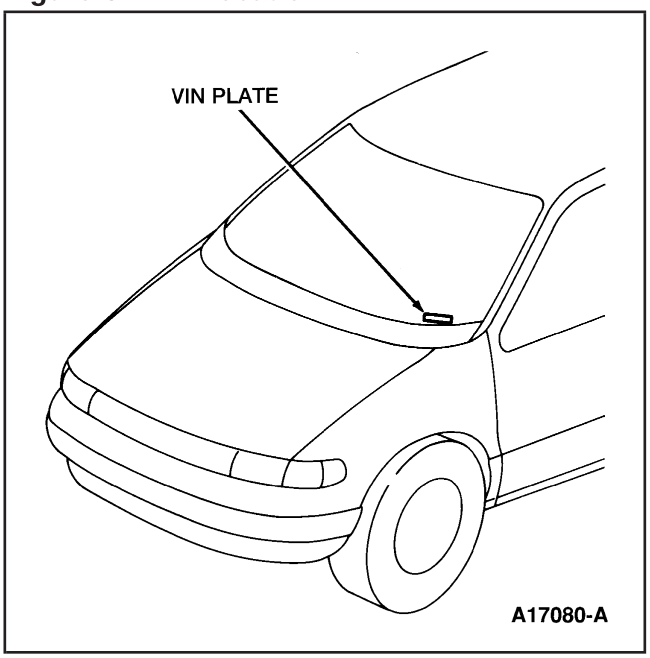
System	Application
Engine	3.3L
Cylinders	6
Injection	SFI
Valves per Cylinder Intake/Exhaust	1/1
Camshaft, Belt Drive	OHC
Free Wheeling	Yes

Vehicle Identification Number

The official Vehicle Identification Number (VIN) for title and registration purposes is stamped on a metal plate. The plate is fastened to the instrument panel near the windshield on the driver side of the vehicle (Figure 3) and is visible from the outside. The VIN is 17 characters long.

The last six digits of the VIN indicate the serial number of each unit built at each assembly plant. The production serial number begins with 100,000 and may sequence through 999,999.

Figure 3: VIN Location



On—Board Diagnostics II System

On-Board Diagnostics II System

Overview

The California Air Resources Board (California ARB) began regulation of On-Board Diagnostics (OBD) for vehicles sold in California beginning with the 1988 model year. The first phase, OBDI, required monitoring of the fuel metering system, exhaust gas recirculation (EGR) system, and additional emission related components. The malfunction indicator lamp (MIL) was required to light and alert the driver of the fault and the need for repair of the emission control system. The MIL must be labeled ''CHECK ENGINE'' or ''SERVICE ENGINE SOON.'' Associated with the MIL was a fault code or diagnostic trouble code (DTC) identifying the specific area of the fault.

The OBD system was proposed by the California ARB to improve air quality by identifying vehicles exceeding emission standards. Passage of the federal Clean Air Act Amendments in 1990 has also prompted the Environmental Protection Agency (EPA) to develop on-board diagnostic requirements. California ARB OBD II regulations will be followed until 1999 when the federal regulations will be used.

The OBD II system meets government regulations by monitoring the emission control system. When a system or component exceeds emission thresholds or a component operates outside of tolerance, a DTC will be stored and the MIL will be illuminated.

Fault detection strategy and MIL operation are associated with trips and drive cycles. Each monitor has requirements for setting and clearing DTCs and for controlling the MIL. These processes, DTC and MIL operation, descriptions of the monitors and the definition of trip and drive cycles are discussed in detail within this section.

The diagnostic executive is the computer program in the powertrain control module (PCM) that coordinates the OBD II self-monitoring system. This program controls all the monitors and interactions, DTC and MIL operation, freeze frame data and diagnostic tool interface.

Freeze frame data describes stored engine conditions, such as state of the engine, state of fuel control, spark, RPM, load, and warm-up status at the point the first fault is detected. Previously stored conditions will be replaced only if a fuel or misfire fault is detected. This data is accessible with the diagnostic tool to assist in repairing the vehicle.

Powertrain Control Module

The center of the OBD II system is a microprocessor called the powertrain control module (PCM). The PCM has a single 104 pin connector. The PCM receives input from sensors and other electronic components (switches, relays, and others). Based on information received and programmed into its memory (keep alive random access memory , and others), the PCM generates output signals to control various relays, solenoids and actuators.

Keep Alive Random Access Memory (RAM) - The powertrain control module (PCM) stores information in keep alive random access memory (RAM), a memory integrated circuit, about vehicle operating conditions, and then uses this information to compensate for component variability. Keep alive RAM remains powered when the vehicle ignition key is OFF so that this information is not lost.

On-Board Diagnostics II System

Fail Safe - This system of special circuitry provides minimal engine operation should the powertrain control module (PCM), mainly the Central Processing Unit or EEPROM, stop functioning correctly. All modes of Self-Test are not functional at this time. Electronic hardware is in control of the system while in fail safe operation.

Component Control	Fail Safe Condition	Operation
IAC	Idle Air Held To Full Open.	
INJ 1 INJ 2 INJ 3 INJ 4 INJ 5 INJ 6	Fuel injection volume fixed according to driving conditions. Fuel is injected simultaneously into all cylinders once per crankshaft revolution. Timing for the injection is based upon the camshaft position sensor signal.	
EVAP	OFF	EVAP Canister Purge Valve Closed.
Ignition Timing	Ignition Timing Fixed.	
High Speed Fan Control	ON	High Speed Fan Control Relay Energized.
Low Speed Fan Control	OFF	Low Speed Fan Control Relay Unenergized.
A/C Relay	OFF	A/C Relay Unenergized.
MIL	ON	Malfunction Indicator Lamp On.
FP	ON	Fuel Pump Control Relay Energized (Engine Running).

Adaptive Fuel Control Strategy

The adaptive fuel control strategy is designed to compensate for variability in the fuel system components. If, during normal vehicle operation, the fuel system is detected to be biased rich or lean, the adaptive fuel control will make a corresponding shift in the fuel delivery calculation.

Whenever an injector or fuel pressure regulator is replaced, keep alive random access memory (RAM) should be cleared. This is necessary so the fuel strategy does not use the previously learned adaptive values.

To clear keep alive RAM, refer to Powertrain Control Module (PCM) Reset in Section 2, Diagnostic Methods.

Failure Mode Effects Management

Failure mode effects management (FMEM) is an alternate system strategy in the powertrain control module (PCM) designed to maintain vehicle operation if one or more sensor inputs fail.

When a sensor input is perceived to be out-of-limits by the PCM, an alternative strategy is initiated. The PCM substitutes a fixed value and continues to monitor the incorrect sensor input. If the suspect sensor operates within limits, the PCM returns to the normal engine running strategy.

On-Board Diagnostics II System

Engine RPM/Vehicle Speed Limiter

The powertrain control module (PCM) will disable all of the fuel injectors whenever an engine RPM or vehicle overspeed condition is detected. The purpose of the engine RPM or vehicle speed limiter is to prevent damage to the powertrain. In this strategy, the vehicle will exhibit a rough running engine condition. Once the driver reduces the excessive speed, the vehicle will return to the normal operating strategy.

Common OBD II Terms

Trip: A trip is defined as a Key-ON, Key-OFF event in which the powertrain control module (PCM) detects the following:

1. Engine coolant temperature should exceed 70°C degrees (158°F).
2. Engine coolant temperature should change more than 20°C degrees (68°F) after starting the engine.
3. Engine speed should go over 400 rpm.

TWO TRIP DETECTION LOGIC

When the powertrain control module (PCM) detects a fault during the 1st trip, the DTC and corresponding freeze frame data are stored in the PCM's memory. The malfunction indicator lamp (MIL) will not be illuminated until the fault is detected again during the 2nd trip. Certain DTCs are capable of turning the MIL light on or blinking it during the first trip.

Diagnostic Trouble Code

Diagnostic trouble codes (DTCs) used in OBD II vehicles will begin with a letter and are followed by four numbers. The letter at the beginning of the DTC identifies the function of the monitored device that has failed. A P indicates a powertrain device, C indicates a chassis device, B is for body device and U indicates a network or data link code.

The first number indicates if the code is generic (common to all manufacturers), or if it is manufacturer specific. A 0 indicates generic, 1 indicates manufacturer-specific.

The second number indicates the system that is affected with a number between 1-7. The following is a list showing what numbers are assigned to each system.

1. Fuel and air metering
2. Fuel and air metering (injector circuit malfunctions only)
3. Ignition system or misfire
4. Auxiliary emission controls

On-Board Diagnostics II System

5. Vehicle speed controls and idle control system
6. Computer output circuits
7. Transmission

The last two numbers of the DTC indicate the component or section of the system where the fault is located.

Malfunction Indicator Light

When the PCM detects an emission related DTC during the 1st trip, the DTC and engine data are stored in the freeze frame memory. The MIL light is illuminated only when the PCM detects the same emission related DTC after it occurs in two consecutive trips. Once the MIL is illuminated, it will only turn off after the PCM detects three trips without any faults occurring. DTCs that would cause vehicle emissions to exceed the federal limit are capable of illuminating or blinking the MIL during the 1st trip.

Diagnostic Trouble Codes Capable of Illuminating the MIL When Detected on the 1st Trip

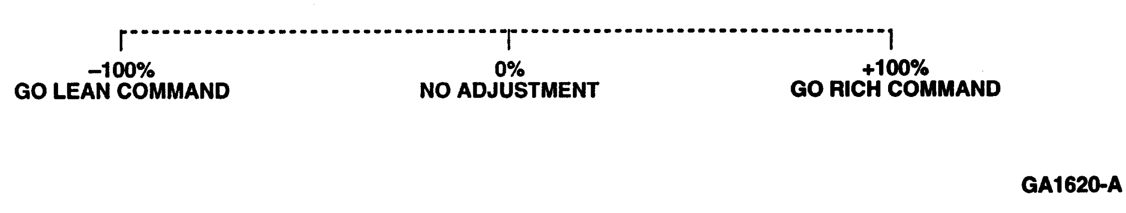
Misfire diagnostic trouble codes

Catalyst diagnostic trouble codes

Closed loop control diagnostic trouble codes

Fuel Trim

For OBD II vehicles, long term and short term fuel trim values will be shown in percentages. Freeze frame will also show fuel trim values as percentages. Fuel trim represents how much compensation the powertrain control module (PCM) must make from ideal conditions. A higher positive value for fuel trim indicates the PCM is commanding more fuel into the engine, this can be caused by vacuum leaks, restricted fuel injectors, and others. A highly negative value indicates a lean engine command, possibly caused by leaky injectors, and others.



On-Board Diagnostics II System

FREEZE FRAME DATA

When a freeze frame event is triggered by an emissions related diagnostic trouble code (DTC), the powertrain control module (PCM) stores various vehicle information as it existed the moment the fault occurred. The DTC number along with the engine data can be useful in aiding a technician in locating the cause of the fault. Once the data from the 1st trip DTC occurrence is stored in the freeze frame memory, it will remain there even when the fault occurs again (2nd trip) and the MIL is illuminated. Freeze frame data will not be displayed after 40 drive cycles have occurred without a fault. Data can be stored in freeze frame for only one event, however, the PCM will prioritize what data it will store. For example, an ECT fault (priority 2) was detected during the 1st trip and the freeze frame data stored. After that, a misfire DTC occurs (priority 1) in another trip; the misfire data will replace the ECT data stored in the freeze frame memory, except after a misfire or fuel injection system DTC, which will not be cleared until 80 consecutive drive cycles have occurred without a fault.

OBD II System Readiness Tests

The OBD II system readiness tests (SRT) are:

- Heated oxygen sensor (HO2S) monitor
- Catalyst efficiency monitor
- Misfire detection monitor
- Fuel system monitor
- Comprehensive component monitor
- Evaporative emission system monitor

Heated Oxygen Sensor Monitor

OBD II regulations require monitoring of the upstream heated oxygen sensor (HO2S) to detect if the deterioration of the sensor has exceeded emission thresholds. An additional HO2S is located downstream of the warm up- three way catalytic converter (WU-TWC), or after the pre-catalytic converter to determine the efficiency of the catalyst. Although the downstream HO2S is similar to the type used for fuel control, it functions differently. The downstream HO2S is monitored to determine if a voltage is generated. That voltage is compared to a calibrated acceptable range.

Catalyst Efficiency Monitor

The catalyst efficiency monitor is a self-test strategy within the powertrain control module (PCM) that uses the downstream heated oxygen sensor (HO2S) to determine when a catalyst has fallen below the minimum level of effectiveness in its ability to control exhaust emissions.

On-Board Diagnostics II System

Misfire Detection Monitor

Misfire is defined as the lack of proper combustion in the cylinder due to the absence of spark, poor fuel metering, or poor compression. Any combustion that does not occur within the cylinder(s) at the proper time is also a misfire. The misfire detection monitor detects fuel, ignition or mechanically induced misfires. The intent is to protect the catalyst from permanent damage and to alert the customer of an emission failure or an inspection maintenance failure by illuminating the malfunction indicator lamp (MIL). When a misfire is detected, special software called ‘‘freeze frame’’ data is enabled. The freeze frame data captures the operational state of the vehicle when a fault is detected from misfire detection monitor strategy.

Fuel System Monitor

The fuel system monitor is a self-test strategy within the powertrain control module (PCM) that monitors the adaptive fuel table. The fuel control system uses the adaptive fuel table to compensate for normal variability of the fuel system components caused by wear or aging. During normal vehicle operation, if the fuel system appears ‘‘biased’’ lean or rich, the adaptive fuel table will shift the fuel delivery calculations to remove the bias.

Comprehensive Component Monitor

The comprehensive component monitor is a self-test strategy within the powertrain control module (PCM) that detects faults of any electronic powertrain component or system that provides input to the PCM and is not exclusively an input to any other OBD II monitor.

Evaporative Emission System Monitor

The evaporative emission (EVAP) system monitor is a self-test strategy within the powertrain control module (PCM) that tests the integrity of the EVAP system. When a fault occurs, the EVAP system monitor is reset to ‘‘NO’’ and a diagnostic trouble code (DTC) is set in the PCM memory. After the DTC is repaired the vehicle drive cycle must be driven to reset the monitor in preparation for Inspection Maintenance (I/M) testing.

Trips and Drive Cycles

Trip

A trip is defined as a Key-ON, Key-OFF event in which the powertrain control module (PCM) detects the following:

(1) Engine coolant should exceed 70°C (158°F).

(2) Engine coolant temperature should change more than 20°C (68°F) after starting the engine.

(3) Engine speed should go over 400 rpm.

When the PCM detects an emission related diagnostic trouble code (DTC), it uses the trip information to make its decision on whether to illuminate the malfunction indicator lamp (MIL) light.

Trip Display on Diagnostic Tool

The on-board system readiness function is available on all diagnostic tools. This function indicates the status of each OBD II System Readiness Tests (SRT). One parameter identification display (PID) on a diagnostic tool summarizes the status of all monitors.

Trips and Malfunction Indicator Lamp Function

Trips are used by the software strategy to control the malfunction indicator lamp (MIL) off function. The MIL is turned on after an emission related diagnostic trouble code (DTC) is stored in memory. The MIL is turned off if there are three consecutive drive cycles (refer to Drive Cycle in Section 2) without the identical fault under similar conditions or three trips without the identical fault present. The actual number of drive cycles or trips necessary to control the MIL varies with each monitor. (Refer to specific monitor description and operation in this section.)

Trips and Diagnostic Trouble Codes

A diagnostic trouble code (DTC) will be stored in memory after the identical fault has been detected consecutively on at least two separate drive cycles (not necessarily completing a trip). A misfire detection monitor DTC can be stored immediately depending on the misfire type. A catalyst efficiency monitor DTC can be stored after three identical faults are detected on three separate drive cycles. A DTC will be erased from memory after 40 engine warm-up cycles, except for misfire or fuel injection system DTCs which will be cleared after 80 warm-up cycles, if the fault has not been detected after the malfunction indicator lamp (MIL) is turned off. DTC memory storage requirements vary with each monitor. (Refer to the specific monitor in this section for more information.)

Drive Cycle

A drive cycle is a method of driving a vehicle to run all of the on-board diagnostics. It can also be a method of driving a vehicle to initiate and complete a specific OBD II System Readiness Test (SRT) or trip. A drive cycle may be done in the service bay or may require specific drive modes such as a number of idle periods, steady vehicle speed per time, accelerations at certain throttle angles, and others.

Trips and Drive Cycles

OBD II Drive Cycle

The OBD II Drive Cycle is a specific method used to perform all trip monitor tests, as well as the catalyst efficiency monitor test. (Refer to Drive Cycle in Section 2.)

Inspection/Maintenance Testing — OBD II System Readiness Tests

In some areas of the country, it may become a legal requirement to pass an Inspection/Maintenance (I/M) test of the On-Board Diagnostic Generation II (OBD II) system. Before I/M testing can proceed, the OBD II System Readiness Tests (SRT) must all indicate a ‘‘yes’’ condition; if not, the OBD II Drive Cycle must be performed. During the mix of city and highway driving involved in the OBD II drive cycle, the diagnostic monitors will test certain parts of the OBD II software and hardware used to control vehicle emissions. While some of the monitors will run to completion and indicate a Yes or No, others such as misfire or fuel system will continuously run.

The Villager OBD II System Readiness Tests (SRT) are listed below:

Misfire	Continuous
Fuel System Monitoring	Continuous
Comprehensive Component Monitoring	Continuous
Catalyst	No/Yes
Oxygen Sensor	No/Yes
Oxygen Sensor Heater	No/Yes
Evaporative Emission System	No/Yes

Malfunction Indicator Lamp (MIL)

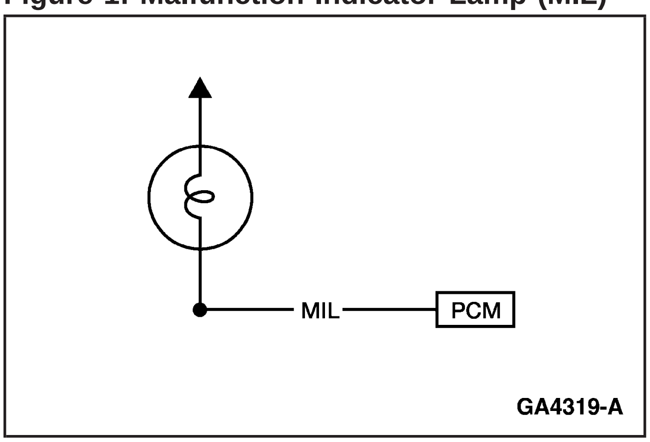
The malfunction indicator lamp (MIL) (Figure 1) alerts the driver that the powertrain control module (PCM) has detected an OBD II emission related component or system fault. When this occurs, an OBD II diagnostic trouble code (DTC) will be set.

When a fault has been detected in two consecutive drive trips, a DTC will be stored in the PCM and the MIL will be turned on. The MIL will be turned off after three consecutive trips have been completed without the same fault being detected. The DTC will be erased from keep alive random access memory (RAM) after 40 warm-ups without the fault being detected, except for misfire or fuel injection system DTCs which will be erased after 80 warm-ups without a fault being detected. The only exception to this is if a misfire occurs that could cause damage to the catalyst. In that event, the MIL will be turned on immediately or may flash.

The MIL is located on the dashboard and is labeled ‘‘CHECK ENGINE.’’ Power is supplied to the MIL whenever the ignition switch is in the run or crank position. The MIL will remain on in the run/crank mode as a bulb check until the camshaft position (CMP) signal is detected. The light may also be on due to a short to ground of the MIL circuit, or operation in the fail safe mode. In addition, the MIL will remain on if the MIL was on when the vehicle was last shut down. If the MIL does not turn off while the engine is cranking, it could indicate the PCM is not receiving the CMP signal or the MIL circuit is shorted to ground. If the MIL blinks, there is a severe misfire or an intermittent in the MIL circuit.

To extinguish the MIL after a repair, a reset command from the diagnostic tool must be sent, or three consecutive drive cycles must be completed without a fault. (Refer to Trips and Drive Cycles in this section for more information.) If the MIL never comes on or the vehicle is a no-start, go to Section 3, Symptom Charts.

Figure 1: Malfunction Indicator Lamp (MIL)



Ignition System

Ignition System

Ignition and Timing Systems

The ignition system provides spark control to the engine during all modes of operation. The ignition system consists of three subsystems: primary ignition, secondary ignition, and timing advance.

Primary Ignition Components

The primary ignition components include the coil primary circuit, the power transistor, and the ignition switch. When the ignition switch is turned on, it charges the primary coil windings. When the engine is running, the powertrain control module (PCM) sends a signal to the power transistor. The power transistor grounds the negative side of the coil primary circuit, generating the proper voltage in the secondary circuit which induces spark.

Secondary Ignition Components

The secondary ignition components include the spark plugs, the spark plug wires, the distributor cap, the rotor, and the coil secondary circuit. When the power transistor grounds the primary circuit, the inductive charge built up in the secondary circuit sends a spark from the coil to the rotor. The rotor and distributor cap then send a spark to each spark plug.

Timing Advance Components

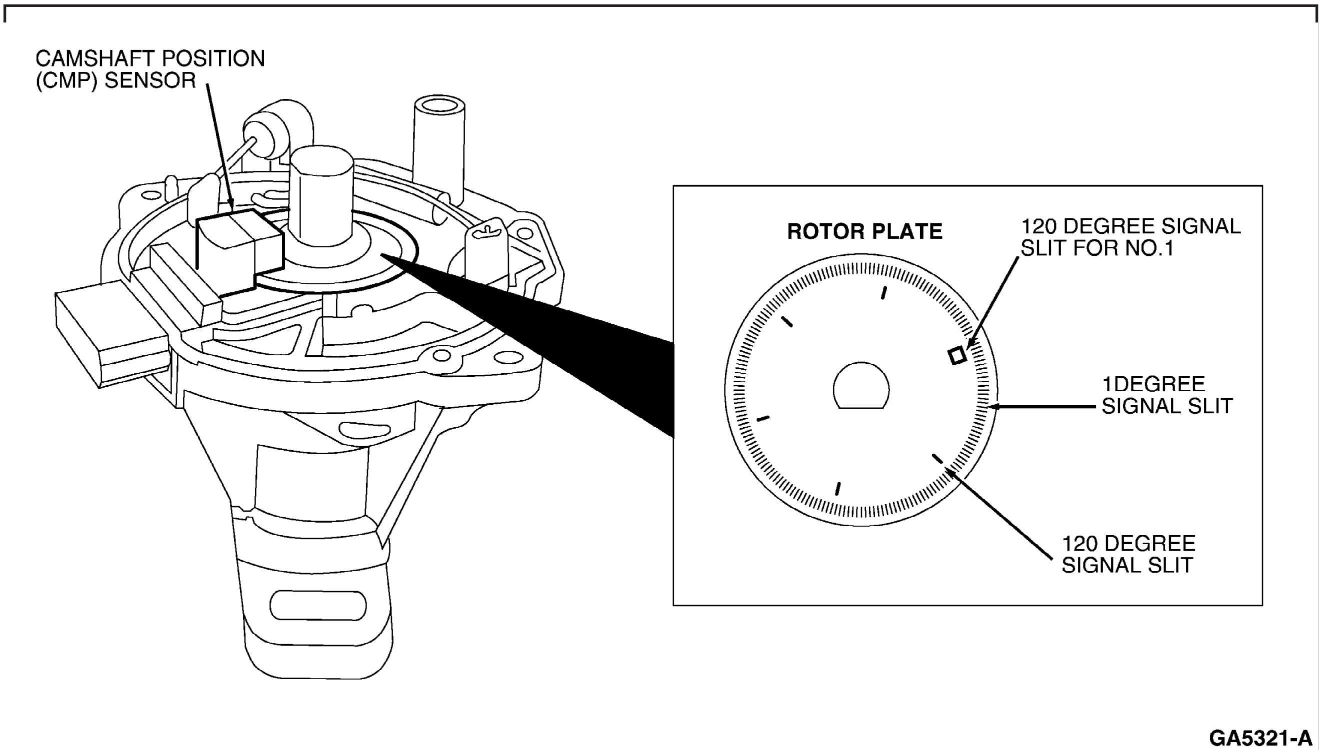
The spark advance and retard functions are controlled by the powertrain control module (PCM). The PCM receives signals from various switches and sensors and then sends the spark timing signal through the power transistor and the ignition coil.

Camshaft Position Sensor

The camshaft position (CMP) sensor (Figure 1) is mounted inside the distributor housing. The CMP sensor has a rotor plate and a wave-forming circuit. The rotor plate has 360 slits for 1 degree signals and 6 slits for 120 degree signals. When the rotor plate passes between the light emitting diodes (LEDs) and the photo diode built into the wave-forming circuit, an input signal is generated and sent to the powertrain control module (PCM). This signal notifies the PCM of the engine speed at 1 degree intervals and the crankshaft position at 120 degree intervals.

Ignition System

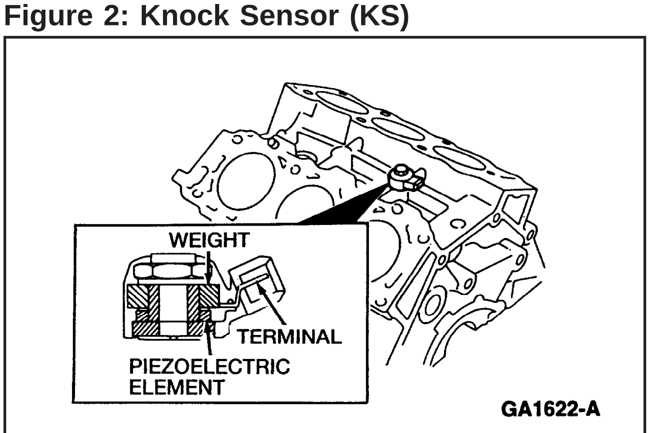
Figure 1: Camshaft Position (CMP) Sensor



Knock Sensor

The knock sensor (KS) (Figure 2) detects engine knocking conditions and sends a signal to the powertrain control module (PCM). A knocking vibration from the engine block is applied as a pressure to the piezoelectric element of the KS. This vibrational pressure is then converted into a voltage signal which is delivered to the PCM. The PCM then retards the ignition timing to compensate for the condition. The KS is attached to the engine block between the cylinder banks. The MIL will not be illuminated for a KS fault.

Figure 2: Knock Sensor (KS)

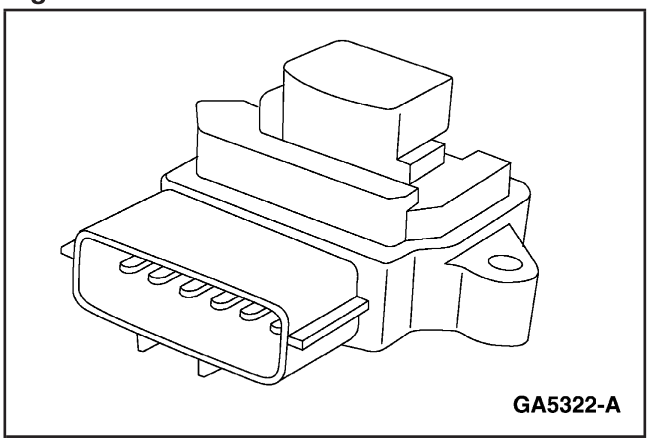


Ignition System

Power Transistor

The ignition timing is controlled by the powertrain control module (PCM). The PCM detects information such as the injection pulse width and camshaft position sensor (CMP) signal which varies every moment. Then, responding to this information, an ignition signal is sent to the power transistor which is combined with the camshaft position sensor (CMP) as one component (Figure 3). The power transistor amplifies this signal and turns the ignition coil primary circuit on and off, inducing a high voltage in the secondary circuit. The ignition coil is a small, molded type.

Figure 3: Power Transistor



Fuel System

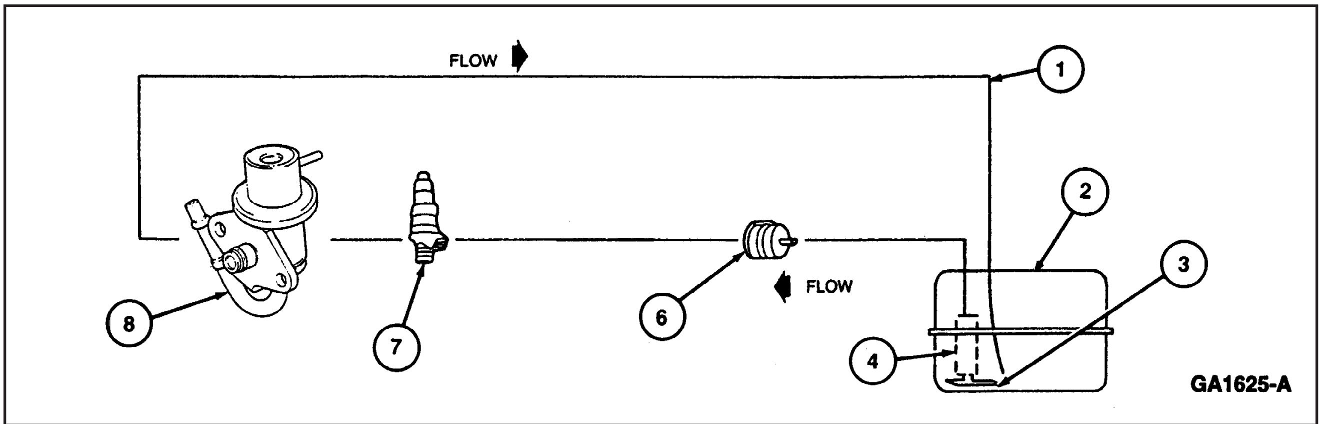
Fuel System

Fuel System

The fuel system consists of a fuel tank with reservoir, fuel pump assembly, fuel supply and return lines, fuel filters, fuel rail, fuel injector, and fuel pressure regulator (Figure 1).

When the ignition switch is in the ON or START position, power is supplied to the fuel pump relay and to the powertrain control module (PCM). The fuel pump is commanded on by the PCM grounding the coil in the fuel pump relay. The fuel pump is turned on via the inertia fuel shutoff switch whenever the ignition switch is in the ON or START position. If the PCM detects that the engine has not started or has stopped, it will turn off the fuel pump after 1.5 seconds. This is done to reduce the risk of draining the battery and damaging the fuel pump. The inertia fuel shutoff switch is a safety device which interrupts fuel pump power in the event of a collision. If the inertia fuel shutoff switch is "tripped," it must be reset by depressing the button on top of the switch. The switch is located on the LH side of the kick panel, below the hood release handle.

Figure 1: Fuel System Schematic



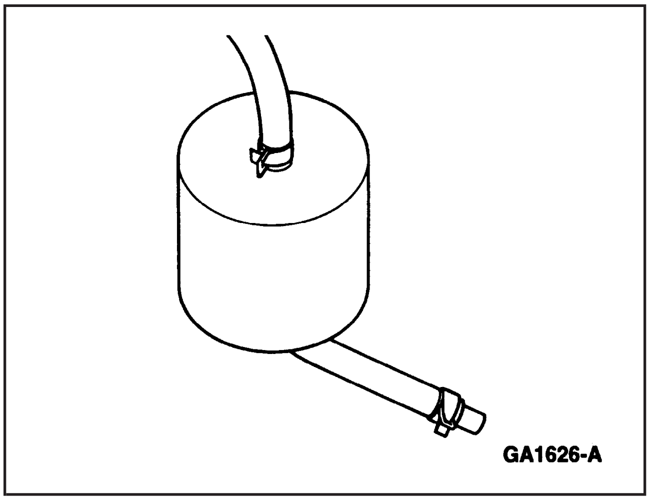
Item	Part Number	Description
1	—	Fuel Line Return
2	—	Fuel Tank
3	—	Inlet Fuel Filter
4	—	Fuel Pump
5	—	Pressure Fuel Line
6	—	In-Line Fuel Filter
7	—	Fuel Injectors
8	—	Fuel Pressure Regulator

Fuel Filter

The fuel filter (Figure 2) strains particles from the fuel through a paper element. This filtration process reduces the possibility of an obstruction in any of the fuel injector orifices. This vehicle uses a specially designed fuel filter that has a metal case in order to withstand high fuel pressure.

Fuel System

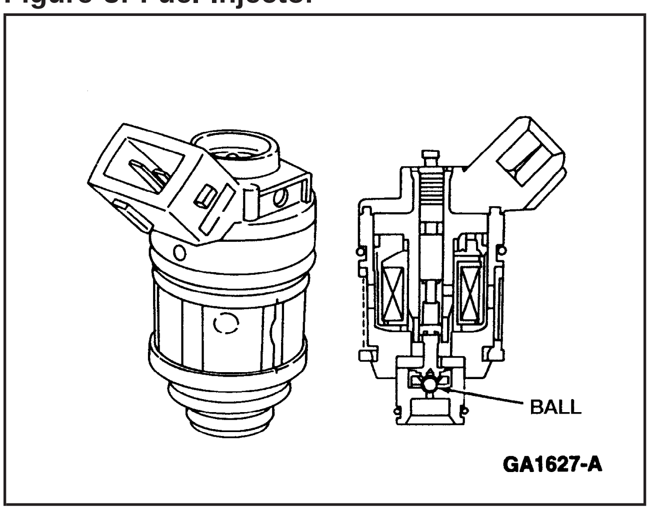
Figure 2: Fuel Filter



Fuel Injector

The fuel injectors (Figure 3) are electronically controlled solenoid valves that control fuel flow to the engine.The injectors are controlled by the powertrain control module (PCM), the fuel pressure regulator, and the intake manifold vacuum. When the PCM sends a signal to the injector, the coil in the injector pulls a ball back and fuel is released into the intake manifold through the nozzle. The injected fuel is controlled by the PCM in terms of injection pulse duration. These injectors are side feed type injectors.

Figure 3: Fuel Injector

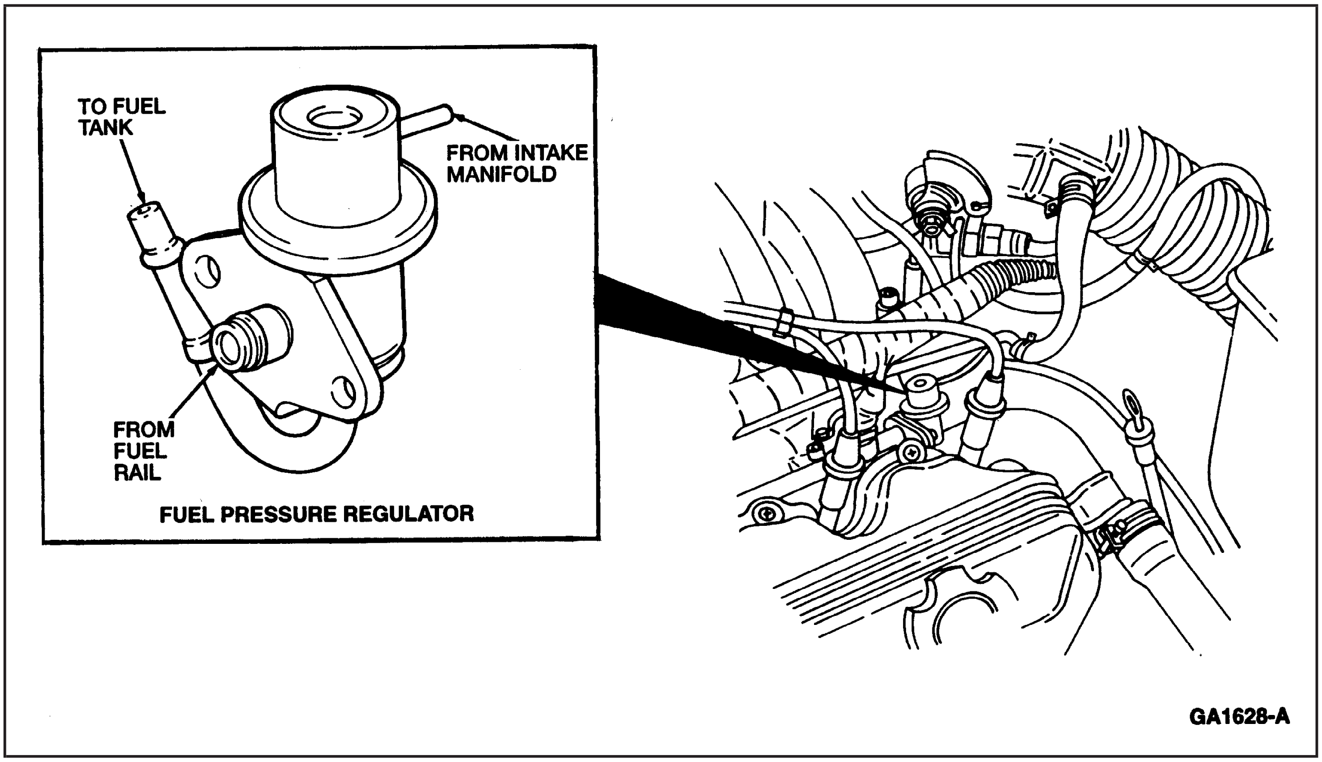


Fuel System

Fuel Pressure Regulator

The fuel pressure regulator (Figure 4) maintains the fuel pressure at 294 kPa (43 psi). Since the injected fuel amount depends on injection pulse duration, it is necessary to maintain the pressure at the above value. The fuel pressure decreases as the vacuum increases. At idle when vacuum is applied, the fuel pressure is 235 kPa (34 psi). When no vacuum is applied, the fuel pressure is 294 kPa (43 psi).

Figure 4: Fuel Pressure Regulator

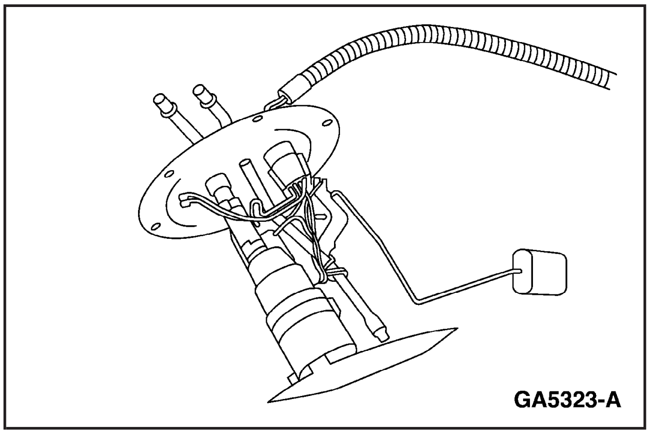


Fuel Pump

The fuel pump (FP) filters solid particles from the fuel and allows the fuel to be transmitted from the fuel tank to the engine. The FP with a fuel damper is an in-tank type. This means the pump and the damper are located in the fuel tank. The FP (Figure 5) has an internal motor which creates pressure in the fuel lines. The FP is controlled by a fuel pump relay, which is controlled by the powertrain control module (PCM).

Fuel System

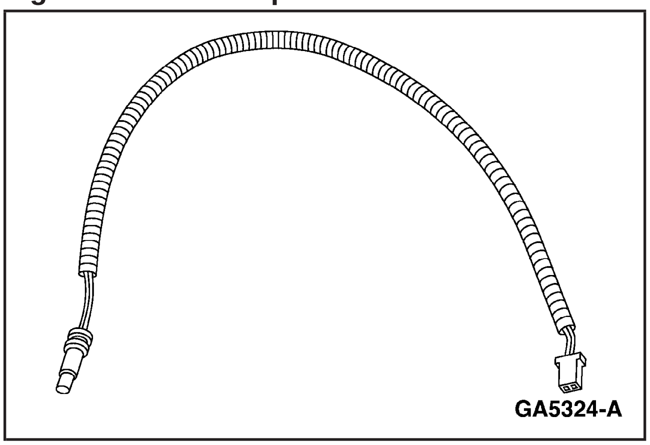
Figure 5: Fuel Pump



Fuel Temperature Sensor

The fuel temperature sensor (Figure 6) is located in the fuel tank, clipped onto the fuel tank baffle. This sensor is an input into the powertrain control module (PCM). Its data is used primarily by the PCM in calculating the operation of the evaporative (EVAP) emission system.

Figure 6: Fuel Temperature Sensor

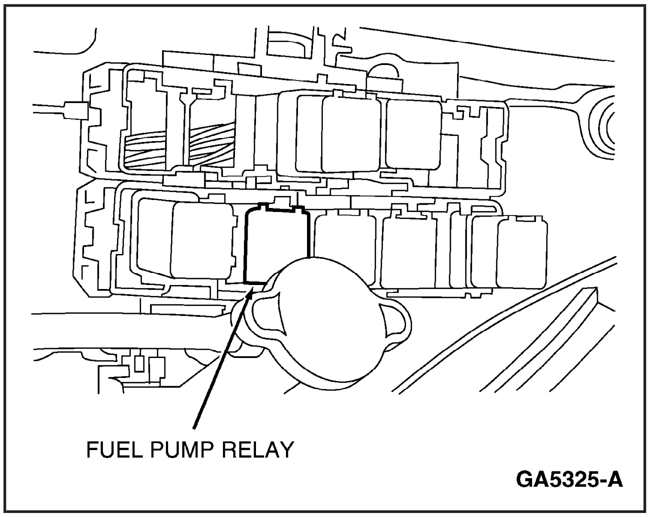


Fuel System

Fuel Pump Relay

The fuel pump (FP) relay (Figure 7) supplies voltage to the FP when activated by the powertrain control module (PCM). The PCM activates the FP relay for five seconds after turning the ignition key ON, and when the engine is cranking or running. The PCM deactivates the FP relay 1.5 seconds after the engine stops. The voltage supplied from the FP relay allows the FP motor to operate. When the PCM receives a 120 degree signal from the camshaft position (CMP) sensor, it knows that the engine is rotating, and causes the FP relay to activate. When activated, the FP relay supplies the FP with voltage, which allows it to operate continuously as long as the engine is running. If the PCM does not receive a 120 degree signal when the ignition switch is ON, the engine is stalled. The FP relay is deactivated and prevents battery discharging, thereby improving safety.

Figure 7: Fuel Pump Relay

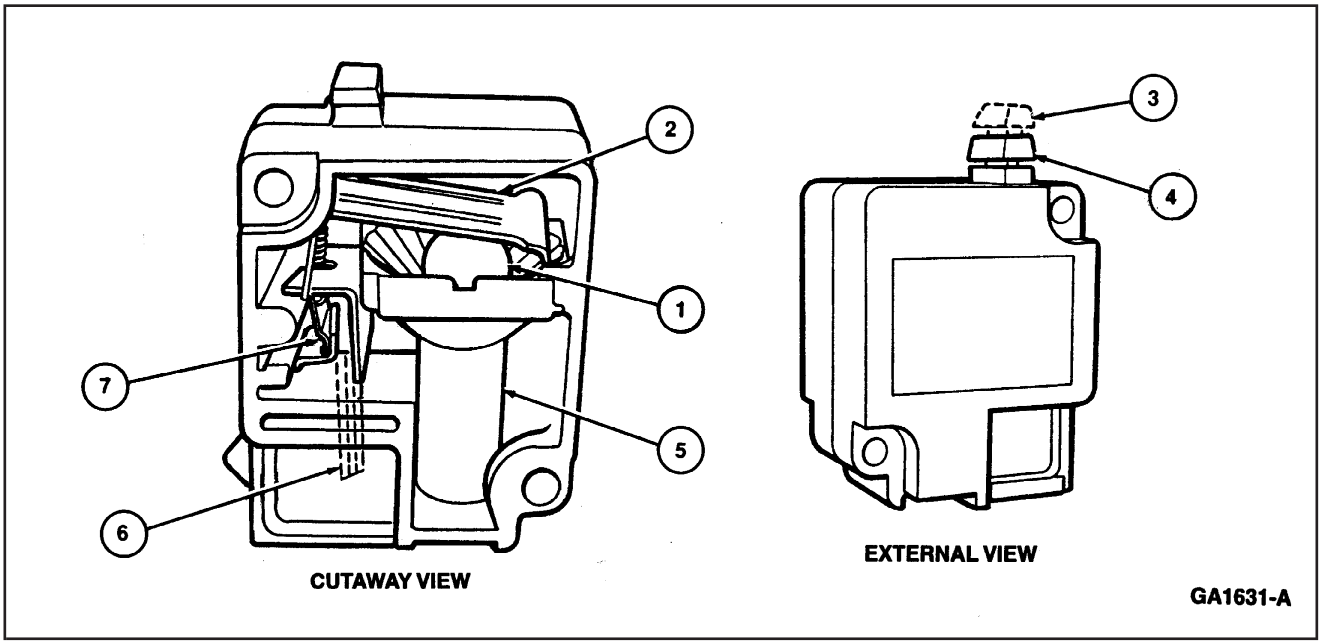


Inertia Fuel Shutoff Switch

The inertia fuel shutoff (IFS) switch (Figure 8) is used in conjunction with the electric fuel pump. The purpose of the IFS is to shut off the fuel pump if a collision occurs. It consists of a steel ball held in place by a magnet. When a sharp impact occurs, the ball breaks loose from the magnet, rolls up a conical ramp and strikes a target plate which opens the electrical contacts of the switch and shuts off the electric fuel pump. Once the switch is open, it must be manually reset before restarting the vehicle. The IFS location can be seen in Figure 9.

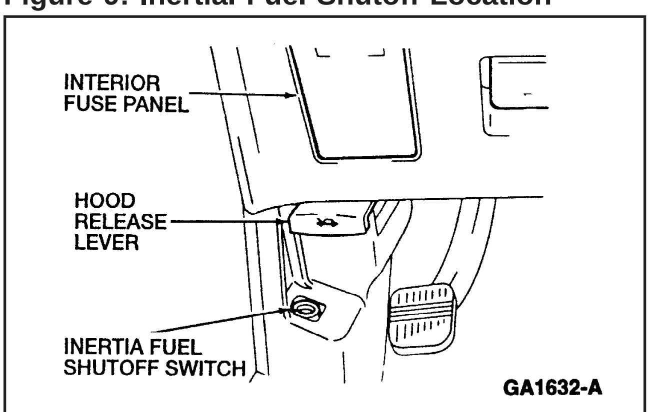
Fuel System

Figure 8: Typical Inertia Fuel Shutoff (IFS) Switch



Item	Part Number	Description
1	—	Ball
2	—	Target Plate
3	—	Reset Button Position for Open Switch
4	—	Reset Button Position for Closed Switch
5	—	Magnet
6	—	Switch Terminals
7	—	Electrical Contacts

Figure 9: Inertial Fuel Shutoff Location



Evaporative Emission System

Evaporative Emission System

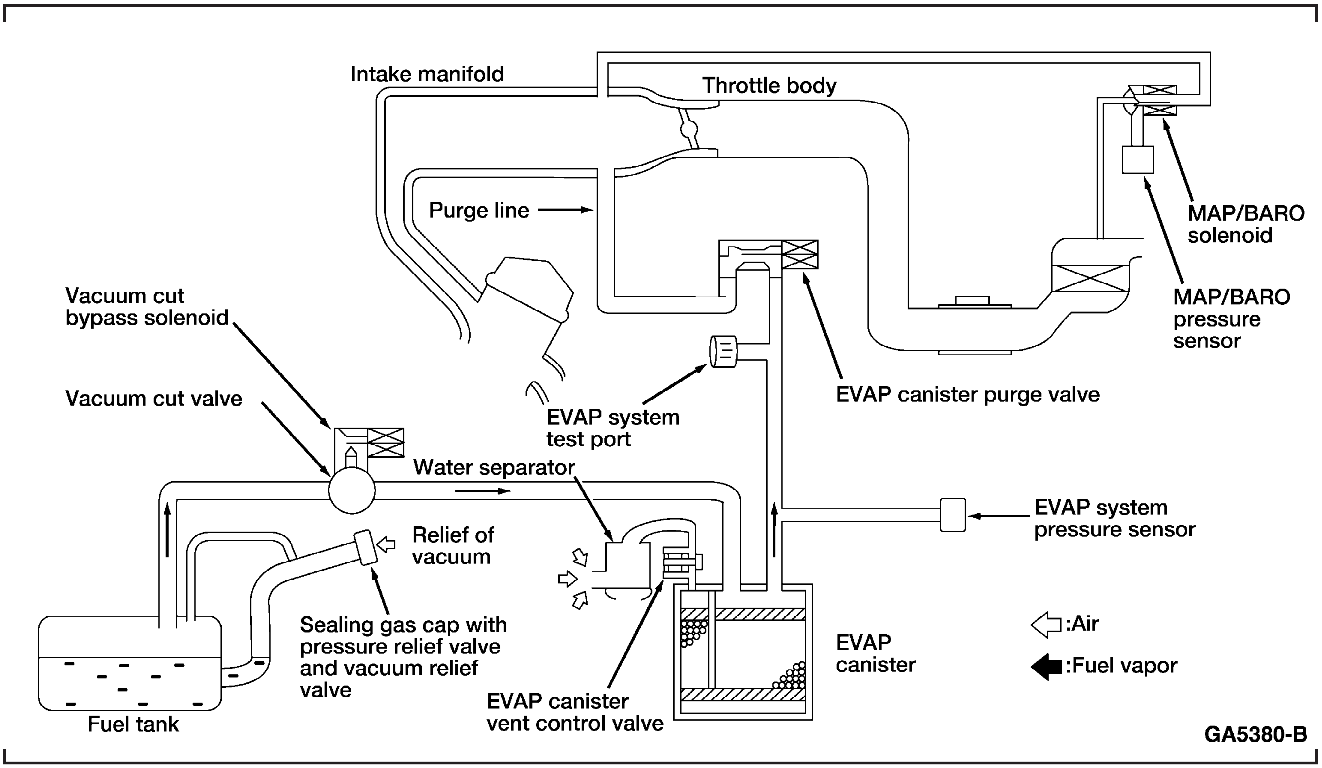
Evaporative Emission (EVAP) System

The evaporative emission (EVAP) system (Figure 1) is used to absorb fuel vapors from the fuel tank to reduce the amount of hydrocarbons emitted into the atmosphere. In a hot soak or refueling condition, fuel vapor pressure inside the fuel tank increases. In order to depressurize the fuel tank the excess air (which was drawn into the fuel tank as the fuel level decreased) and fuel vapor mixture in the fuel tank pass through the vacuum cut valve into the EVAP canister and out the EVAP canister vent valve. The EVAP canister contains activated carbon which collects the fuel vapors to prevent them from being emitted into the atmosphere with the escaping air. The fuel vapors are stored in the EVAP canister until they can be consumed by the engine during normal engine operation (i.e. not decel, idle, low engine coolant temperature, starting, and wide open throttle (WOT). During normal engine operation the powertrain control module (PCM) commands the EVAP canister purge valve ON which opens the EVAP canister purge valve. When the EVAP canister purge valve is open, intake manifold vacuum is applied to the EVAP canister which draws in fresh air and fuel vapors from the EVAP canister into the intake manifold. The PCM uses various sensor inputs to calculate the desired amount of EVAP purge flow. The PCM meters the purge flow by varying the duty cycle of the EVAP canister purge valve input signal.

The evaporative emission (EVAP) system monitor is a self-test strategy within the powertrain control module (PCM) that tests the integrity of the EVAP system. When a fault occurs, the EVAP system monitor is reset to NO and a diagnostic trouble code (DTC) is set in the PCM memory. After the DTC is repaired the vehicle drive cycle must be completed to reset the monitor in preparation for Inspection and Maintenance (I/M) testing. The PCM monitors the EVAP system for leaks, electronic EVAP components for irrationally high or low voltage levels sent to the PCM, and the EVAP system for proper operation. The EVAP system monitor uses the positive and the negative pressure leak test methods to test and activate the EVAP system. The positive pressure leak test uses fuel tank fuel vapor pressure (when the fuel tank temperature is sufficient) to test the system. During the positive pressure leak test the EVAP canister purge valve is closed (OFF), the EVAP canister vent valve is closed (ON), the manifold absolute pressure/barometric pressure (MAP/BARO) solenoid is ON (MAP/BARO sensor connected to barometric pressure) and the vacuum cut bypass valve is open (ON). The positive pressure test passes if the EVAP pressure sensor indicates a rise in EVAP pressure and the pressure holds until the EVAP canister vent valve is commanded open. The negative pressure leak test uses intake manifold vacuum to test the system. During the negative pressure leak test the EVAP canister purge valve is open (ON), the EVAP canister vent valve is closed (ON), and the MAP/BARO solenoid is OFF (MAP/BARO sensor connected to manifold absolute pressure). The negative pressure test passes if the EVAP pressure sensor indicates a decrease in EVAP pressure equal to the pressure indicated from the MAP/BARO sensor and the pressure holds until the EVAP canister vent valve is commanded open.

Evaporative Emission System

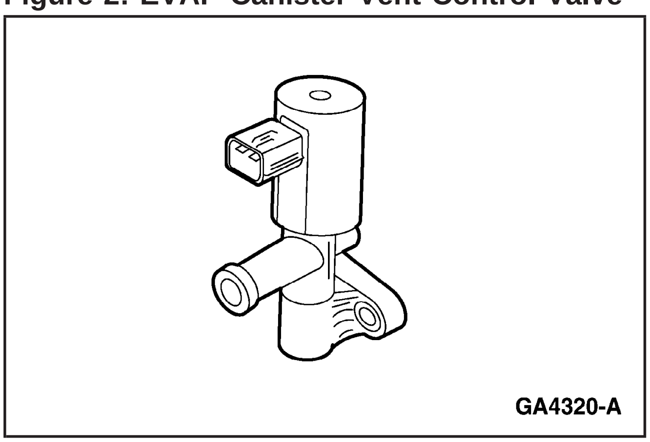
Figure 1: Evaporative Emission (EVAP) System



Evaporative Emissions Canister Vent Control Valve

The evaporative canister (EVAP) vent control valve (Figure 2) is located on the EVAP canister. The powertrain control module (PCM) energizes the solenoid when it is necessary to close the canister vent. The EVAP canister vent valve is used only for diagnosis of the EVAP system and usually remains open. When this vent is closed under normal purge conditions the EVAP system is depressurized and allows EVAP system leak diagnosis.

Figure 2: EVAP Canister Vent Control Valve

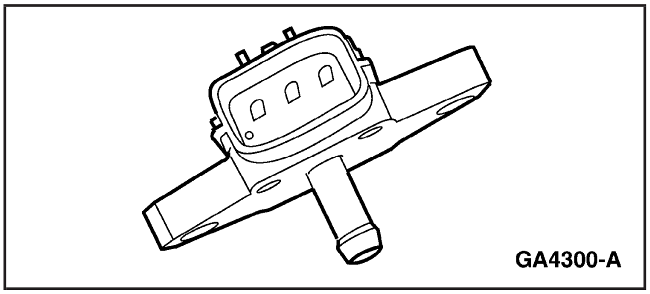


Evaporative Emission System

EVAP Pressure Sensor

The EVAP pressure sensor (Figure 3) is an input to the powertrain control module (PCM) and is used only for on-board diagnosis of the EVAP emission system. The sensor is located in the purge line of the EVAP canister and senses changes in pressure in the EVAP canister purge line.

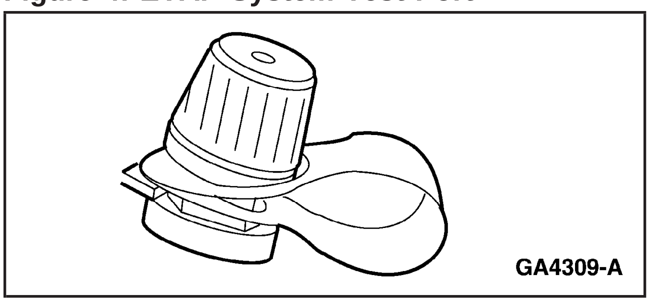
Figure 3: EVAP Pressure Sensor



Evaporative Emission System Test Port

The test port (Figure 4) is located under the hood near the cowl and is used to perform leak testing on the EVAP system.

Figure 4: EVAP System Test Port

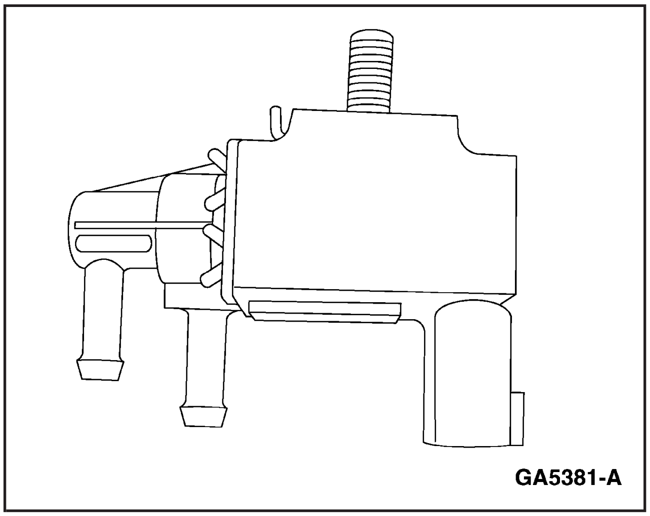


EVAP Canister Purge Valve

The evaporative emission (EVAP) canister purge valve (Figure 5) is controlled by the powertrain control module (PCM). The EVAP canister purge valve controls the EVAP canister purge. When the EVAP purge valve is on (ground supplied by the PCM), vacuum is supplied to the EVAP canister and purging of vapors in the EVAP canister is allowed. When the EVAP purge valve is off (open signal from the PCM), the solenoid is released to prevent purging of the fuel vapors from the EVAP canister.

Evaporative Emission System

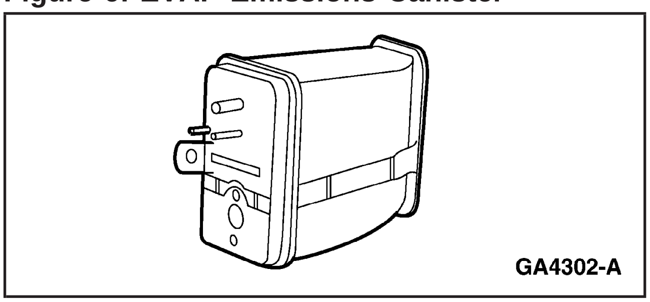
Figure 5: EVAP Canister Purge Valve



Evaporative Emission Canister

The evaporative emission (EVAP) canister (Figure 6) is a storage device for fuel vapors that are emitted by the fuel tank in hot soak conditions. When the vehicle is at normal operating conditions, the vapors are purged from the canister. The EVAP canister is controlled by the evaporative emission (EVAP) canister purge valve. This valve sends vacuum to the EVAP canister which allows the passage of the fuel vapors into the intake manifold where they are mixed with air and burned in the engine. By storing the fuel vapors and purging them into the engine at a later time, hydrocarbon emissions are reduced, and fuel efficiency is increased.

Figure 6: EVAP Emissions Canister

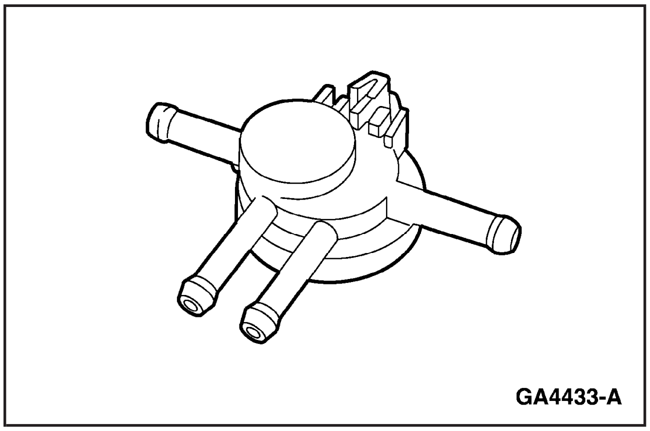


Vacuum Cut Valve

The vacuum cut valve (Figure 7) is a one-way check valve which allows fuel vapors to enter the EVAP purge line, but prevents intake manifold vacuum from being applied to the fuel tank.

Evaporative Emission System

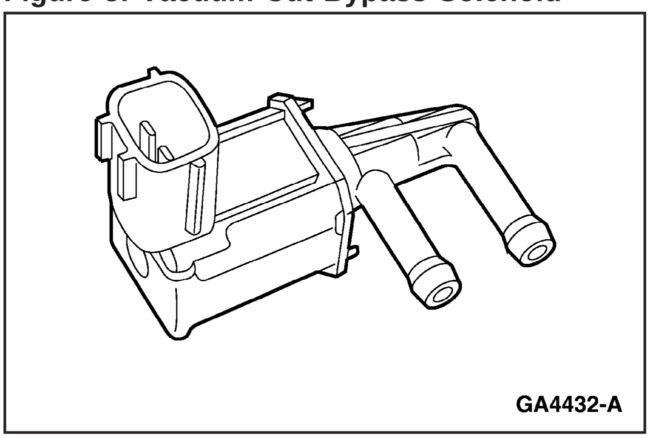
Figure 7: Vacuum Cut Valve



Vacuum Cut Bypass Solenoid

The vacuum cut bypass solenoid (Figure 8) is installed in parallel with the vacuum cut valve on the EVAP purge line between the EVAP canister and the fuel tank. The vacuum cut bypass solenoid generally remains closed. The vacuum cut bypass solenoid is open when on (ground supplied by the PCM). When open, the vacuum cut valve is bypassed to apply intake manifold vacuum to the fuel tank. The vacuum cut bypass solenoid is used only for EVAP system diagnostics.

Figure 8: Vacuum Cut Bypass Solenoid

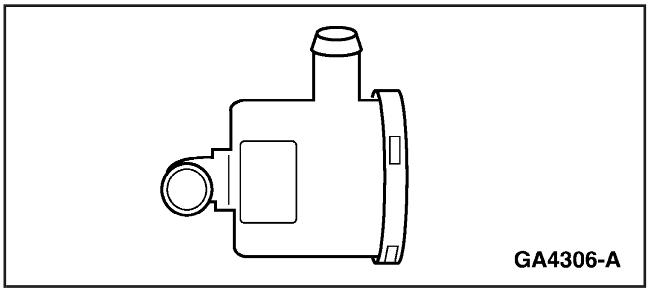


Water Separator

The water separator (Figure 9) is attached to the EVAP canister vent control valve inlet. When the EVAP canister vent control valve is open, air is drawn into the EVAP canister through the water separator. The water separator draws water vapor from the incoming air and then vents it back to the atmosphere.

Evaporative Emission System

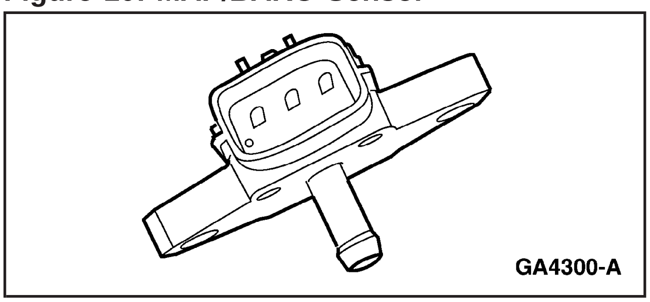
Figure 9: Water Separator



Manifold Absolute Pressure/Barometric Pressure Sensor

The manifold absolute pressure/barometric pressure (MAP/BARO) sensor (Figure 10) is an input to the powertrain control module (PCM). The sensor is used in conjunction with a MAP/BARO solenoid that either supplies manifold vacuum (MAP function) to the MAP/BARO sensor or opens the sensor to atmospheric pressure (BARO function). The PCM uses the MAP/BARO data to control the EVAP emissions system.

Figure 10: MAP/BARO Sensor

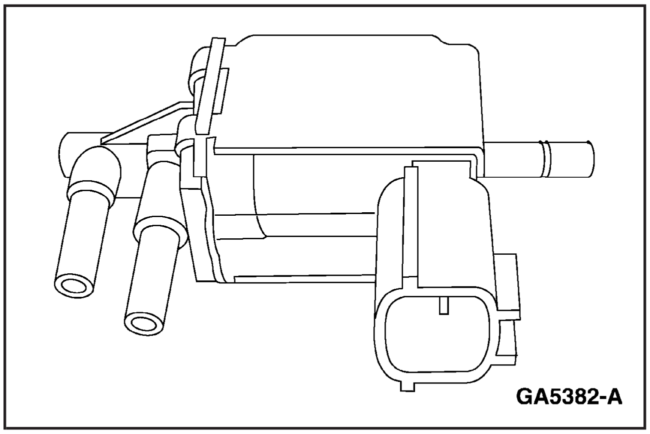


MAP/BARO Solenoid

The MAP/BARO solenoid (Figure 11) switches air flow passage between manifold vacuum and atmospheric pressure upon demand from the PCM. When voltage is supplied from the PCM, the MAP/BARO solenoid turns ''ON''. When ''ON'' the MAP/BARO sensor monitors barometric pressure (BARO); when the MAP/BARO solenoid is ''OFF'' manifold vacuum is monitored (MAP).

Evaporative Emission System

Figure 11: MAP/BARO Solenoid



Intake Air and Throttle Body System

Intake Air and Throttle Body System

Intake Air System

The intake air system delivers filtered and controlled air flow to the engine. Three groups of components make up the system: air handling, sensors, and control devices.

Intake Air System Air Handling Components

Intake air system components include:

- Air inlet duct
- Air cleaner
- Throttle body
- Intake manifold
- Resonance chambers

Intake air system air handling components include the inlet air duct, air cleaner, throttle body (TB), intake manifold, and two resonance chambers. The resonance chambers suppress air inlet noise caused by air flow pulsations. The TB contains the idle speed control (ISC) valve, idle air control (IAC) valve, throttle valve and throttle position (TP) sensor.

Intake Air System Sensors

Intake air system sensors include a heated resistor-type mass air flow (MAF) sensor and throttle position (TP) sensor; both supply data to the powertrain control module (PCM). The PCM also monitors engine speed.

Idle Speed Control Valve

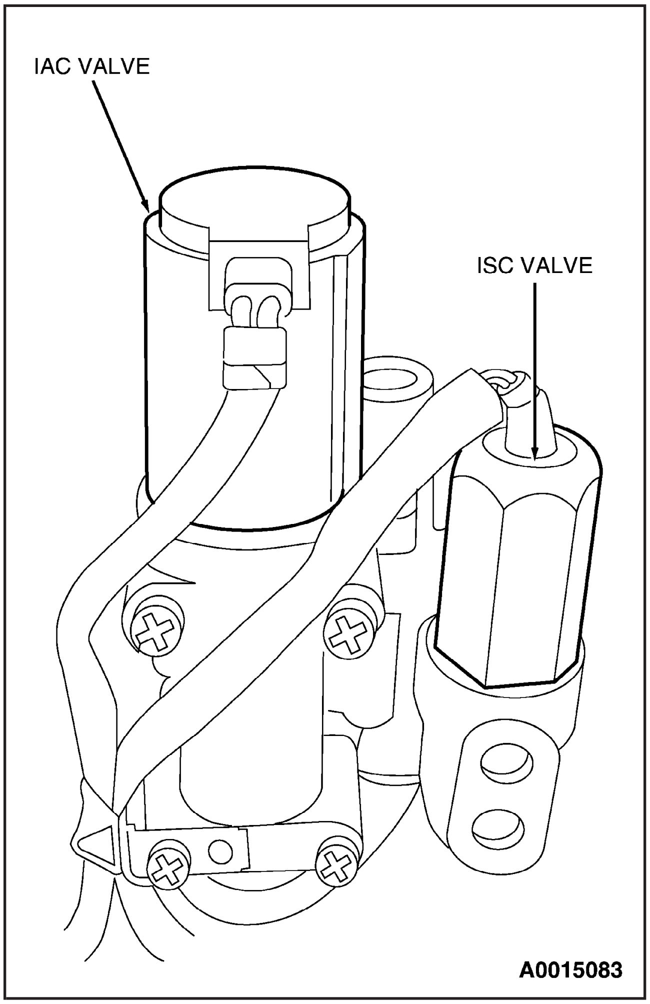
The idle speed control (ISC) valve (Figure 1) compensates for idle speed change caused by the operation of the air conditioner compressor. The ISC valve is energized when the air conditioner clutch is energized.

Idle Air Control Valve

The idle air control (IAC) valve (Figure 1) adjusts the amount of air allowed into the engine at idle condition and during rapid engine deceleration. This adjustment is done by means of an adjustable duty cycle output by the powertrain control module (PCM). The PCM increases the duty cycle based on different inputs such as RPM, load and others.

Intake Air and Throttle Body System

Figure 1: ISC Valve



Idle Switch

The idle switch detects idle position when the throttle plate is closed and sends a signal to the powertrain control module (PCM). This signal is sent by the PCM to the transmission control module (TCM) for transmission torque converter clutch control.

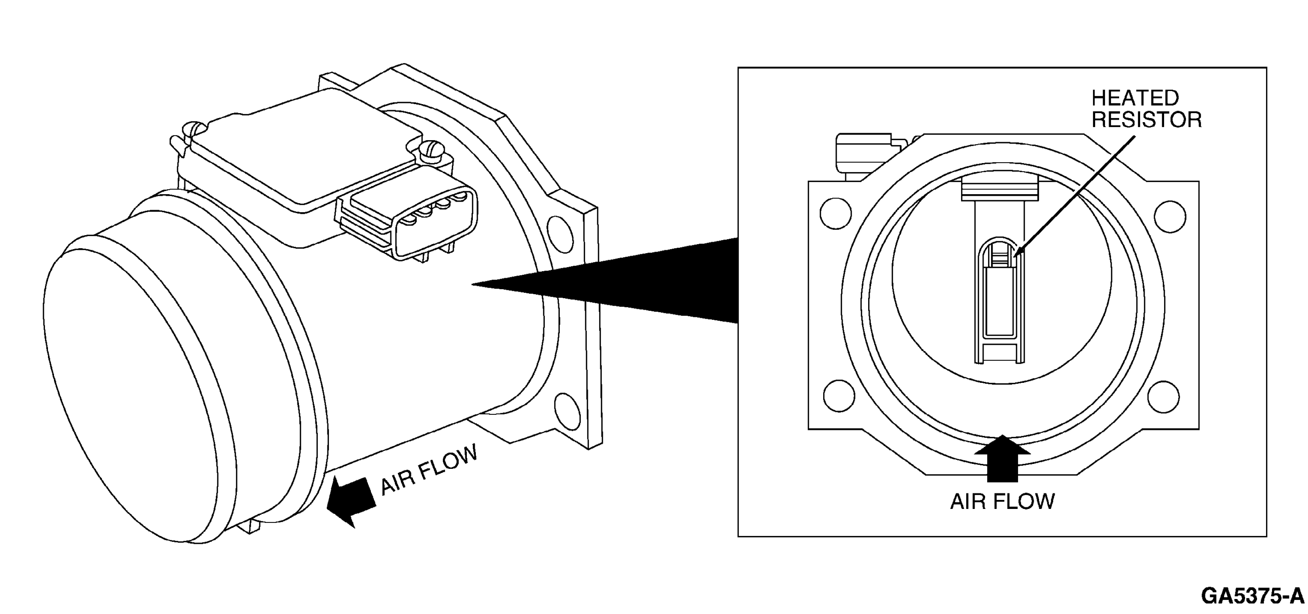
- Fuel injection
- Ignition timing
- Fuel pump
- Idle speed

Intake Air and Throttle Body System

Mass Air Flow Sensor

The mass air flow (MAF) sensor (Figure 2) is a heated resistor type that indicates to the powertrain control module (PCM) the amount of air being allowed into the engine. The MAF sensor works by trying to keep a resistor at a constant high temperature. The temperature of the hot resistor is referenced with the temperature of a resistor that is held at ambient temperature. As air passes by the heated resistor, the temperature drops and the PCM compensates by allowing more voltage to the MAF. The more air that flows past the heated resistor, the more the temperature will change and cause an increase in required voltage from the PCM. This change in voltage indicates to the PCM that there is more air flowing through the MAF so the PCM can adjust fuel flow, ignition timing, and other outputs.

Figure 2: MAF Sensor



Throttle Body

The throttle body (TB) controls the amount of air that flows into the engine through a single butterfly valve. The single butterfly valve opening is determined by the accelerator pedal. The TB is cast with an air bypass channel and houses several emission-related components for the powertrain control module (PCM).

Throttle Position Sensor

The throttle position (TP) sensor responds to the accelerator pedal movement. The TP sensor is a potentiometer that transforms the throttle plate opening angle into output voltage and sends the voltage signal to the powertrain control module (PCM). In addition, the sensor detects the opening and closing speed of the throttle plate and sends the voltage signal to the PCM. Also, the TP sensor is used to determine the air intake when the mass air flow (MAF) sensor fails. This mode of operation is called fail safe.

Intake Air and Throttle Body System

The TP sensor integrates the idle switch within the housing. The idle switch detects when the throttle plate is closed and an idle condition occurs. The PCM is supplied with this input signal.

Positive Crankcase Ventilation System

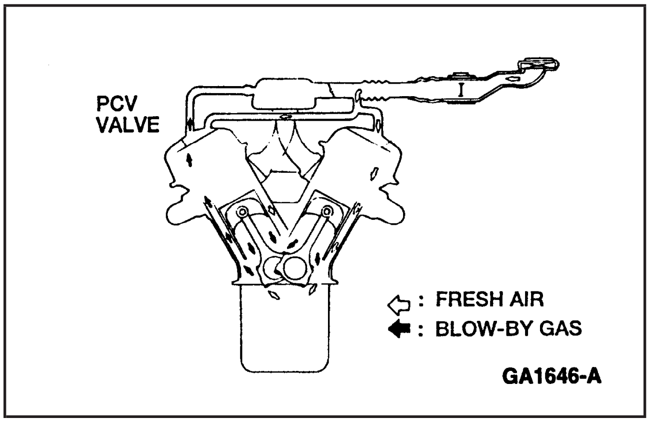
Positive Crankcase Ventilation

Positive Crankcase Ventilation System

The positive crankcase ventilation (PCV) system (Figure 1) vents harmful blow-by fumes from the engine crankcase into the engine air intake for burning with the fuel and air mixture. The PCV valve limits crankcase blow-by gas to the fresh air intake to suit the engine demand and serves to prevent combustion from backfiring into the crankcase. Thus, the benefits from the PCV system include the ability to:

- Maximize the oil cleanliness by venting moisture and corrosion from the crankcase.
- Protect against excessive crankcase pressure.
- Automatically regulate the ventilation system air flow to the engine air intake as required by engine operating conditions.

Figure 1: Positive Crankcase Ventilation System

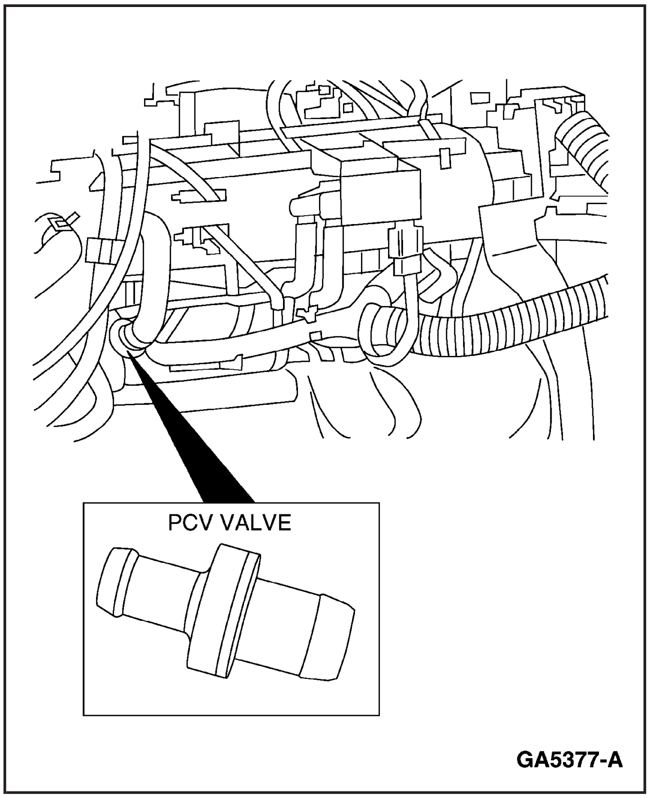


Positive Crankcase Ventilation Valve

The positive crankcase ventilation (PCV) valve (Figure 2) is provided to regulate crankcase blow-by gas to the intake manifold. Normally, the capacity of the valve is sufficient to handle all blow-by and a small amount of ventilating air.

Positive Crankcase Ventilation

Figure 2: PCV Valve



Catalyst and Exhaust System

Catalyst and Exhaust System

Overview

The catalytic converter and exhaust system work together to control the release of harmful engine exhaust emissions into the atmosphere. The engine exhaust gas consists mainly of nitrogen, carbon dioxide and water vapor. However, it also contains carbon monoxide, oxides of nitrogen, hydrogen, and various unburned hydrocarbons. Carbon monoxide, oxides of nitrogen, and hydrocarbons are major air pollutants, and emission into the atmosphere must be controlled.

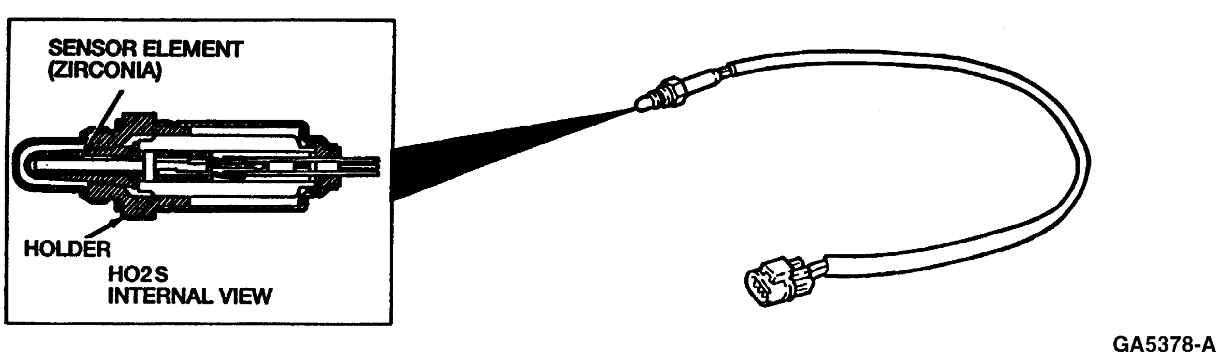
The exhaust system consists of an exhaust manifold combined with a pre-catalytic converter, upstream heated oxygen sensor (HO2S11), (located just in front of the pre-catalytic converter), three way catalytic converter (TWC), downstream heated oxygen sensor (HO2S12) (located in front of the TWC), a muffler and an exhaust tailpipe.

Heated Oxygen Sensors

The Villager is equipped with both upstream and downstream heated oxygen sensors (HO2S) (Figure 1). The upstream heated oxygen sensor (HO2S11) is used to control engine fuel flow. The sensor detects the concentration of oxygen in the exhaust gas and sends a signal to the powertrain control module (PCM). In a rich condition, the HO2S will output a voltage of 0.6 volts or greater, and in a lean condition a voltage of 0.4 volts or less will be output.

The downstream heated oxygen sensor (HO2S12) is used primarily for monitoring the efficiency of the catalytic converter system. The HO2S12 works in a similar way to the HO2S11 but only indicates to the PCM that the catalyst is functioning properly. In the event that the HO2S11 fails, fuel control will be switched over to the HO2S12 and the malfunction indicator lamp (MIL) will be illuminated. This allows the vehicle to operate with fewer emissions, even with a sensor failure.

Figure 1: Typical Heated Oxygen Sensor (HO2S)



Three Way Catalytic Converter System

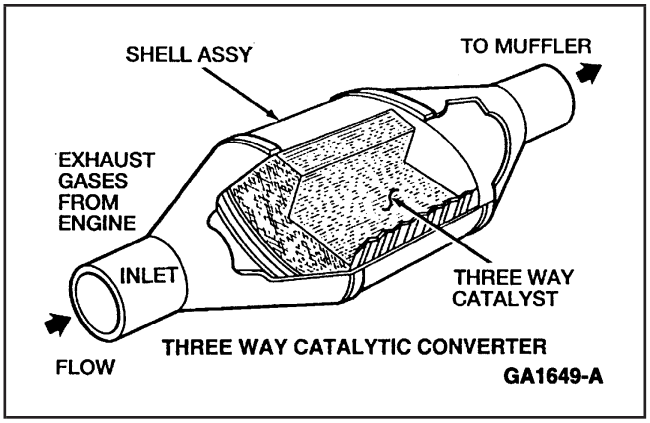
The engine exhaust consists mainly of nitrogen (N_2); however, it also contains carbon monoxide (CO), carbon dioxide (CO_2), water vapor (H_2O), oxygen (O_2), nitrogen oxides (NOx), and hydrogen (H_2) as well as various unburned hydrocarbons (HC). Three of these exhaust components - CO, NOx, and HC - are major air pollutants, so their emission to the atmosphere must be controlled.

Catalyst and Exhaust System

The three way catalytic converter (TWC) (Figure 2), mounted in the engine exhaust system, works as a gas reactor to convert and reduce the pollutant levels to within legally prescribed limits.

The TWC reduces the air pollutants HC, CO, and NOx. The TWC removes these pollutants from the exhaust gases by means of a chemical reaction. The remaining gases are transferred to the muffler.

Figure 2: Three Way Catalytic Converter (TWC)



The catalyst metals are thinly coated onto and supported by a honeycomb shaped high temperature ceramic, mounted inside the converter shell. The result is a highly effective converter design having minimum restriction to exhaust gas flow and good durability.

Pre-Catalytic Converter

The pre-catalytic converter (Figure 3) is designed to reduce HC, CO, and NOx.

The pre-catalytic converter is mounted ahead of the TWC, causing it to warm up faster upon vehicle start up. This results in less air pollutants escaping during warm up.

Catalyst and Exhaust System

Figure 3: Pre-Catalytic Converter