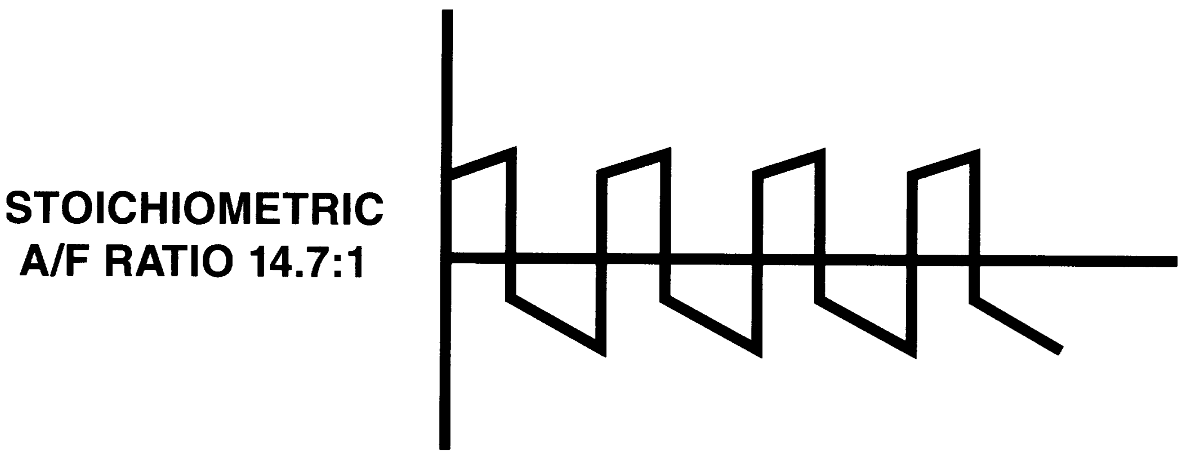
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Engine Management

Engine Management

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Engine Management

INTRODUCTION AND OBJECTIVES

The Viper “Engine Management” Book contains information regarding the systems controlled by the Powertrain Control Module (PCM). These include fuel, emissions, charging, radiator fan, PCM–related A/C control functions, and PCM–related transmission control functions.

From 1992–1995 engine controllers were SBEC PCMs with a supplemental Viper Ignition Controller (VIC). 1992–1995 Vipers were not OBDII compliant. From 1996 forward, all Vipers are equipped with a Jeep Truck Engine Controller (JTEC), and are OBDII compliant.

The fuel system for all Viper engines utilizes a speed density sequential multiport fuel injection system, to deliver precise amounts of fuel to each cylinder. Fuel for all vehicles is delivered by an in–tank pump module.

All engines use a distributorless ignition system. The PCM (and VIC for 1992–1995) controls the ignition and fuel injector operation and provides outputs to fuel and ignition components to promote the most efficient operation possible.

Note: *Early 1997 PCMs have an eight–digit part number and operate like a 1996 PCM. Later 1997 models have a 10–digit part number.*

After completing the “Engine Management” book, you will understand the various operations of the PCM (inputs/outputs) and the operation of the fuel system.

ACRONYMS

The following is a list of acronyms used throughout this publication:

- **ACM** Airbag Control Module
- **A/D** Analog to Digital
- **ASD Relay** Automatic Shutdown Relay
- **ATF** Automatic Transmission Fluid
- **Baro** Barometric Pressure
- **BTS** Battery Temperature Sensor
- **BCM** Body Control Module
- **CARB** California Air Resources Board
- **C2D** Chrysler Collision Detection (also CCD)
- **CKP** Crankshaft Position Sensor
- **CMP** Camshaft Position Sensor
- **DB** Decibel
- **DCP Solenoid** Duty Cycle Purge Solenoid
- **DIS** Distributorless Ignition System
- **DLC** Data Link Connector
- **DRBIII® Scan Tool** Diagnostic Readout Box
- **DRL** Daytime Running Lamps
- **DTC** Diagnostic Trouble Code
- **ECT** Engine Coolant Temperature
- **EEM** Electronic Entry Module
- **EEPROM** Electrically Erasable Programmable Read–Only Memory
- **EES** Electronic Entry System
- **EIC** Electronic Instrument Cluster
- **EMCR** Equipment Manufacturer's Claim Request Form
- **EMI** Electro Magnetic Interface
- **EPP** Engine Position Pulse
- **HDPE** High Density Polyethylene
- **HO2S** Heated Oxygen Sensor
- **IAC** Idle Air Control
- **IAT** Intake Air Temperature

ACRONYMS (CONTINUED)

ICM	Ignition Control Module
ISO	International Standards Organization
JTEC	Jeep/Truck Engine Controller
LDP	Leak Detection Pump
MAP	Manifold Absolute Pressure
MDS	Mopar® Diagnostic System
MIC	Mechanical Instrument Cluster
MIL	Malfunction Indicator Lamp
NTC	Negative Temperature Coefficient
OBD II	On–Board Diagnostics Generation Two
O2S	Oxygen Sensor
PCM	Powertrain Control Module
PDC	Power Distribution Center
PPA	Polyphthalamide
PTC	Positive Temperature Coefficient
RFI	Radio Frequency Interface
RIM	Reaction Injection Molding
RKE	Remote Keyless Entry
RPM	Revolutions Per Minute
RTM	Resin Transfer Molding
RTV	Room Temperature Vulcanizing
SAM	Security Alarm Module
SCI	Standard Corporate Interface
SBEC	Single Board Engine Controller
SMC	Sheet Molded Compound
SPIO	Serial Peripheral Interface/Output
TDC	Top Dead Center
TPO	Thermal Plastic Olefin
TPS	Throttle Position Sensor
VIC	Viper Ignition Control Module (also ICM)
VSS	Vehicle Speed Sensor
VTSS	Vehicle Theft Security System

POWERTRAIN CONTROL MODULE (PCM) – GENERAL INFORMATION

The PCM is a digital computer that contains a microprocessor. The PCM receives input signals from various switches and sensors that are referred to as PCM Inputs. Based on these inputs, the PCM adjusts various engine and vehicle operations through devices that are referred to as PCM Outputs. Based on inputs it receives, the PCM adjusts injector pulse width, idle speed, ignition spark advance, ignition coil dwell, and EVAP canister purge operation. The PCM also performs diagnostics.

The PCM used on the Viper varies, depending on the year and specific vehicle application. It is important to understand which PCM is used on the vehicle you are servicing because replacement controllers are model year specific with internal hardware differences. Refer to Table One for a list of vehicles along with their specific PCM.

Table One PCM Applications

Model Year(s)	Vehicle/Application
1992 – 1994	Roadster (multi–piece intake manifold) – SBEC/VIC
1994 – 1995	Roadster (one–piece intake manifold) – SBEC/VIC
1996	Roadster – Unique JTEC
1996 – 1998	Coupe – JTEC
1997 – 1998	Roadster – JTEC
1999 – 2000	Coupe and Roadster – JTEC+

SINGLE BOARD ENGINE CONTROLLER (SBEC) – 1992–1995

The PCM, also referred to as Single Board Engine Controller (SBEC) or engine controller, and the Viper Ignition Controller (VIC), also referred to as the Ignition Control Module (ICM), are located under the hood and are mounted to the right of the heater housing (fig. 1). This engine controller arrangement is used on Vipers from 1992–1995. As a running change in 1994, a revised intake manifold was used. This change required a revised SBEC calibration. The recalibrated SBEC cannot be used to service models with the previous intake manifold.

The SBEC and the VIC manage the operation of the engine control system. They receive information from input sensors that monitor engine conditions. After processing this information, the SBEC and VIC control a number of outputs, which regulate engine performance. The SBEC and VIC communicate with each other through the SCI Transmit, SCI Receive, and the MUX lines of communication.

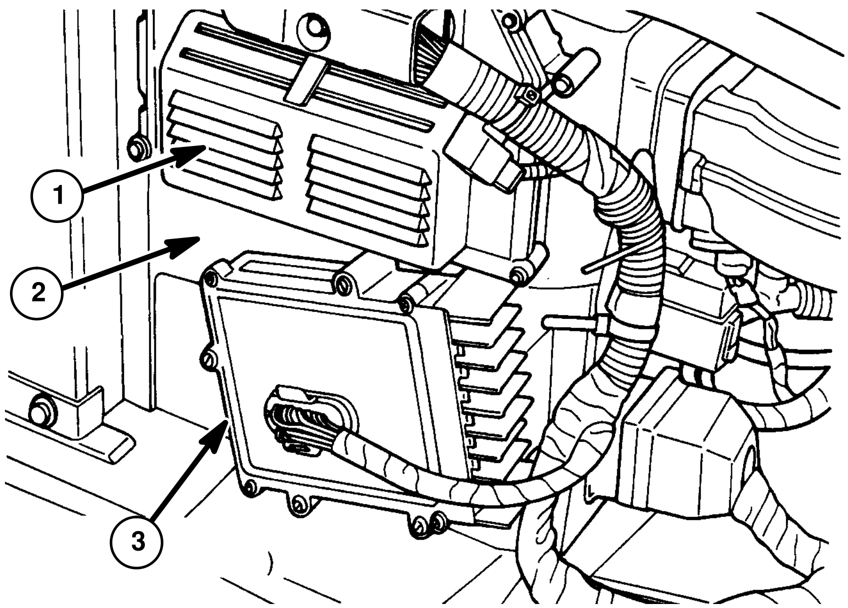


Figure 1 SBEC/VIC Locations

1	SBEC Engine Controller (PCM)	3	Viper Ignition Controller (VIC)
2	Heater Housing		

VIPER IGNITION CONTROLLER (VIC)

Inputs

As mentioned earlier, the VIC and SBEC communicate with each other through the SCI Transmit, SCI Receive, and the MUX lines of communication. The VIC receives information from the following inputs:

- Sync pickup
- Reference pickup
- Vehicle speed in
- Ignition
- SCI Receive

The VIC receives information from these inputs and determines when to energize the Ignition Coils and injectors #1 and #5.

Outputs

There are two Ignition Coil assemblies used on the Viper. One is a single unit that contains three separate Ignition Coils. The other is a single unit that contains two separate Ignition Coils (fig. 2). Each Ignition Coil Primary is joined to the power wire from the ASD Relay. Based on information from the Crankshaft Position Sensor (CKP) and Camshaft Position Sensor (CMP), the VIC will provide a ground for each coil primary, which causes spark plugs on two cylinders to fire. Since two spark plugs are fired at the same time, one cylinder is on the compression stroke, and the other cylinder is on the exhaust stroke.

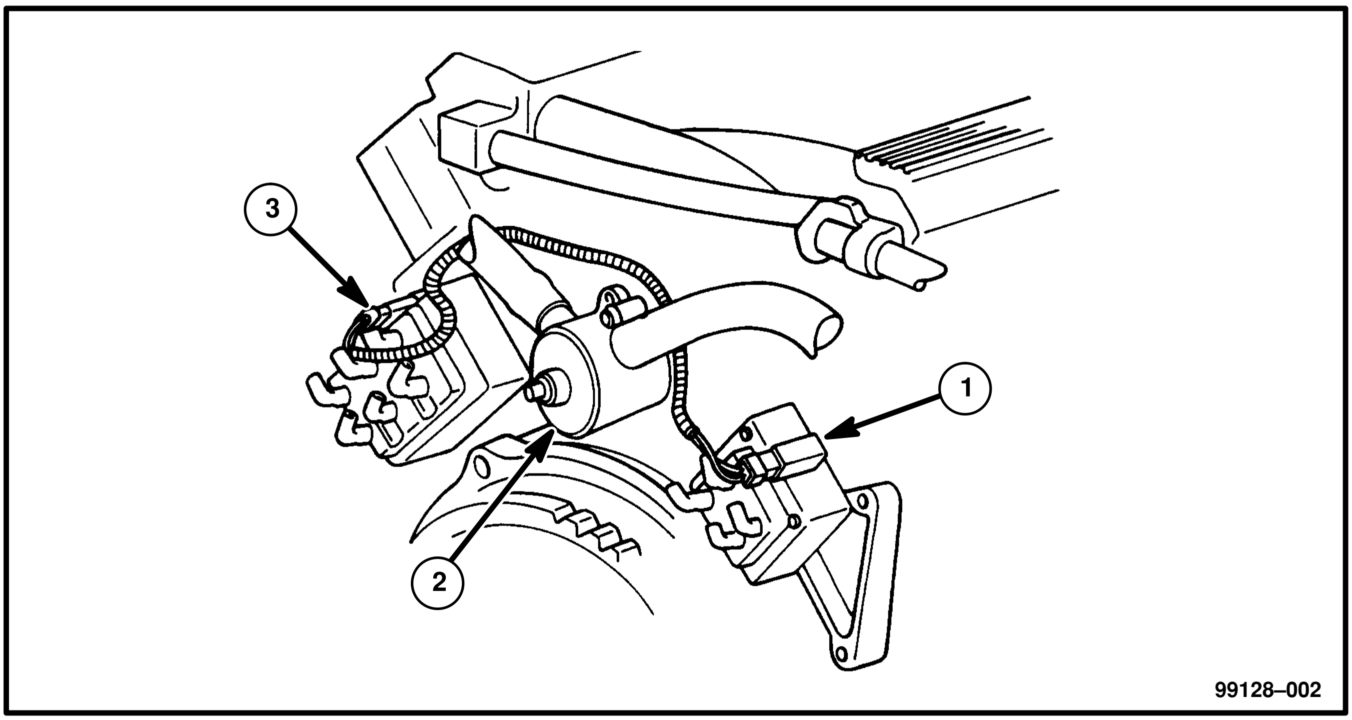


Figure 2 Ignition Coil Locations

1	DIS Coils (4)	3	DIS Coils (6)
2	Thermostat Housing		

The following table shows the VIC Pin number that fires the applicable coil:

Table Two VIC/Ignition Coil Firing

VIC Pin Number	Fired Coil	Cylinders
Pin 3	Coil #1	Cylinder #1 and #6
Pin 1	Coil #2	Cylinder #5 and #10
Pin 12	Coil #3	Cylinder #8 and #9
Pin 18	Coil #4	Cylinder #4 and #7
Pin 10	Coil #5	Cylinder #2 and #3

JEEP/TRUCK ENGINE CONTROLLER (JTEC) –1996–2000

Introduced in 1996, the Jeep/Truck Engine Controller (JTEC), also known as the Powertrain Control Module (PCM) does not require air to flow through the controller for cooling (fig. 3).

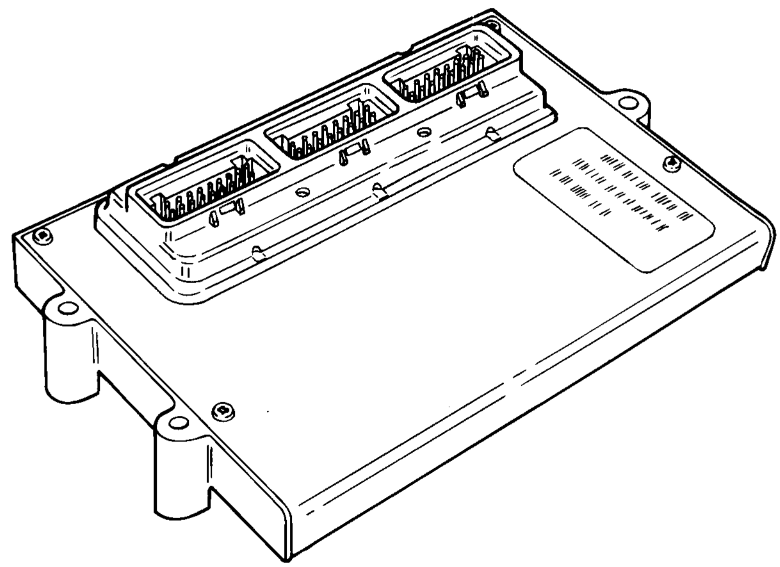


Figure 3 JTEC Powertrain Control Module

The changes to the PCM from previous Chrysler controllers include:

- Increased memory:
  - 2k 1996
  - 4k 1997
- Increased speed at which the processor runs:
  - Clock speed (8 MHz) (22MHz for JTEC+)
  - 16–bit microprocessor
  - Two 8–bit microprocessors
- Increased number of drivers to control outputs from 22 to 30
- Increased number of terminals in the connector from 60 to three 32–way connectors (96 total).
- Gold–plated, low–insertion–force terminals (new tool No. 6934 required for servicing the terminals).
- Uses an Electrically Erasable Programmable Read–Only Memory (EEPROM) on all PCMs (flashable).
- Full Range Misfire Detection (2000)

The PCM is a multiprocessor unit, containing one 16–bit microprocessor and two 8–bit microprocessors. The PCM controls operation of the fuel, emissions, charging, idle, radiator fan, and air conditioning systems. This is accomplished by the 16–bit processor, which transmits fuel and spark requirements to the two 8–bit processors, communicating with outside devices; and processing some of the analog inputs. One of the 8–bit processors controls fuel–injector timing pulses and some 1–bit inputs and outputs. The other 8–bit processor controls spark timing pulses, handles a few analog inputs and some 1–bit (on/off) inputs and outputs. After the PCM processes the information, it operates outputs regulating engine performance, ignition components, generator field, A/C compressor, and radiator fan. This cycle of input/processing/output ensures that the engine meets emission, performance, fuel economy, driveability and customer expectations.

The JTEC PCM uses voltage level detection to determine when a switched device or circuit is present. This means that the internal circuit of an input is constructed in a way that there must be a specific voltage present to recognize a change. The voltage required is approximately 5 volts.

The analog to digital (A/D) converters are part of the microprocessors in the JTEC. The A/D converter changes the analog input signal from a sensor into a digital signal with the same value. The digital signal is then processed by the microprocessor.

JTEC Learning Functions

Because the same basic controller is used on a wide variety of engine packages, it is necessary for the PCM to learn the options on the vehicle. This function is shown as “Learned Vehicle Configuration” on the DRBIII®. In order for the PCM and DRBIII® to diagnose and report faults, for items such as air conditioning, the PCM must see the input of the item at least once with the engine running. The PCM then knows that the vehicle is equipped with that option. This is important because if the DRBIII® does not show the item as equipped, it will not display any fault codes, even though they may be present in the PCM.

Anytime the direct battery is disconnected from the PCM, for approximately 60 seconds, the “Learned Vehicle Configuration” is erased. Erasing fault codes with the DRBIII® causes the PCM to perform a battery reset function if the PCM has an 8–digit number. This means that the previously mentioned configuration is erased, as well as all learned memory functions, such as Long Term Adaptive Memory and IAC steps. On l0–digit part numbered PCMs, erasing DTCs clears faults, freeze frames and similar conditions only.

SPEED DENSITY

A speed density system measures the engine rpm, as well as the intake manifold absolute pressure. Coolant temperature and throttle position are necessary inputs also. On PCMs from 1992–1996, both the crankshaft and camshaft position inputs are needed to start and run the engine. The engine cannot run without them. On 10–digit JTEC PCMs (1997 and later), once the engine is running, the cam sensor signal is not needed for continued operation. The RPM signal tells the PCM how often to add fuel, while the Manifold Absolute Pressure (MAP) Sensor input determines how much fuel the engine receives (fig. 4).

For a speed density system to operate, the first and most important piece of information that must be determined is the amount of air that is entering the engine. To do this, the PCM looks first at the current rpm, divided by the MAX rpm. This allows the PCM to calculate the greatest volume of air entering the engine at that rpm. The PCM then looks at the present manifold vacuum, compared to the barometric pressure that was seen at key–ON. This gives the PCM the reference for current air pressure in the intake system. With these two pieces of information, the PCM determines the current load being placed on the engine. For instance, if rpm was low and vacuum nearly matched baro, wide open throttle (WOT), then the PCM would know that the engine is under a heavy load and inhaling as much air as possible for that rpm.

The PCM uses the TPS to determine the current mode of operation such as idle, off–idle acceleration, WOT, or deceleration. The PCM uses this information to perform various operating strategies. If the TPS increases rapidly, the injectors will be fired longer to increase fuel flow. If the TPS is closed and the vehicle is moving, the PCM will limit and/or close off injectors during coast down.

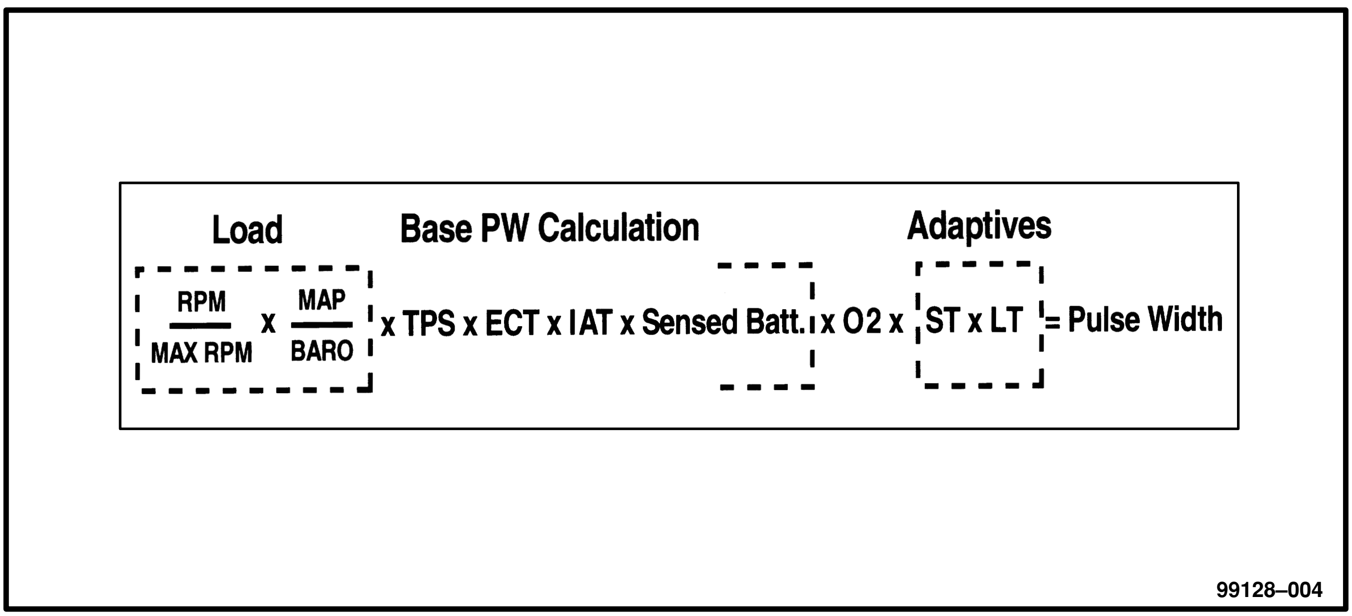


Figure 4 Speed Density Engine Management Strategy

The PCM has to see a value for every sensor so that it can correctly calculate the pulse. If a sensor goes bad, a value must be substituted. For example, if the MAP Sensor is bad, the PCM will use the TPS and rpm to make up a value to use as MAP.

The next modifier is Engine Coolant Temperature (ECT), which is the second biggest modifier of pulse width, after MAP. If the engine is cold, the fuel will not atomize easily. To overcome this problem, the PCM will add extra fuel, depending on the value from the ECT. Conversely, if the engine is very hot, fuel will be limited. ECT is also used for engine cooling control. If ECT becomes too high, the PCM will automatically turn on the cooling fan. If the ECT signal is lost, the PCM will substitute a preset (limp–in) value and turn the cooling fan on.

Intake Air Temperature (IAT) is also used to modify the amount of fuel delivered, although it is not as big a modifier as ECT. If ECT is high and IAT shows cold (dense air), then the PCM will add extra fuel. Another feature of IAT is that spark advance is limited, if the air is hot (thin). If the IAT signal is lost, the PCM will substitute a value based on Battery/Ambient Temperature Sensor.

Sensed battery voltage is needed as a modifier because the injectors are rated for specific flow at a specific voltage. If the voltage is lower than what the injector was rated at, it will take longer for the injector to open, and it may not open as far. Therefore, the PCM needs to know the voltage, so it can compensate by changing the pulse width on–time.

Up to this point, it is not necessary that any fuel is burned, and/or the PCM is in an open–loop operating condition.

After the fuel is delivered, the PCM looks at the 02 signal to determine how well it did on the initial calculation. The 02S provides the PCM with the raw input, as to how much oxygen was left over, after the combustion process.

The adaptive memories allow the PCM to do two things. First, it gives it the capability to change the pulse width to bring the 02S to its mid–range of operation (short term). Second, it allows to store in memory corrections required for specific operating conditions (long term).

Based upon all of these inputs, the PCM delivers what it believes to be the optimum pulse width, to deliver the correct emissions performance, fuel economy, and driveability.

FUEL DELIVERY SYSTEM

The fuel system receives fuel pressure from an in–tank pump module. The PCM controls the operation of the fuel system by providing battery voltage to the fuel pump through the Fuel Pump Relay. The PCM requires only two inputs and a good ground to operate the Fuel Pump Relay. The two inputs are:

- Ignition voltage
- Crankshaft Position (CKP) Sensor

Note: *The PCM uses inputs from the CMP and CKP sensors to calculate engine speed.*

EMISSIONS SYSTEM

The emissions system has several components, all used to lower the quantities of hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NOx). Emissions systems are required not only to control the quantity of emissions out the tailpipe, but also any emissions that might be escaping into the atmosphere from the fuel system and engine. The emissions system includes:

- Evaporative control system
- Engine crankcase pressure–control system (positive crankcase pressure)
- Exhaust emissions

The PCM controls the evaporative emissions by the operation of a Duty–Cycle Purge (DCP) solenoid. The inputs required to control the DCP solenoid include:

- ECT Sensor
- 02 Sensor
- TPS Engine speed
- MAP Sensor
- Ambient/Battery Temperature Sensor

The engine crankcase is ventilated by a Positive Crankcase Ventilation (PCV) system. It is not controlled by the PCM.

The exhaust emissions are controlled by the use of a catalytic converter, and almost every input and output of the PCM. The only inputs and outputs that DO NOT control emissions are:

- Tachometer
- Air Conditioning (A/C Request) circuit, A/C Relay, and the A/C Pressure Switches
- ASD and Fuel Pump relays

IDLE CONTROL SYSTEMS

The PCM maintains a quality idle by controlling the Idle Air Control (IAC) motor. Inputs to the PCM required to operate the IAC motor include:

- TPS
- MAP Sensor
- ECT Sensor
- VSS
- Spark scatter (output)
- A/C Switch
- Ambient/Battery Temperature sensor

CHARGING CONTROL SYSTEMS

1996 Viper Roadster

The PCM does not control the charging system on the Roadster. Charging system voltage control is performed by a regulator built into the generator.

1996 Viper Coupe/1997 All Vipers

The PCM maintains battery voltage within a range of approximately 13.04 volts to 15.09 volts by providing battery voltage to the generator field through the ASD Relay and by controlling the ground side of the generator field.

The inputs required to maintain the proper battery voltage are:

- Battery voltage
- BTS
- Engine speed

ENGINE COOLING CONTROL SYSTEMS

To maintain engine temperature, the PCM controls the electric Radiator Fan, by providing battery voltage to the fan through the Radiator Fan ON and High/Low Relays. The PCM controls the ground side of both fan relay coils. The PCM uses the following inputs to operate the Radiator Fan Relays:

- ECT Sensor
- A/C Switch
- Vehicle speed

A/C CONTROL SYSTEMS

Finally, the PCM uses the A/C Request and Select circuits to identify when to energize the A/C Relay. The A/C Relay provides the A/C Compressor Clutch with battery voltage, when energized. Besides the A/C Request and Select circuits, the PCM uses the following inputs to determine when the A/C Relay should be energized:

- Engine speed
- TPS
- Engine Running Timer
- A/C pressure switches
- ECT Sensor

TRANSMISSION CONTROL

Although the Viper is equipped with a manual transmission, the PCM still has some control functions that it performs. The PCM controls operation of the reverse lockout solenoid, first–to–fourth gear shift indicator and the skip shift solenoid.

Note: *The following pages of this student reference book describe each section in detail. The function and operation of the inputs and outputs are explained the first time each input or output is introduced. Subsequent sections will elaborate on any input or output not previously described.*

FUEL DELIVERY COMPONENTS

FUEL TANK

From 1992–1997 fuel tanks on Vipers were made of high density polyethylene (HDPE). Starting in 1998, the fuel tank is constructed of extruded 5–layer polypropylene. From 1992–1995, fuel tank capacity was 22 gallons. In 1996, all models switched to a 19–gallon tank. For the 2000 model year, all models switched to a 18.5–gallon tank. All tanks also incorporate a fuel pump module and rollover valve (fig. 5). Roadster models have a fuel tank access panel located in the trunk area, attached with rivets. When servicing the fuel tank on Coupes, an access panel must be cut in order to remove the tank. If only the fuel pump needs to be serviced, Coupe models have a fuel pump module access panel that can be removed, while the Roadster fuel tank must be removed.

In 1998, a leak detection pump (LDP) was added to all Viper models. Starting in 2000, all Vipers are equipped with an On–Board Refueling Vapor Recovery (ORVR) system. The LDP and vapor canister move to the rear of the vehicle.

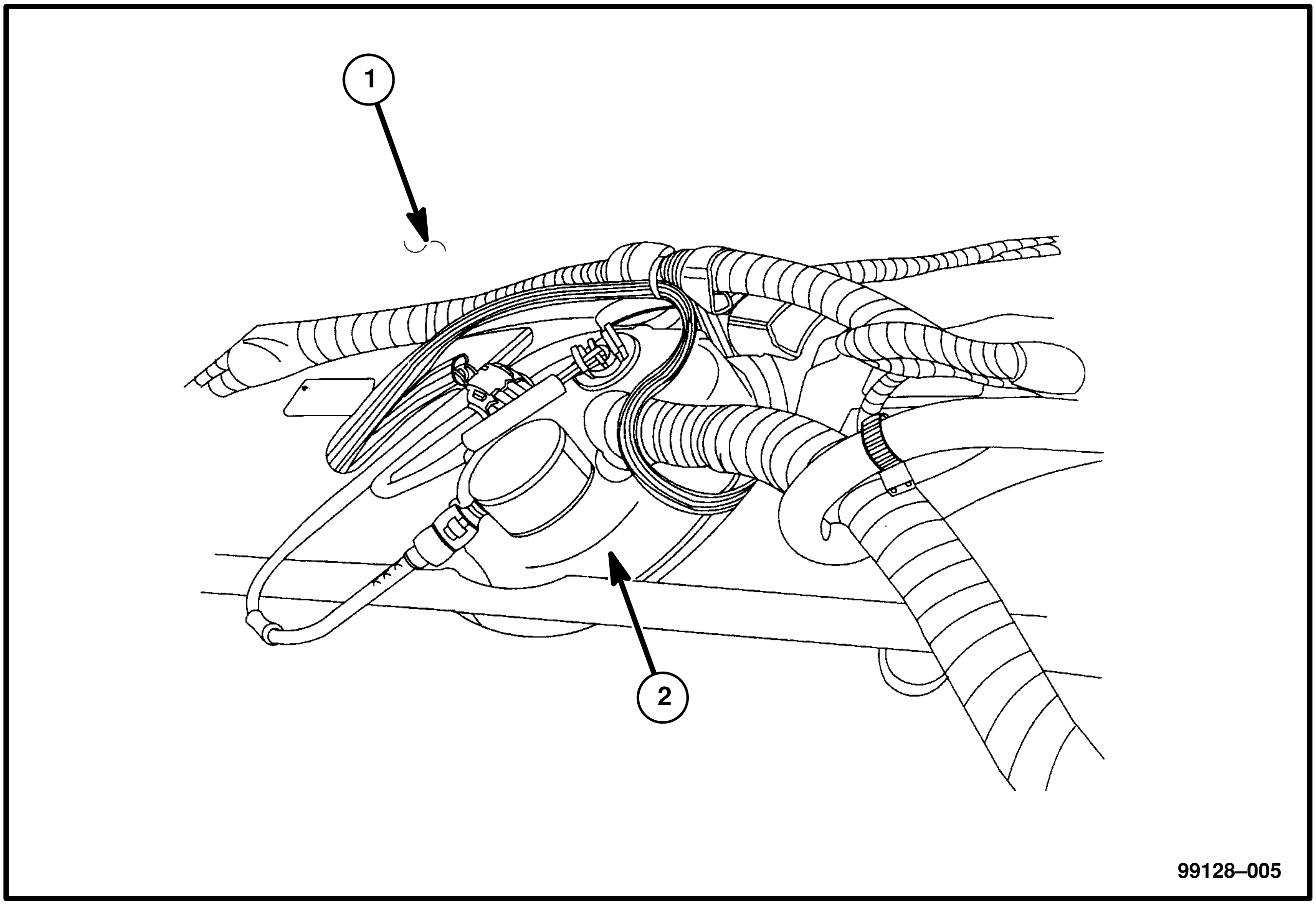


Figure 5 Fuel Tank (Typical)

1	Fuel Tank	2	Fuel Pump Module

FUEL PUMP MODULE

The Viper fuel pump module is an in–tank unit with an integral fuel level sensor and pressure regulator (fig. 6). The pump is driven by a 12–volt DC motor anytime the fuel pump relay is energized. Serviceable components on the module may be:

- Inlet strainer
- Fuel level sensor
- Filter/pressure regulator

The pump draws fuel through a strainer and pushes it through the motor to the outlet. The pump contains two check valves. One valve relieves internal fuel pump pressure and regulates maximum pump output. The second valve, in the pump outlet, maintains pump pressure during engine–off conditions.

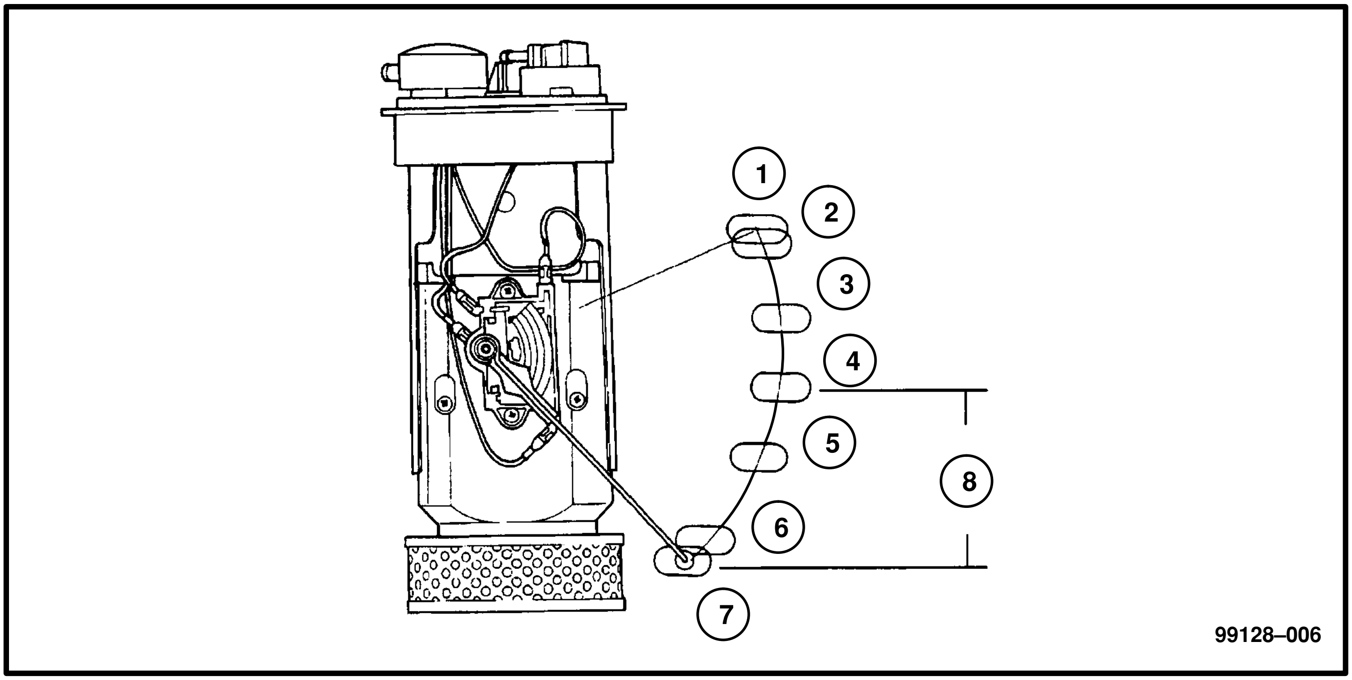


Figure 6 Fuel Pump Module

1	Full Stop	5	1/4 Tank
2	Full Tank	6	Empty Tank
3	3/4 Tank	7	Empty Stop
4	1/2 Tank	8	Height

Check Valve Operation

The electric fuel pump outlet contains a one–way check valve to prevent fuel flow back into the tank and to maintain fuel supply–line pressure (engine warm) when the pump is not operational. It is also used to keep the fuel supply line full of gasoline when the pump is not operating. After the vehicle has cooled down, fuel pressure may drop to 0 psi (cold fluid contracts), but liquid gasoline will remain in the fuel supply line between the check valve and the fuel injectors. **Fuel pressure that has dropped to 0 psi on a cooled–down vehicle (engine off) is a normal condition.** When the electric fuel pump is activated, fuel pressure should **immediately** rise to specification.

The fuel systems use a positive displacement, gerotor, immersible pump with a permanent magnet electric motor.

This fuel system does not contain the traditional fuel return lines. The regulator contains a calibrated spring, which forces a diaphragm against the fuel filter return port. When pressure exceeds the calibrated amount, the diaphragm retracts, allowing excess pressure and fuel to vent into the tank.

If the fuel delivery system becomes blocked between the fuel pump and the regulator, the maximum deadhead pressure of the pump is approximately 880 kPa (130 psi). The regulator adjusts fuel system pressure to approximately 379 kPa (55 +/– 5 psi).

A fuel gauge level sending unit is attached to the fuel pump module. The fuel level input is used as an input for OBD II. Fuel level below 15% or above 85%, on LDP–equipped vehicles, of total tank capacity disables several monitors. There are diagnostics for the fuel level circuit open and shorted (Table 3).

Table Three Fuel Level Diagnostics

Diagnostic	**DTC**	**MIL**
OBDII Major Monitors	Disabled	Disabled
Front O2S Voltage Checks	Active	Active
Rear O2S Voltage Checks Faults	Active	Active
Front/Rear O2 Heater	Active	Active
VSS Rationality	Active	Active

Warning: *Be very careful when removing the fuel pump module from the fuel tank as gasoline remaining in the module reservoir will spill.*

FUEL PRESSURE REGULATOR

All Viper vehicles use a returnless fuel system. On a return system, all fuel is routed through the hot environment of the engine compartment. Without a return line, the fuel remains in the tank and is cooler. This reduces evaporative emissions, resulting in less evaporative canister purging.

Returnless fuel systems do not have a return line routed from the fuel rail to the fuel tank. The pressure regulator is part of the fuel pump module. It is part of a regulator assembly on some vehicles and a separate piece on others.

The pressure regulator is a mechanical device that is not controlled by the PCM (fig. 7). The regulator contains a calibrated spring and a diaphragm that actuates the regulator valve. Fuel pressure operates on one side of the diaphragm, while spring pressure operates on the other side. The diaphragm opens the valve to the return port, allowing fuel to be dumped back into the fuel tank. System fuel pressure reflects the amount of fuel pressure required to open the port. The spring on the opposite side of the diaphragm attempts to close the valve, causing an increase of pressure on the fuel as it travels to the fuel rail. The spring is not adjustable. The spring is calibrated to maintain approximately 379 kPa (55 +/– 5 psi) of fuel pressure.

In the past, the regulator was mounted on the fuel rail so that as the manifold vacuum at the tip of the injector changed, fuel pressure was modified to maintain a constant injector flow volume. With the regulator mounted at the tank, a constant fuel pressure is always supplied to the injectors. The PCM uses a special formula using MAP information that calculates the pressure differential across the injector, and then adjusts injector pulse width.

Fuel Flow

- **Remote–mounted filter (two hoses) (1992–1999)** – Fuel flows from the pump to the regulator mounted on top of the module. From the regulator, it flows to the filter, mounted to the frame, and then to the fuel rail. The regulator on the pump module maintains 55 +/– 5 psi in the filter and lines.
- **2000** – The Viper uses a new filter & regulator which is integral to the pump module. The in–line filter is removed for the 2000 MY.

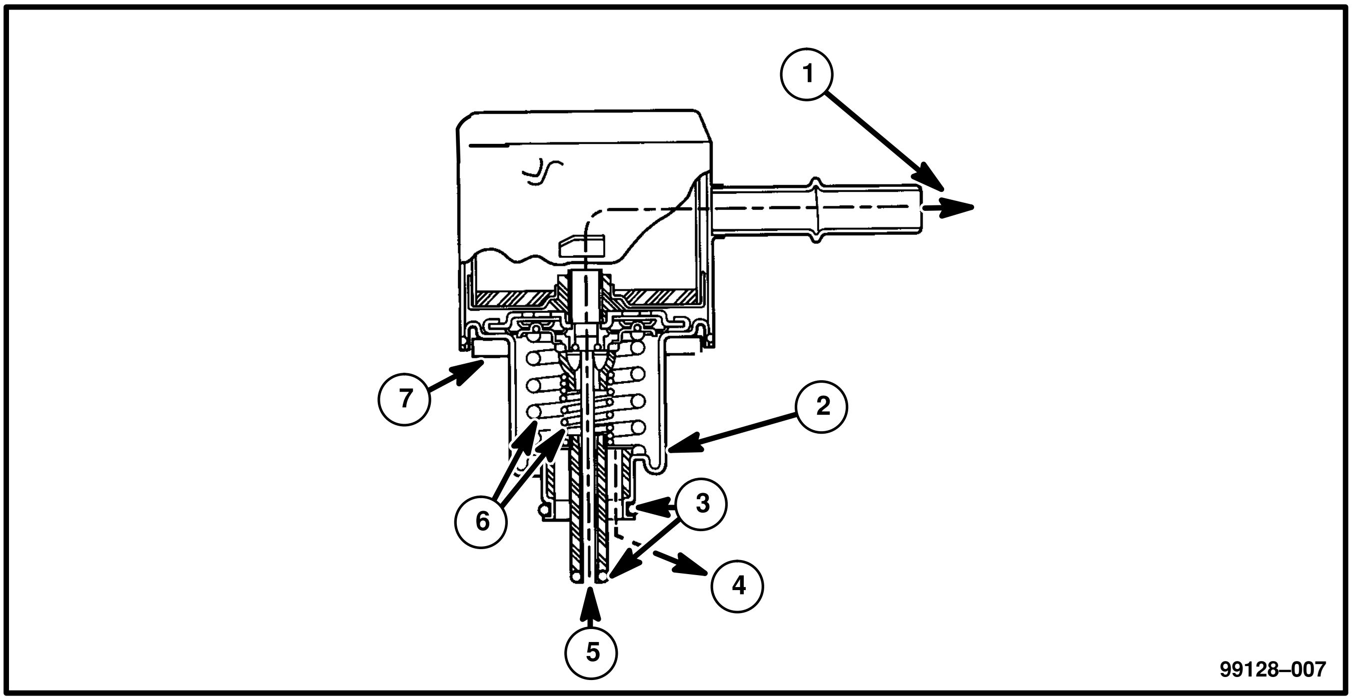


Figure 7 Typical Fuel Pressure Regulator

1	Fuel Flow to Fuel Injectors	5	Fuel Inlet
2	Pressure Regulator	6	Calibrated Springs
3	O–Rings	7	Rubber Grommet at Pump Module
4	Excess Fuel Back to Tank		

FUEL PUMP RELAY

The Fuel Pump Relay is located in the trunk. It is energized to provide power to operate the fuel pump under the following conditions:

- For approximately 1.8 seconds during the initial key–on cycle (JTEC).
- For approximately 0.5 to 1.5 seconds during the initial key–on cycle, depending on temperature (SBEC).
- While the CKP sensor is providing an RPM signal that exceeds a predetermined value.

Ignition voltage is provided to the fuel–pump relay coil anytime the key is in the RUN/START position (figs. 8 & 9). The PCM provides the ground control to energize the relay. Unlike previous Chrysler systems (non–OBD II), the fuel pump relay does not provide power to operate the 02 Sensor heater.

The relay is energized when the key is cycled to RUN to prime the fuel rail with liquid fuel, allowing for a quick start–up. Anytime the CKP sensor indicates that an RPM signal exceeds a predetermined value, the relay is energized to ensure proper fuel pressure and volume during engine cranking and running conditions. Anytime the CKP sensor signal is lost (engine has been shut off or the sensor indicates no rpm), the fuel pump relay is de–energized.

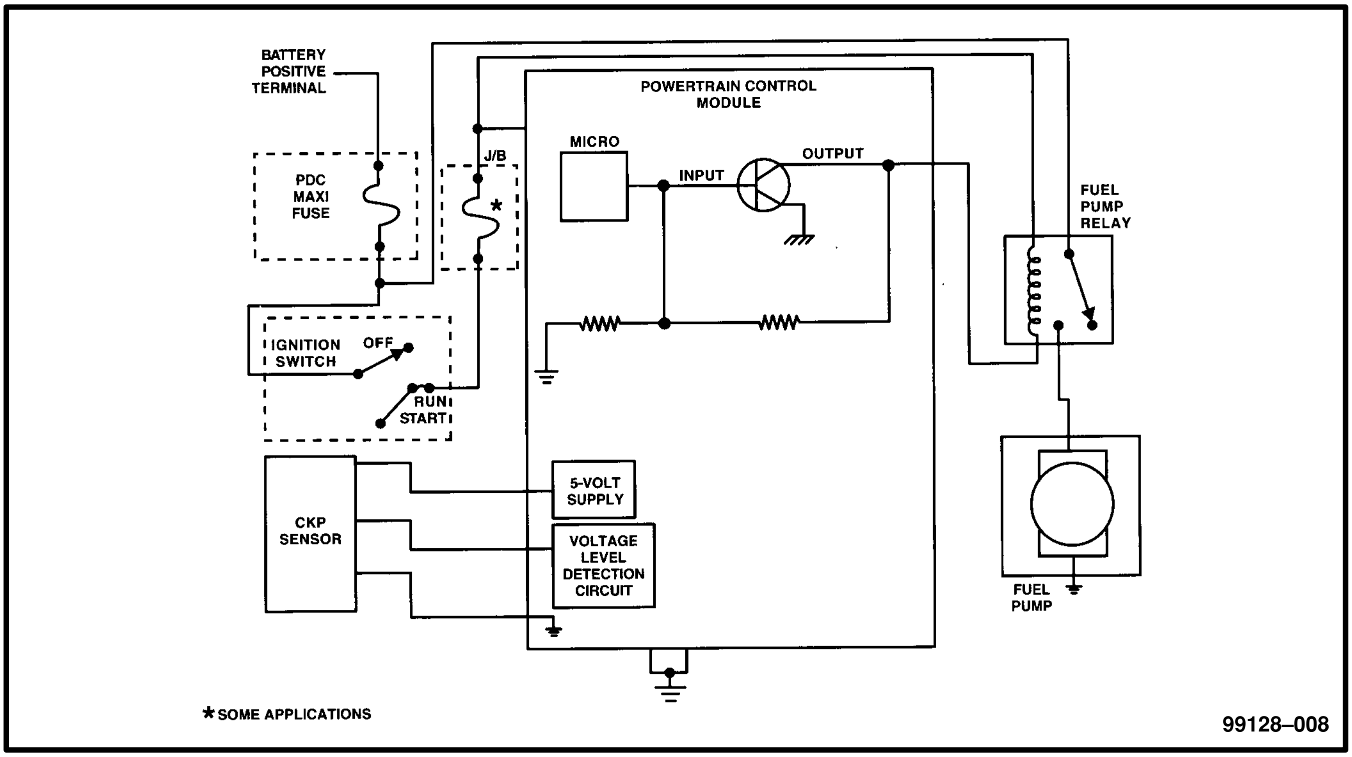


Figure 8 JTEC Fuel Pump Relay Circuit

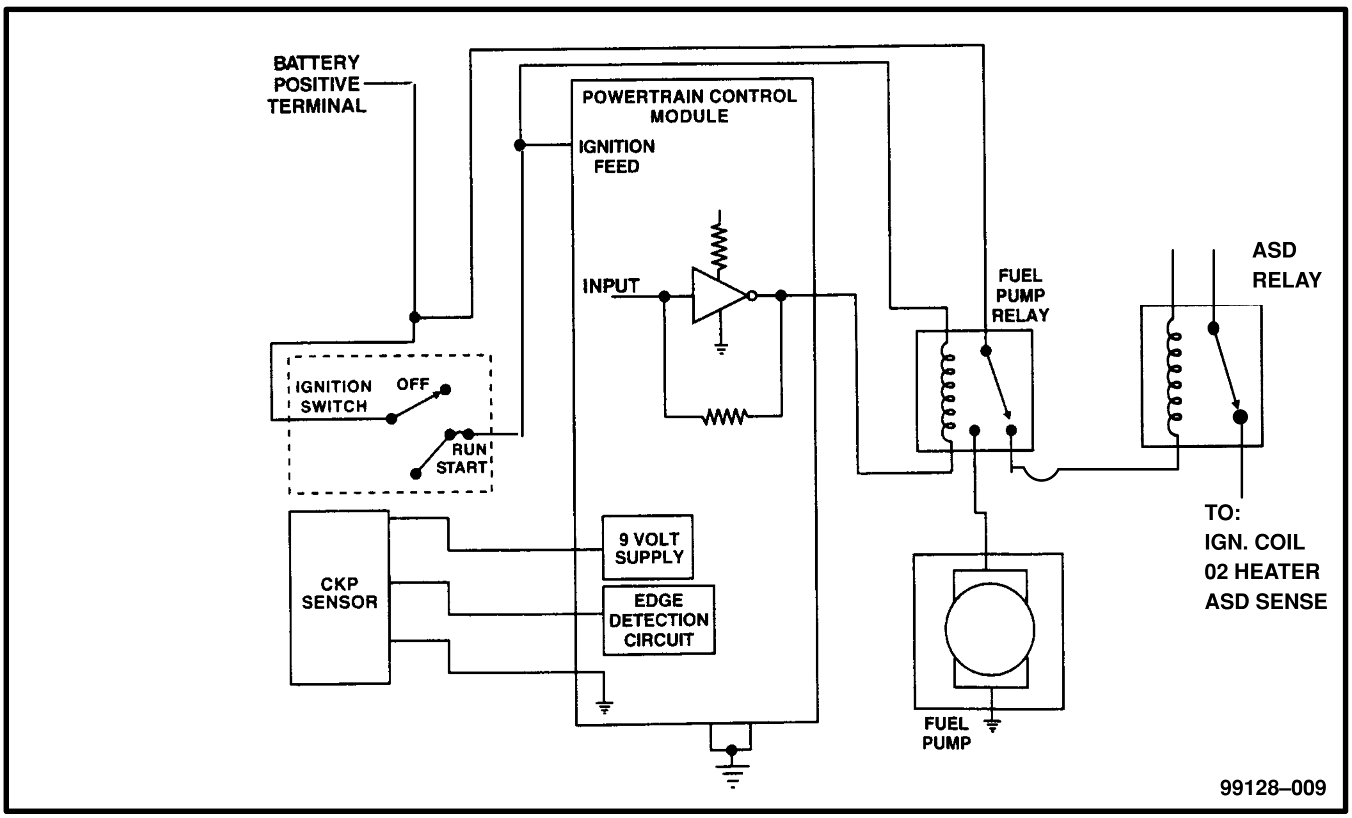


Figure 9 SBEC Fuel Pump Relay Circuit

FUEL INJECTORS

Warning: *Release fuel system pressure before servicing fuel system components. The procedure is described on the MDS2 and the Service Manual. Service vehicles and fuel system components in well–ventilated areas. Avoid sparks, flames and other ignition sources. Never smoke while servicing the vehicle's fuel system.*

Caution: *If an injector must be removed on a Viper for inspection or service, you must purge the fuel rail of all fuel, otherwise, flooding of one cylinder with fuel may occur. Consult the Fuel Injection section on the MDS2 or the appropriate Service Manual for proper service procedures.*

The Viper engine uses bottom feed injectors. They are supplied fuel from a rail that is part of the intake manifold.

The fuel injectors are 12–ohm electrical solenoids (fig. 10). Each injector contains a needle valve that closes off an orifice at the nozzle end. When electrical current is supplied to the injector, the armature and needle move a short distance against a spring, allowing fuel to flow out the orifice. Because the fuel is under high pressure, a fine spray is developed in the shape of a hollow cone. The spraying action atomizes the fuel, adding it to the air entering the combustion chamber.

The fuel injectors are positioned in the intake manifold with the nozzle ends directly above the intake valve port for the corresponding cylinder. Fuel is dispersed through one opening at the bottom of each injector. This design allows for an atomized spray, similar to that of a pintle injector, but with the low cost and easy serviceability of a pencil–stream injector.

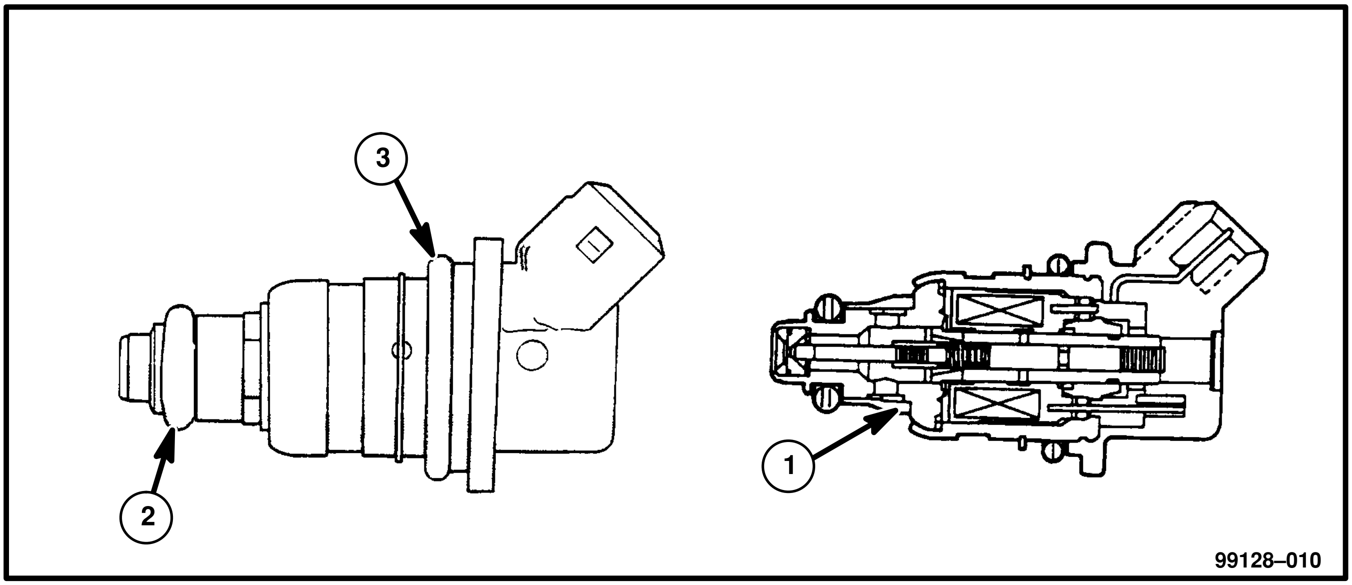


Figure 10 Fuel Injector

1	Screen (fuel inlet)	3	Upper O–ring
2	Lower O–ring		

FUEL FILTER

The fuel filter is mounted just outside the tank (fig. 11). The remote filter has two lines attached to it. Filters are life–of–the–vehicle items. Replacement is necessary only if something has caused the filter to become plugged, such as contaminants in the fuel. Regular maintenance is no longer required because only the fuel actually being used by the engine is filtered.

Note: *Always lubricate the O–rings inside the quick–connect fittings with engine oil, before reassembling the fuel line connections at the fuel pump module, fuel filter fuel lines and the fuel rail.*

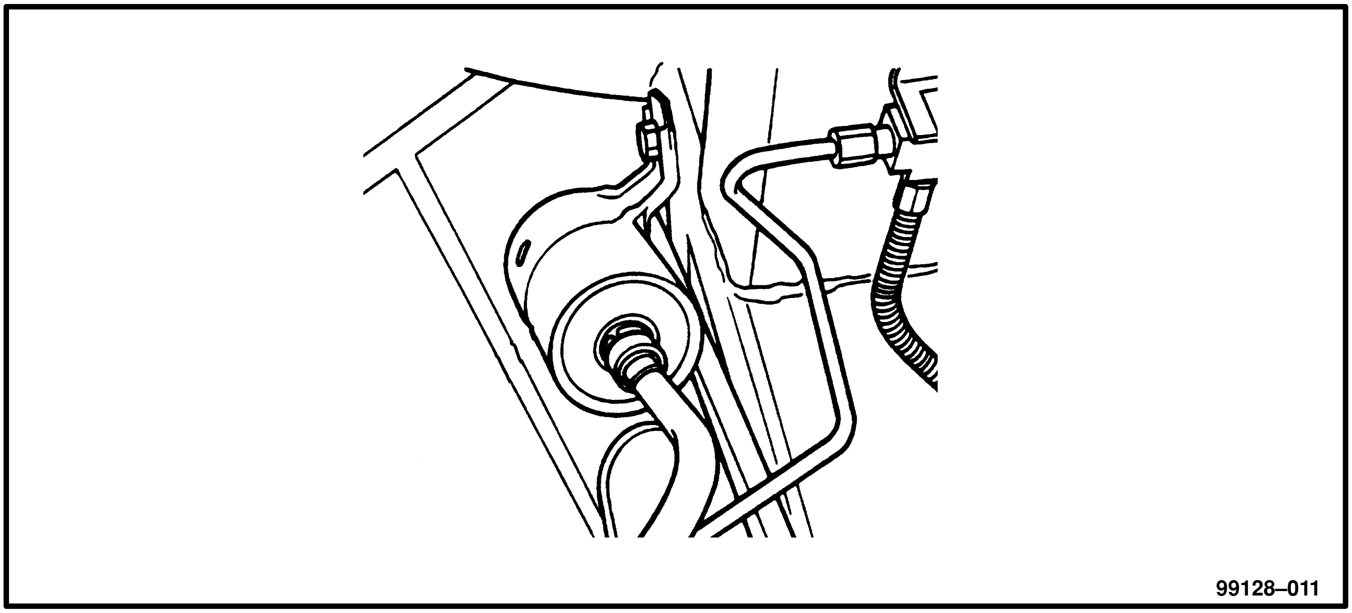


Figure 11 Fuel Filter

FUEL LINES AND RAIL

Fuel Lines

The high–pressure line from the tank to the filter or engine is a combination of rubber, plastic, and steel lines. The hose clamps used to secure rubber hose sections have a special rolled edge construction to prevent the edge of the clamp from cutting into the hose.

Note: *If the O–rings at the quick–connect fittings become damaged, the line must be replaced.*

Fuel Rail

The fuel rail is an integral part of the intake manifold (fig. 12). The fuel rails attach to the fuel line with a quick connect fitting. If the O–rings at the quick connect fittings become damaged, the line must be replaced. There is a test port located on the Intake Manifold Right Bank between Injectors #9 and #10. Always follow the procedures on the MDS2 or the Service Manual when removing fuel system components.

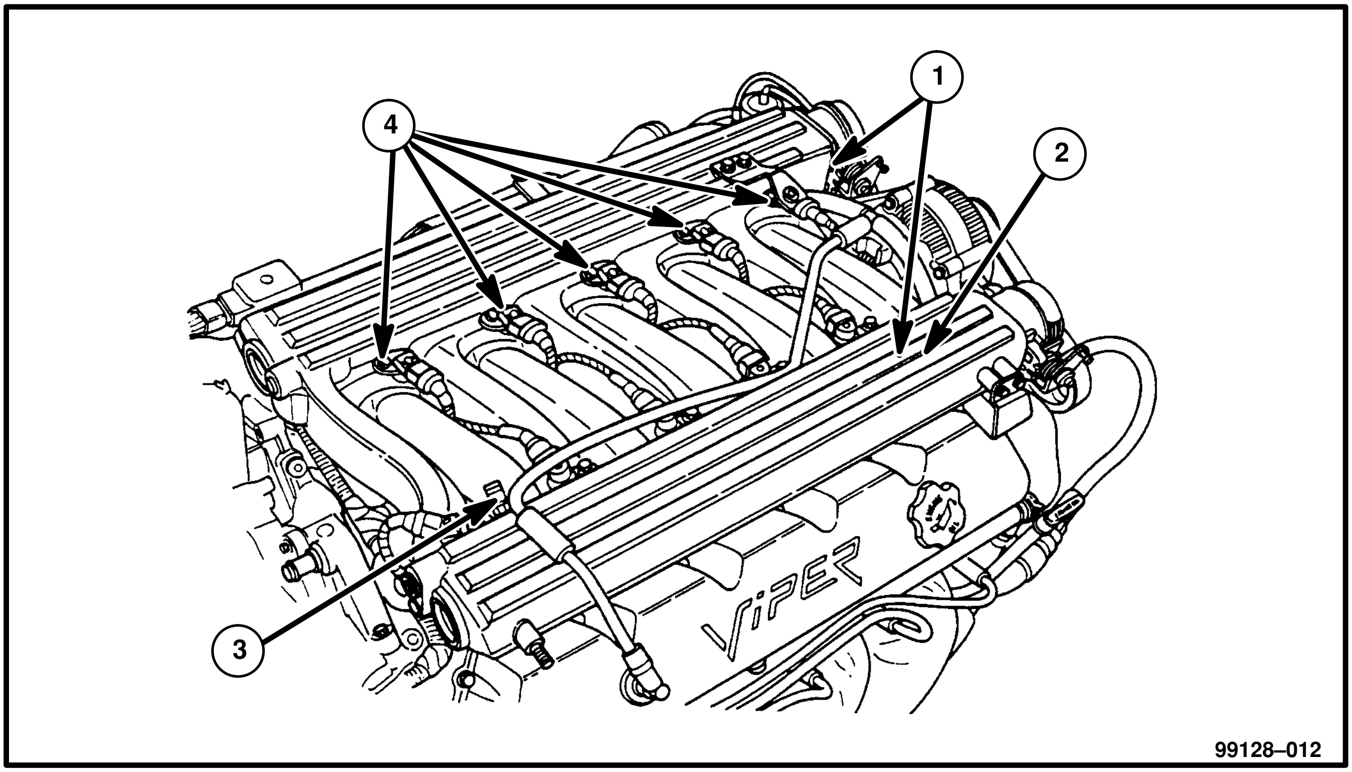


Figure 12 Fuel Rails

1	Fuel Rails	3	Fuel Pressure Test Port
2	Intake Manifold	4	Fuel Injection

NOTES:

THROTTLE BODY

The throttle bodies are mounted to the intake manifold. On Vipers equipped with the heavyweight engine, a separate throttle cable and linkage control each throttle body (fig. 13). The throttle cables must be adjusted after replacement or removal of one or both throttle bodies, or after installation of a new throttle cable. The throttle cable will require adjustment if the throttle arm does not contact the throttle stop on the throttle body housing at WOT. For throttle cable adjustment procedures, refer to the MDS2 or the Service Manual.

Vipers equipped with the lightweight engine incorporate a single throttle cable design with a synchronization shaft (fig. 14). The throttle cable controls the left throttle plate and mechanical motion is transmitted to the opposite throttle plate through a synchronization shaft. This shaft is not an adjustable component. It is calibrated at the factory and is serviced as a replacement component only.

The contoured throttle body changes air velocity slightly with moderate pedal movement. The first 1/3 of opening takes a lot of throttle movement, then opening occurs much faster. This helps reduce buck and bobble at light throttle positions. The TPS is attached to the left throttle body.

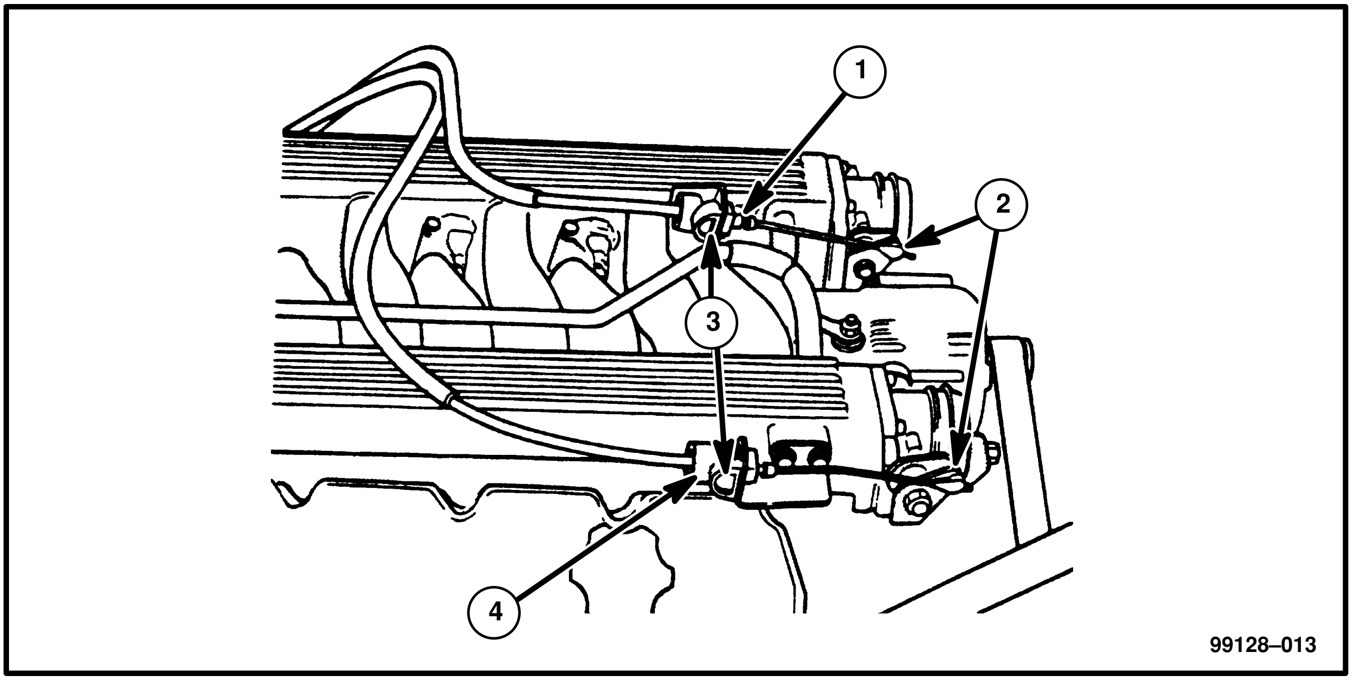


Figure 13 Heavyweight Throttle Attachments

1	Shaft	3	Button
2	Clasp	4	Ratchet

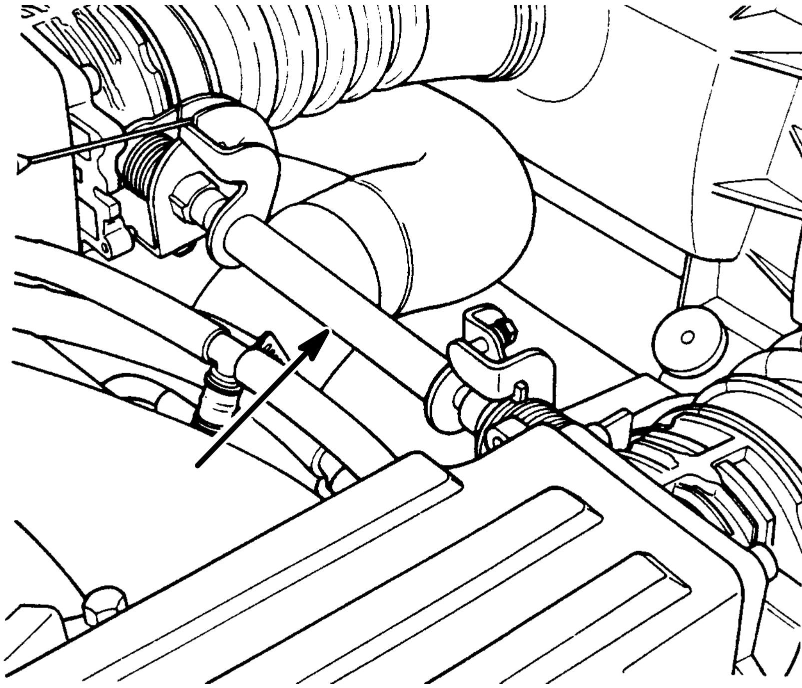


Figure 14 Lightweight Throttle Synchronization Shaft

POWERTRAIN CONTROL MODULE

POWER SUPPLIES AND GROUNDS (JTEC)

In order to function, the PCM must be supplied with battery voltage and a ground (fig. 15). The PCM monitors battery voltage during engine operation. If the voltage level falls, the PCM increases the initial injector opening point to compensate for low voltage at the injector. Low voltage causes a decrease in current flow through the injector and can prevent the injector plunger from fully opening in the allotted time, resulting in decreased fuel flow.

Battery charging rate is controlled by the PCM, except on 1996 Roadsters. The target charging rate voltage is based upon inputs from Battery Temperature Sensor (BTS). The BTS is located in the bottom of the battery tray.

The PCM must be able to store diagnostic information. This information is stored in a battery–backed RAM. Once a Diagnostic Trouble Code (DTC) is read, the technician can clear the RAM by disconnecting the battery for approximately 60 seconds, or using the DRBIII® scan tool.

The PCM has two power inputs: direct 12 volts and switched ignition 12 volts. Battery voltage is supplied to the PCM to power the 5–volt power supply and allow the PCM to perform fuel, ignition and emission control functions. The PCM monitors this direct battery–feed input to determine charging rate, control the injector initial opening point, and back up the RAM used to store the DTC functions. This is called sensed battery and will be discussed later.

When the ignition switch is turned ON, the 12–volt input acts as a “wake up” signal to an integrated circuit that then turns on the power supply.

The power supply output of 5 volts supplies multiple locations within the controller and is also used as the reference voltage for sensor operation. Some of the locations within the controller that use 5 volts are the microprocessors. Another output of the 5–volt power supply is a line that is split to make the primary and secondary 5–volt outputs.

The primary output is used as a reference voltage for the TPS and MAP sensors as well as a power supply to operate the CMP and CKP sensors. It is also used as a power supply for the VSS.

Another use of the power supply is a reference voltage for the internal use of the PCM. The microprocessors determine current sensor state by comparing the sensor signal to the reference voltage. The difference between the two voltages equals the sensor state.

The PCM has two grounds, both identified as power grounds. All the high current, noisy devices are connected to these grounds as well as all the sensor returns. The sensor return comes in, passes through noise suppression and is then connected to the power ground.

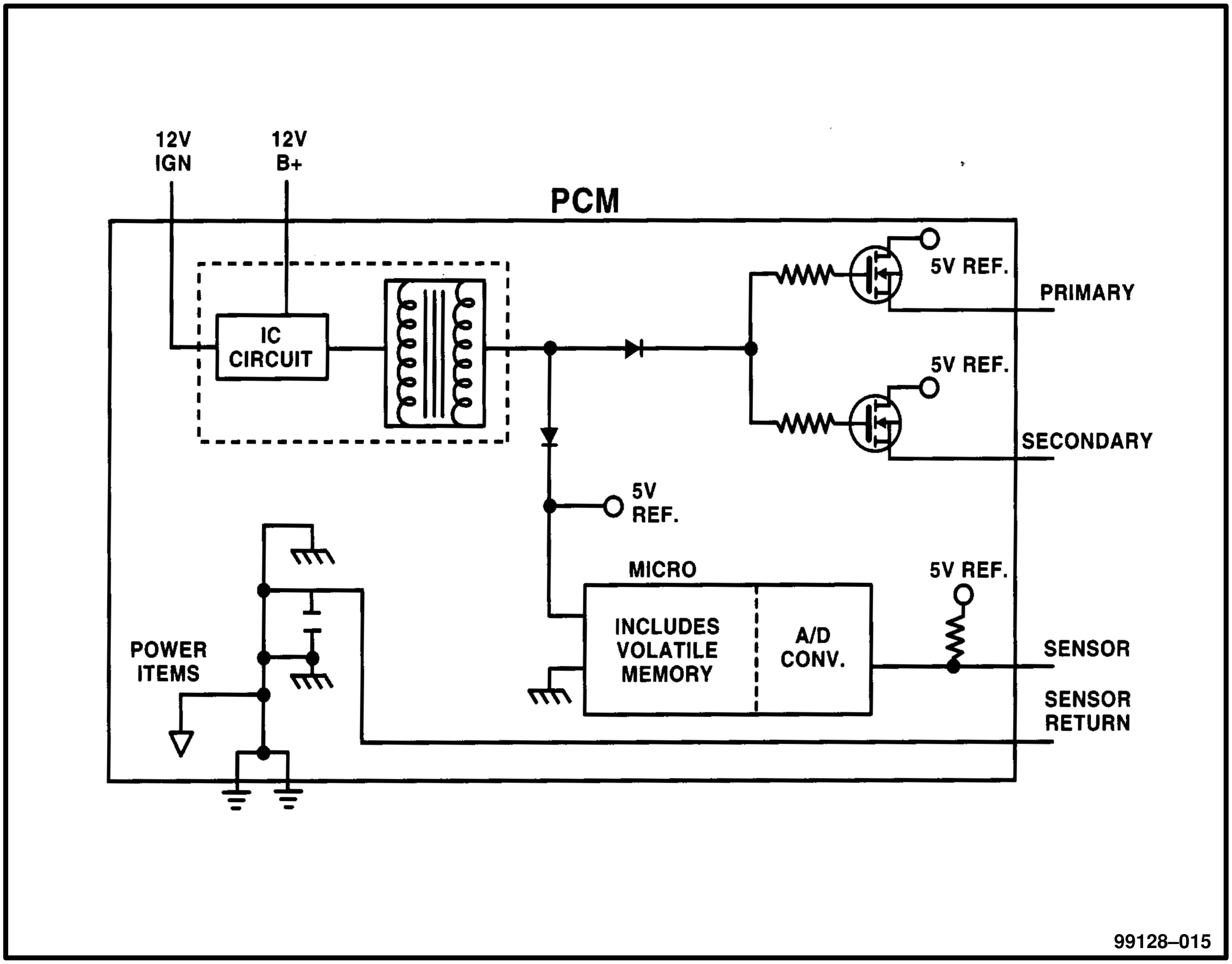


Figure 15 JTEC Power Supplies and Grounds

POWER SUPPLIES AND GROUNDS (SBEC)

In order to function, the PCM must be supplied with battery voltage and a ground (fig. 16). The PCM monitors battery voltage during engine operation. If the voltage level falls, the PCM increases the initial injector opening point to compensate for low voltage at the injector. Low voltage causes a decrease in current flow through the injector and can prevent the injector plunger from fully opening in the allotted time, resulting in decreased fuel flow.

The PCM must be able to store diagnostic information. This information is stored in a battery–backed RAM. Once a DTC is read by the technician, the technician can clear the RAM by disconnecting the battery for approximately 60 seconds, or using the DRBIII® scan tool.

The PCM monitors the direct battery feed input to control the injector initial opening point and back–up the RAM used to store DTCs. Direct battery feed is also used to supply working voltage to the controller. This is called sensed battery and will be discussed later.

Ignition voltage is supplied to the PCM. Battery voltage is supplied to this pin through the Ignition Switch when the ignition key is in the RUN or START position. Voltage is supplied to this circuit to power the 9–volt regulator and to allow the PCM to perform fuel, ignition, and emissions control functions. This ignition input acts as a “wake up” signal to the PCM. The battery voltage on this line is supplied to the 9–volt regulator which then passes on a power supply to the 5–volt regulator. Voltage on the ignition input can be as low as 6 volts and the PCM will still function.

Internally, all ground pins are connected together, however there is a noise suppression on the sensor ground. For Electro Magnetic Interface (EMI) and Radio Frequency Interface (RFI) protection, the case is also grounded separately from the ground pins.

A 9–volt power supply is provided to supply the VSS, CKP, and CMP sensors with a regulated voltage. The same power supply also provides the 5–volt regulator with power. The 9–volt regulator is protected from short circuits. If the regulator were externally shorted to ground, a circuit in the regulator would cause the external supply voltage to shut down, but still provide power to the 5–volt regulator.

A 5–volt power supply is used to provide a regulated power supply to most of the inputs to the PCM. This circuit is also protected from shorts to ground and a circuit in the regulator allows the 5–volt signal to be sent to other inputs if the 5–volt power supply were shorted to ground at the MAP sensor or TPS.

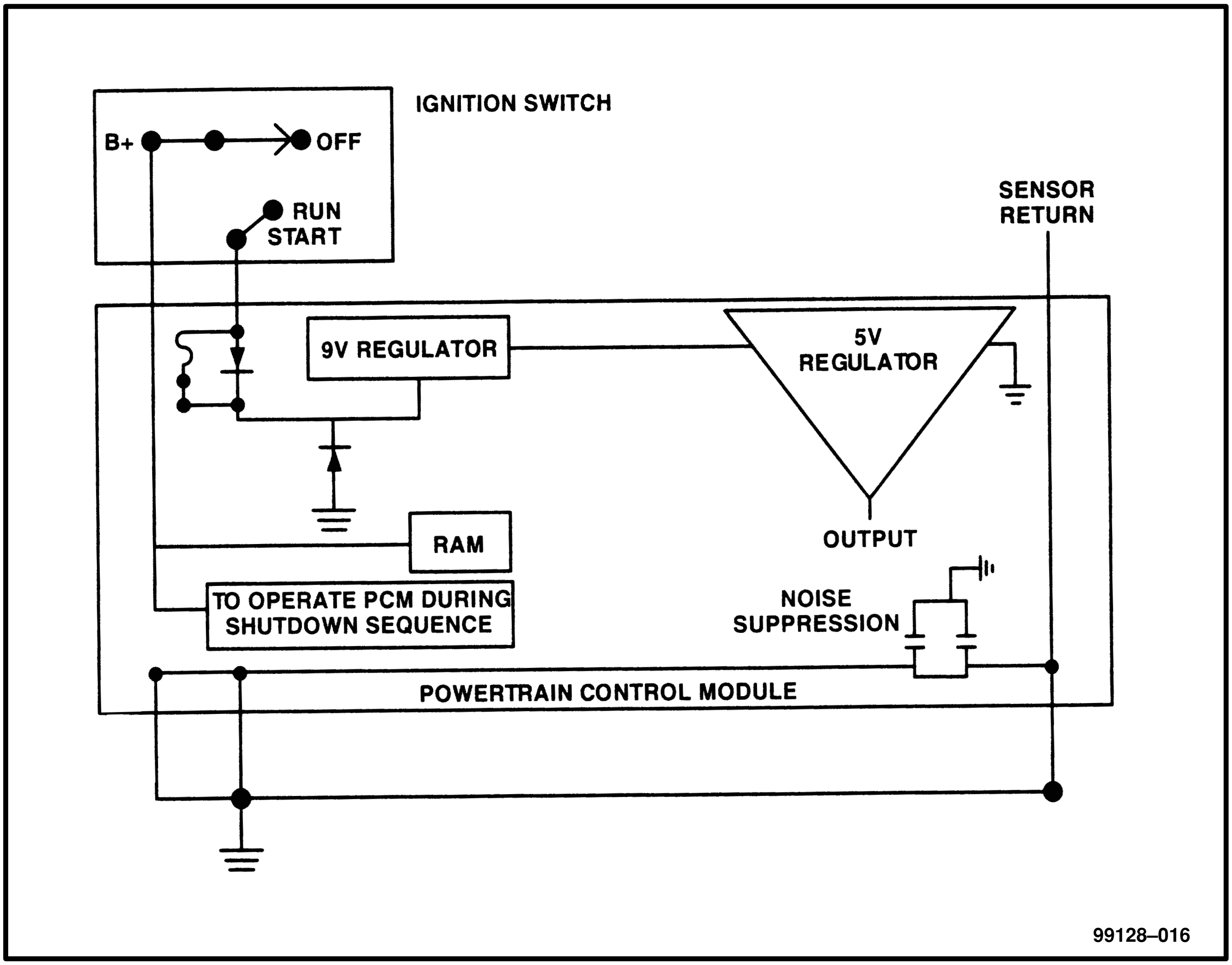


Figure 16 SBEC Power Supplies and Grounds

DATA LINK CONNECTOR (DLC)

The PCM maintains communication with scan tools through the vehicle's DLC. The DLC for pre–1996 Vipers is located under the hood, next to the PCM. From 1996 forward, the DLC is located inside the vehicle, below the Instrument Panel and to the left of the clutch pedal (fig. 17). This change in location is a result of OBD II.

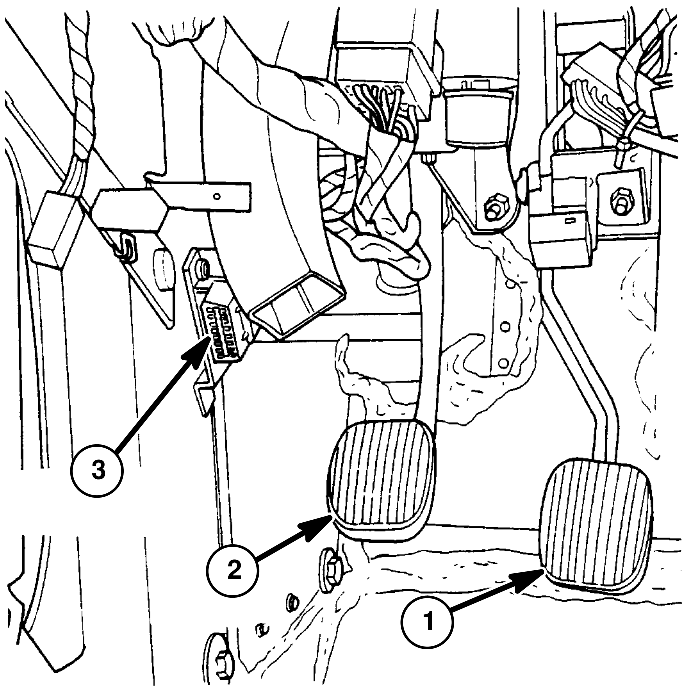


Figure 17 Data Link Connector (1996 and Later)

1	Brake Pedal	3	Data Link Connector
2	Clutch Pedal		

NOTES:

FUEL INJECTION SYSTEM — PCM INPUTS

CRANKSHAFT POSITION SENSOR (CKP)

The Crankshaft Position Sensor (CKP) is mounted in the passenger side of the engine block, below the exhaust manifold. The CKP is a Hall–effect type sensor that is used to provide input to the PCM regarding the exact position of the crankshaft and pistons. This type of sensor detects slots cut into a pulse ring machined into the middle of the crankshaft. The CKP signal alone is used to determine engine RPM. When combined with input from the Camshaft Position Sensor (CMP – discussed later), CKP input is used to determine:

- Top Dead Center (TDC)
- Ignition Timing
- Injector Synchronization

Note: *The engine will not start if the PCM does not receive the CKP signal.*

The pulse ring has five groups of two notches equally spaced at its outer edge (fig. 18). Each group of notches represents a signal for a specific set of pistons. The PCM determines basic timing by the position of the falling edge of the slots. Each corresponding slot is 72° apart and is 3° wide. There are 15° between each slot in the pair. The falling edge of the first slot of each pair of slots is used for cylinders 10, 4, 6,8 and 2, and the second falling edge is used for cylinders 1, 9, 3, 5 and 7 (fig. 19). It may take the PCM one full engine revolution to determine crankshaft position while cranking. The following shows companion or paired cylinders:

- #10 and #5
- #9 and #8
- #4 and #7
- #3 and #2
- #1 and #6

The V10 is a 90° block. This means that the combined angle of the bore center lines of the opposing banks are 90° and that a piston comes up to TDC every 90°. With 10 cylinders, each one would be fired in 900° of crankshaft rotation (10 x 90 =900). To match cylinder firing with crankshaft rotation, it was necessary to make an “odd fire” engine. This means that all the cylinders are not fired at the same amount of crankshaft rotation. Five cylinders are fired at 54° and the other five are fired at 90° of crankshaft rotation (fig. 19). All of these angles added together total 720° or two complete crankshaft revolutions. Because of the odd firing, it is necessary to use different notch edges to properly stagger the spark.

Note: *The CKP does not inform the SBEC which pistons are approaching top dead center (TDC). The CMP signal provides this information.*

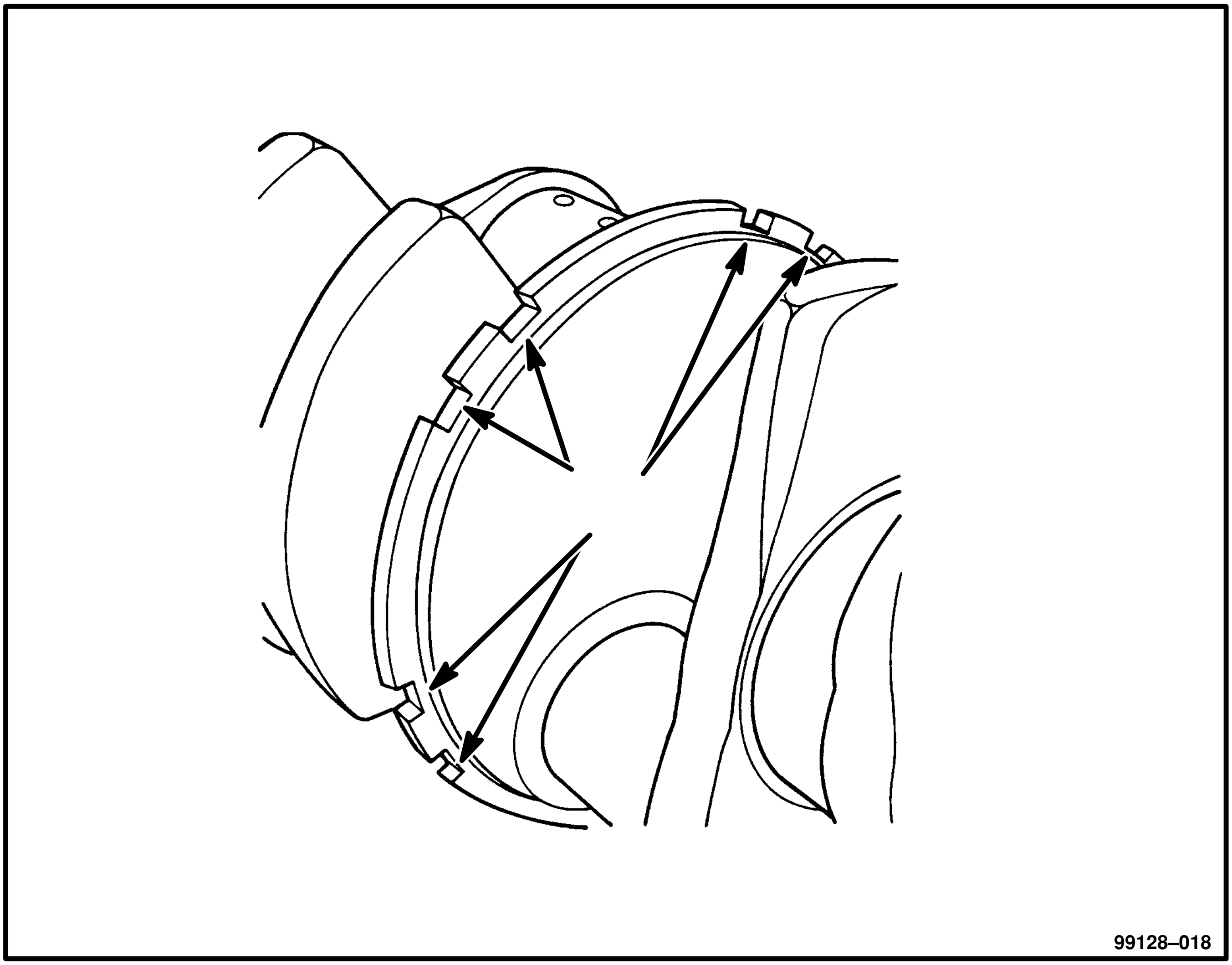


Figure 18 Crankshaft Notches

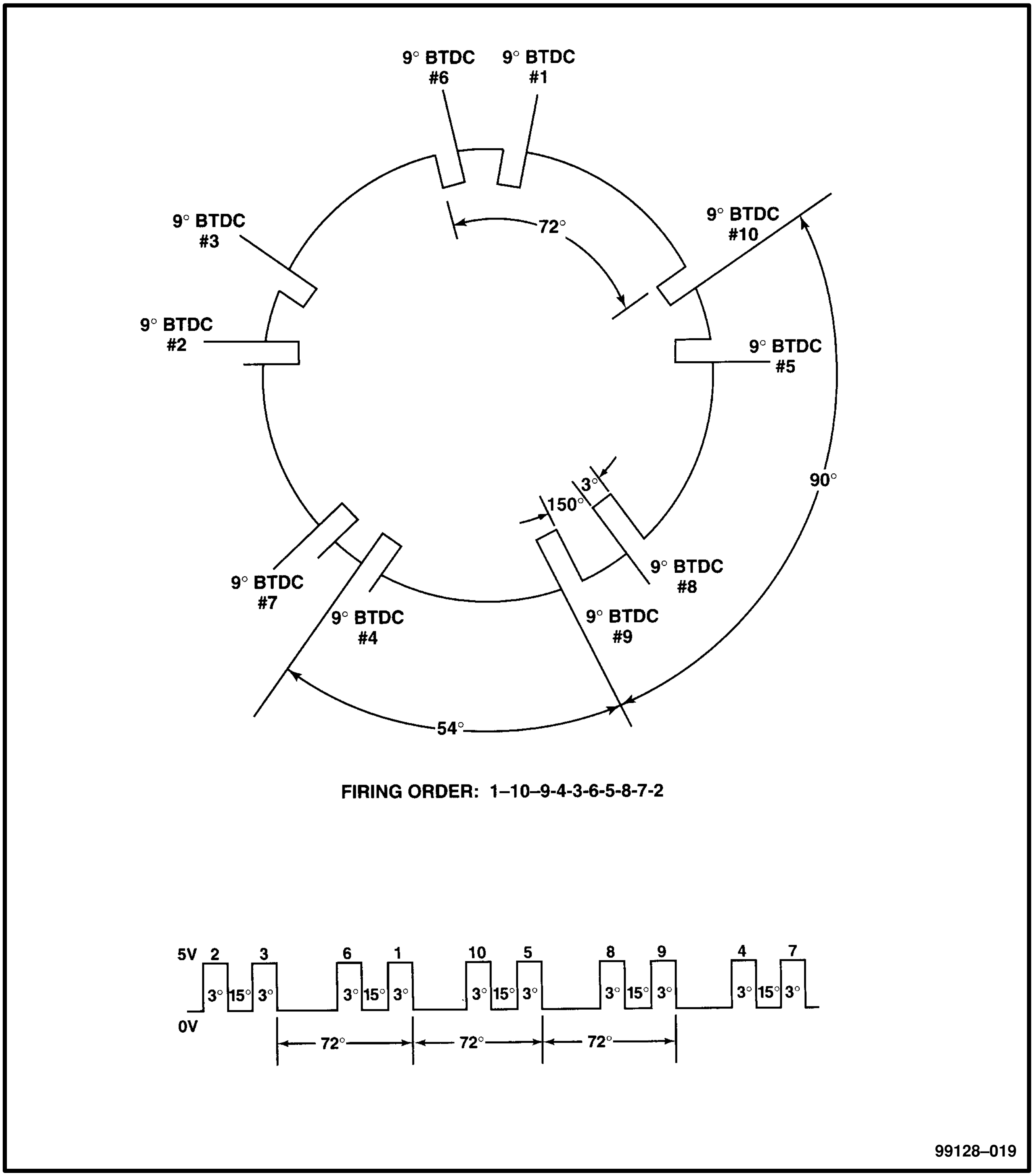


Figure 19 Crankshaft Pulse Ring

The PCM supplies 5 volts (9 volts on SBEC) to the sensor for operation of the Hall–effect chip and other sensor electronics (figs. 20 & 21). The PCM also provides a ground for the sensor on the sensor return circuit. Finally, the PCM provides a 5–volt reference signal to the CKP through a third circuit. This reference voltage alternates between 5 volts and 0 volts with the rotation of the crankshaft.

The Hall–effect switch contains a magnet. As the magnetic field passes over the solid portion of the pulse ring, the 5–volt signal is pulled to ground through a transistor in the sensor. When a notch is in front of the sensor, the transistor is turned off and the reference voltage rises to 5 volts. The PCM identifies crankshaft position by registering the cycles from 0 to 5 volts.

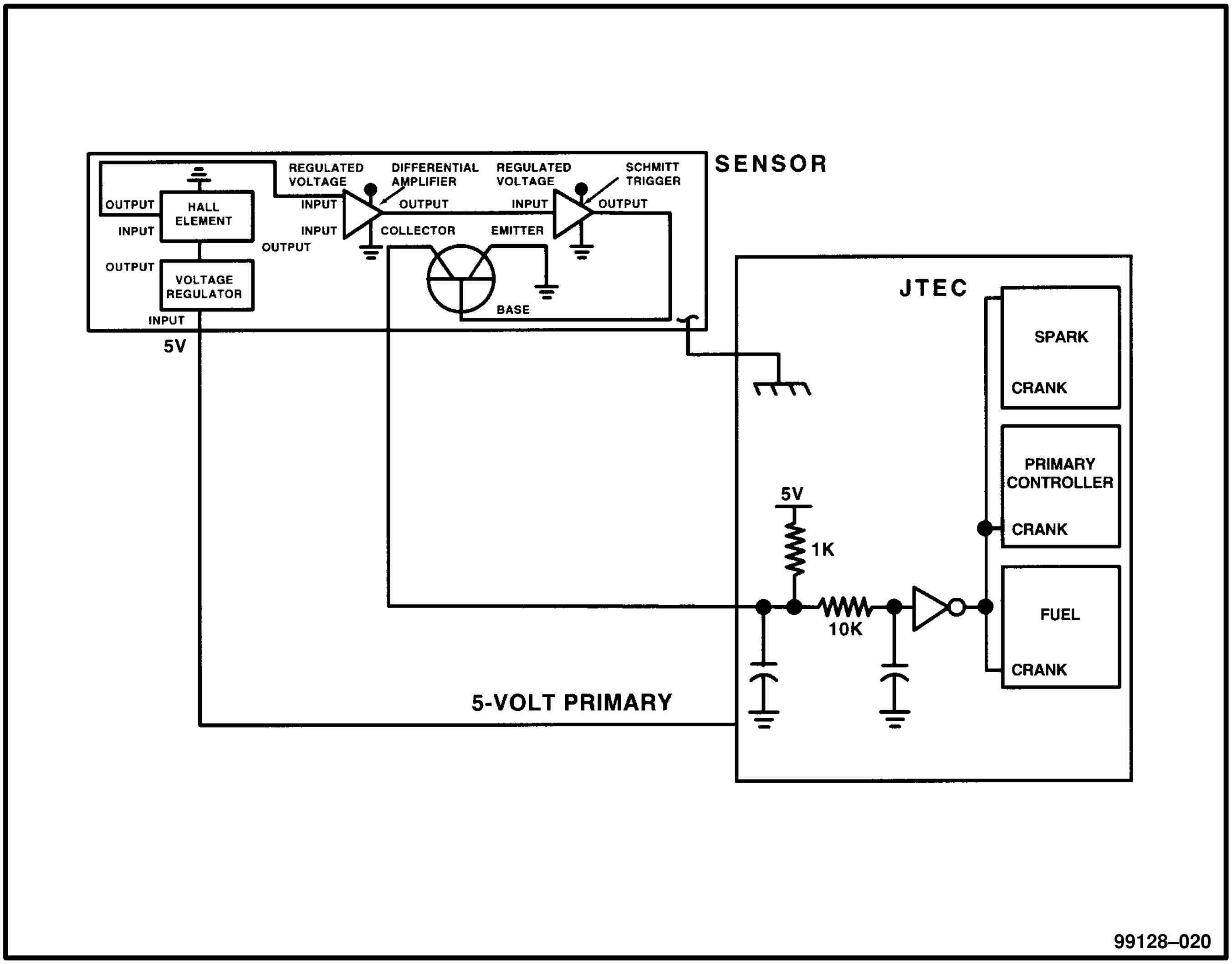


Figure 20 JTEC Crankshaft Position Sensor Circuit

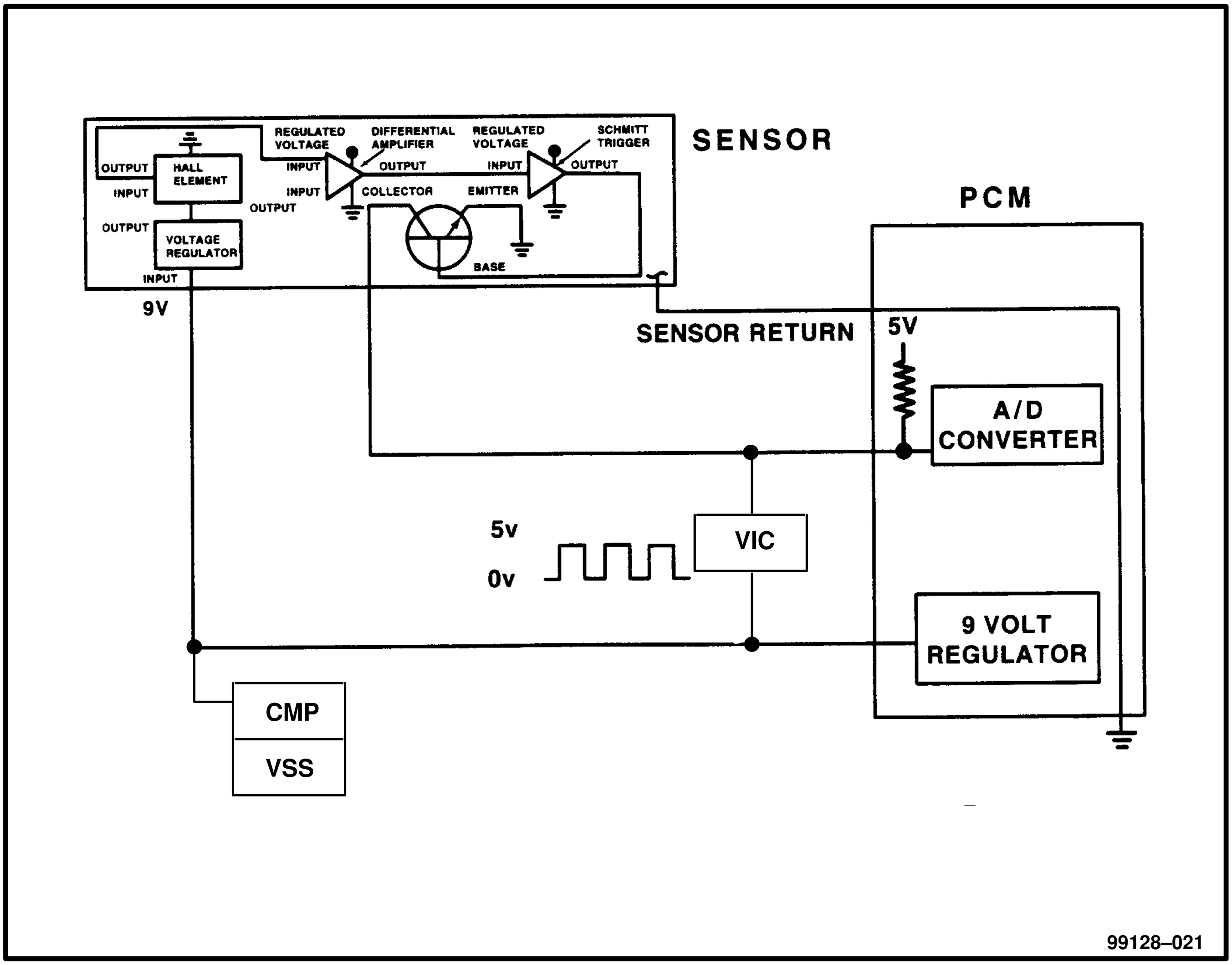


Figure 21 SBEC Crankshaft Position Sensor Circuit

Crankshaft Position Sensor Service

The sensor's powerful magnet is susceptible to damage. Do not drop the sensor on a metal table, or store sensors face–to–face. The clearance between the sensor and the counterweight is not adjustable. Though the clearance is critical, manufacturing tolerances allow for some differences in clearance.

In order for the vehicle to start, both the cam and crankshaft position sensor signals must be present. On SBEC PCMs and eight–digit part number JTEC PCMs, both the cam and crankshaft position sensor signals are necessary for continued operation.

On 10–digit part number PCMs (1997 and later), once the engine is running, the cam sensor signal is not needed for continued operation.

***Caution*:** *The crankshaft position sensor has a foil heat shield attached by the CKP mounting bolt covering the sensor. The heat shield must be property installed to ensure that the CKP sensor remains protected from the heat of the exhaust system.*

CAMSHAFT POSITION SENSOR (CMP) (JTEC)

The Camshaft Position Sensor (CMP) functions similarly to the CKP. The CMP is also a Hall–effect sensor that provides input to the PCM regarding crankshaft position and cylinder identification. The PCM uses the CMP input along with the CKP input to determine exact piston location and determines spark/fuel delivery.

The CMP Sensor is mounted in the front of the timing case cover (fig. 22). The camshaft sprocket has a metallic step that passes in front of the CMP sensor. The PCM is able to identify piston location by monitoring the position of this step.

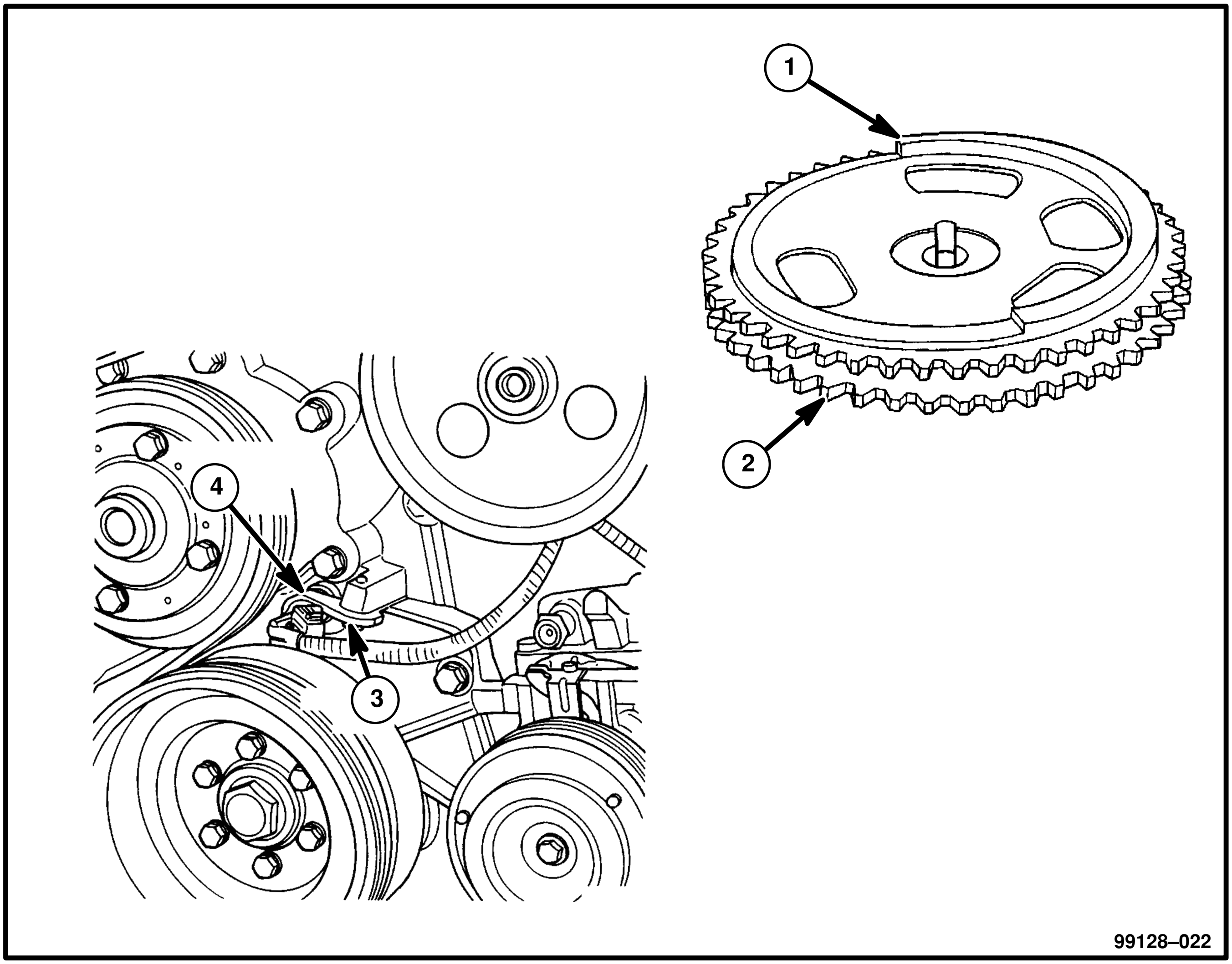


Figure 22 JTEC Camshaft Position Sensor Operation

1	Timing Step	3	Mounting Bolt
2	Camshaft Sprocket	4	Camshaft Position Sensor

The PCM supplies 5 volts to the sensor for operation of the Hall–effect chip and other sensor electronics (fig. 23). The PCM also provides a ground for the sensor on the sensor return circuit. This reference voltage alternates between 5 volts and 0 volts with the rotation of the camshaft.

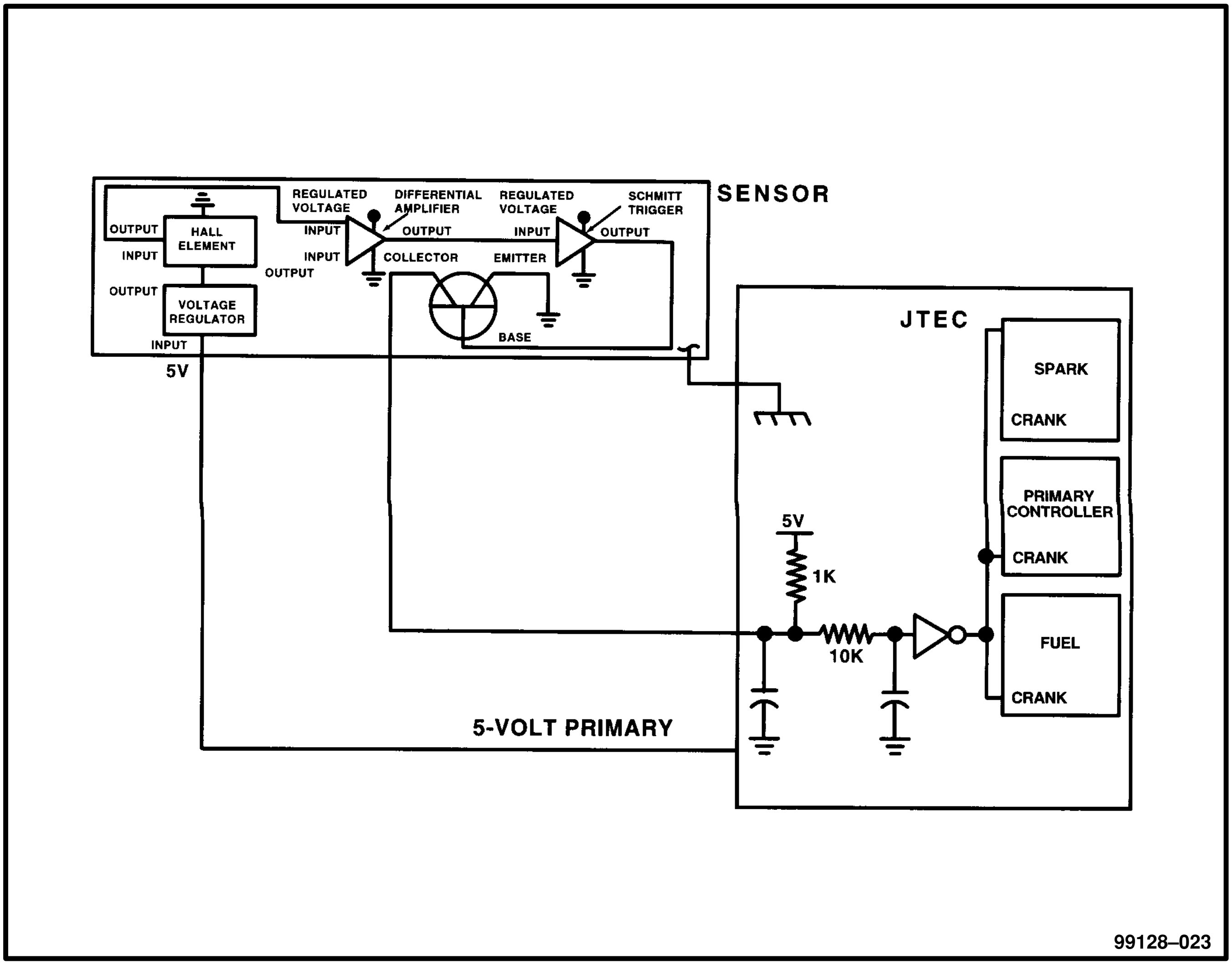


Figure 23 JTEC Camshaft Position Sensor Circuit

Similar to the CKP, when the step passes in front of the CMP, the 5 volt reference voltage from the PCM goes to approximately 0 volts. When the step rotates away from the sensor, the reference voltage returns to 5 volts. The result is a square wave signal that alternates between 0 and 5 volts (fig. 24).

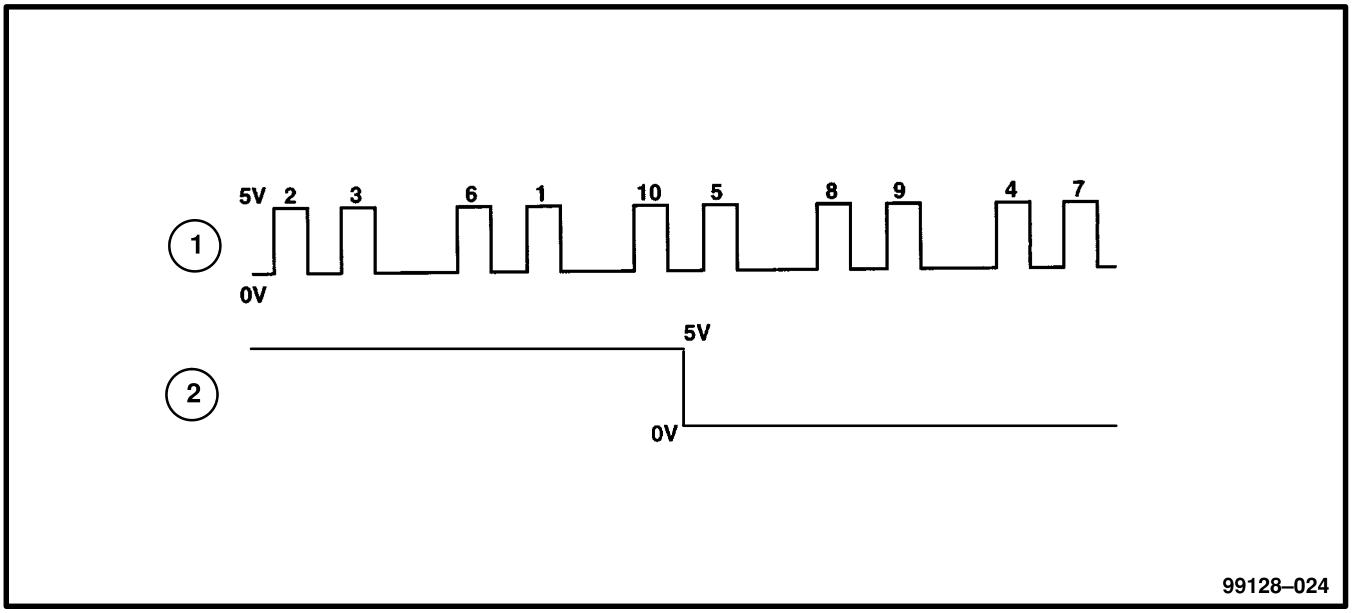


Figure 24 JTEC CMP Sensor Signal

1	Crankshaft	2	Camshaft

The PCM determines crankshaft position from the inputs provided by the Camshaft and Crankshaft Position Sensors. Once the crankshaft position is determined the PCM can synchronize fuel injection and cylinder identification.

In order for the vehicle to start, both the CMP and CKP sensor signals must be present. On 1992–1996 vehicles, both CMP and CKP sensor signals are necessary for continued engine operation. On 1997 and later vehicles, once the engine is running, the CMP sensor signal is not needed for continued engine operation.

When the PCM sees the falling edge of the CMP sensor it knows that cylinder #1 is next. When the PCM sees the second falling edge after the CMP sensor it knows that the crankshaft is at 9° BTDC compression for cylinder #1. The PCM then knows that the next falling edge it will see is 9° BTDC compression for cylinder #10 and so on. Because of the odd fire the injector–firing is also staggered. The injectors for cylinders 1, 9, 3, 5 and 7 are fired at 423° BTDC. The injectors for cylinders 10, 4, 6, 8 and 2 are fired at 441° BTDC.

Cam/Crank Diagnosis

In order for the PCM to diagnose either the CAM or CRANK sensor signals, one of the signals must be present.

Camshaft Position Sensor Service

Caution**:** *When installing a CMP sensor the cam drive gear position must be checked. If the cam gear is positioned at the low area, the sensor will be broken when the engine is started. Refer to the MDS2 or the Service Manual for proper procedures.*

CAMSHAFT POSITION SENSOR (CMP) (SBEC)

The PCM sends approximately 9 volts to the Hall–effect sensor (fig. 25). This voltage is required to operate the Hall–effect chip and the electronics inside the sensor. A ground for the sensor is provided through the sensor return circuit. The input to the PCM occurs on a 5–volt output reference circuit. The PCM identifies camshaft position by registering the change from 5 to 0 volts, as signaled from the CMP.

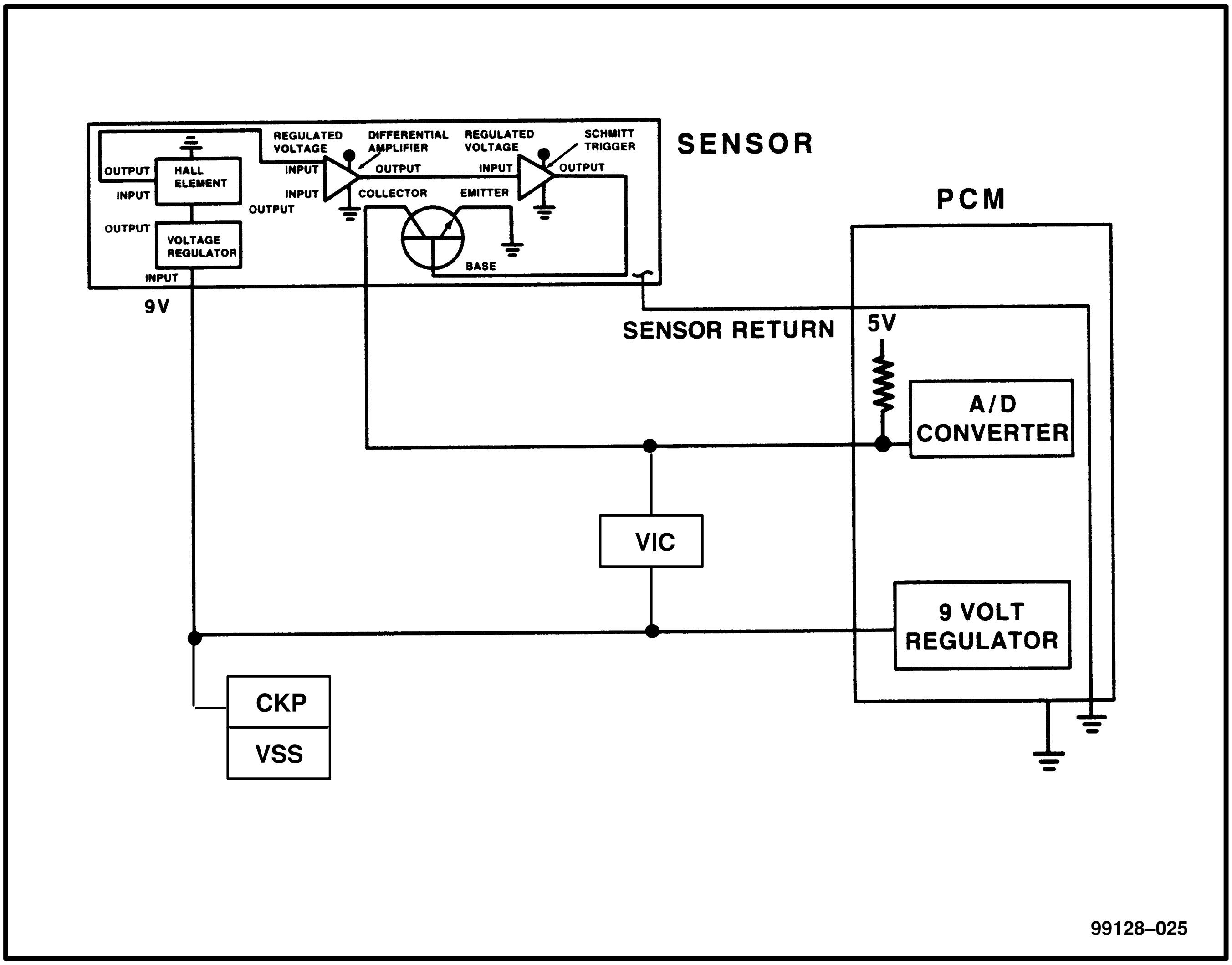


Figure 25 SBEC Camshaft Position Sensor Circuit

The camshaft timing gear has six areas with notched slots (fig. 26). There are two areas with a single slot spaced 180° apart and one area with two slots spaced next to each other. The timing gear also has one long and two shorter, solid, un–notched surfaces. Because of the arrangement of solid and notched areas on the camshaft timing gear, a predictable sequence of signals is produced, which allows the SBEC to determine camshaft position. The SBEC then calculates which coil and injector should be energized. The SBEC is able to make these calculations within one revolution of start–up.

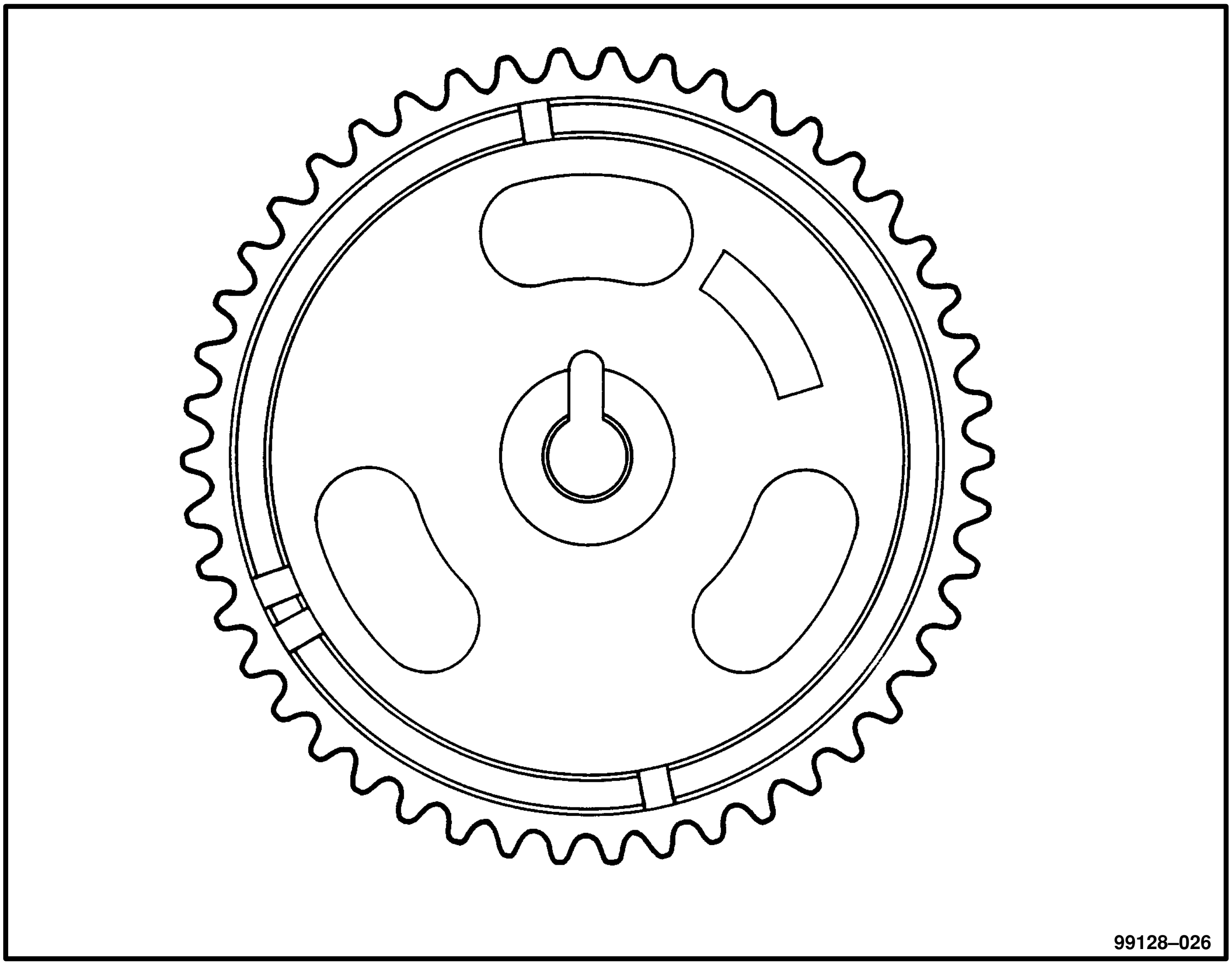


Figure 26 SBEC Camshaft Sprocket

The PCM determines fuel injection synchronization and cylinder identification from inputs provided by the CMP and CKP (fig. 27). From the two inputs, the PCM determines camshaft–to–crankshaft misalignment.

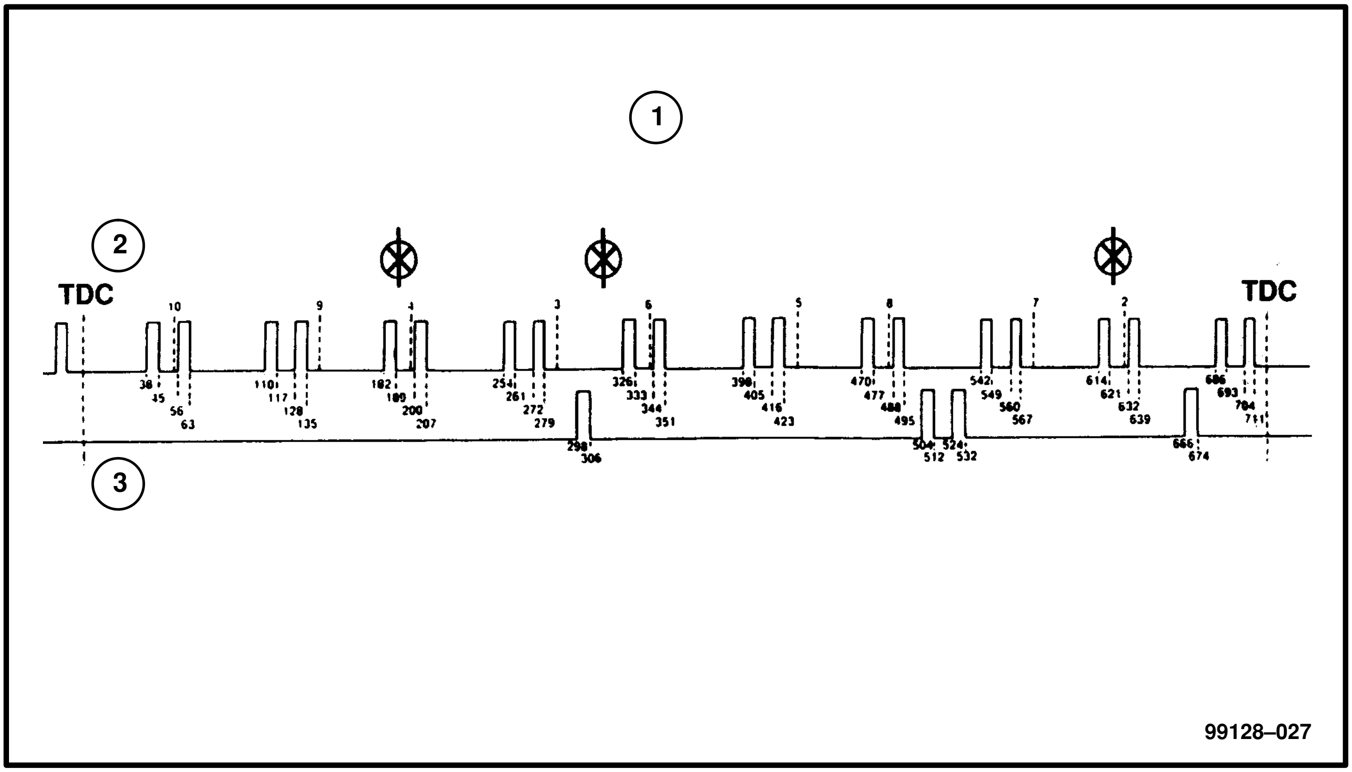


Figure 27 SBEC Camshaft Position Sensor Signal

1	Synchronization	3	Camshaft
2	Crankshaft		

NOTES:

Injection/Ignition Timing

The term "sequential" means the injectors have a specific firing order, and fuel injection is timed to piston movement. Although it is a fuel system, sequential injection is more easily understood if it is compared to an ignition system. Ignition timing matches spark plug firing to piston position, and spark plugs are fired in a specific order: 1–10–9–4–3–6–5–8–7–2.

In order for the SBEC to fire injectors in a specific order timed to crankshaft and piston movement, it must first establish a reference point. Establishing the reference point requires SBEC inputs from the CKP and CMP. The CKP provides the SBEC with crankshaft angle and speed. The SBEC converts crankshaft speed into engine rpm and crankshaft angle into piston position. The notched crankshaft, rotating past the CKP, contains 5 pairs of two notches, equally spaced around the crankshaft. Each notch represents a signal for piston position. The CMP receives signals from the notches on the camshaft timing gear. The timing gear has an area of two single notches spaced 180° apart and an area with two notches next to each other. The timing gear also has one long and two shorter, solid, un–notched surfaces. These signals provide information as to which piston is approaching TDC. Based on these inputs, the SBEC energizes the appropriate injector for a particular cylinder, and energizes the ignition coil to fire the spark plugs of those paired cylinders.

When the engine is running, based on its sync signal, it energizes the injector 432° of crankshaft rotation prior to ignition. For example: when the VIC recognizes cylinder #1, it energizes the injector for cylinder #5. The ignition coil dwell can be started any time before TDC of the previous cylinder in the firing order. However, during high rpms, the dwell time can be as many as four previous cylinders in the firing order.

Sychronization

There are only three ways the engine can “sync”; otherwise, the engine will not start. The three conditions are (fig. 28):

- If the SBEC sees seven crank signals (with no sync) after one camshaft signal has been encountered.
- If the SBEC receives seven (+) crankshaft signals, and then a signal from the CMP.
- If the SBEC receives two camshaft signals encountered between two crankshaft signals.

Since the SBEC does not have enough output drivers to support all of the injectors, two of the injectors, #1 and #5, are controlled by the VIC.

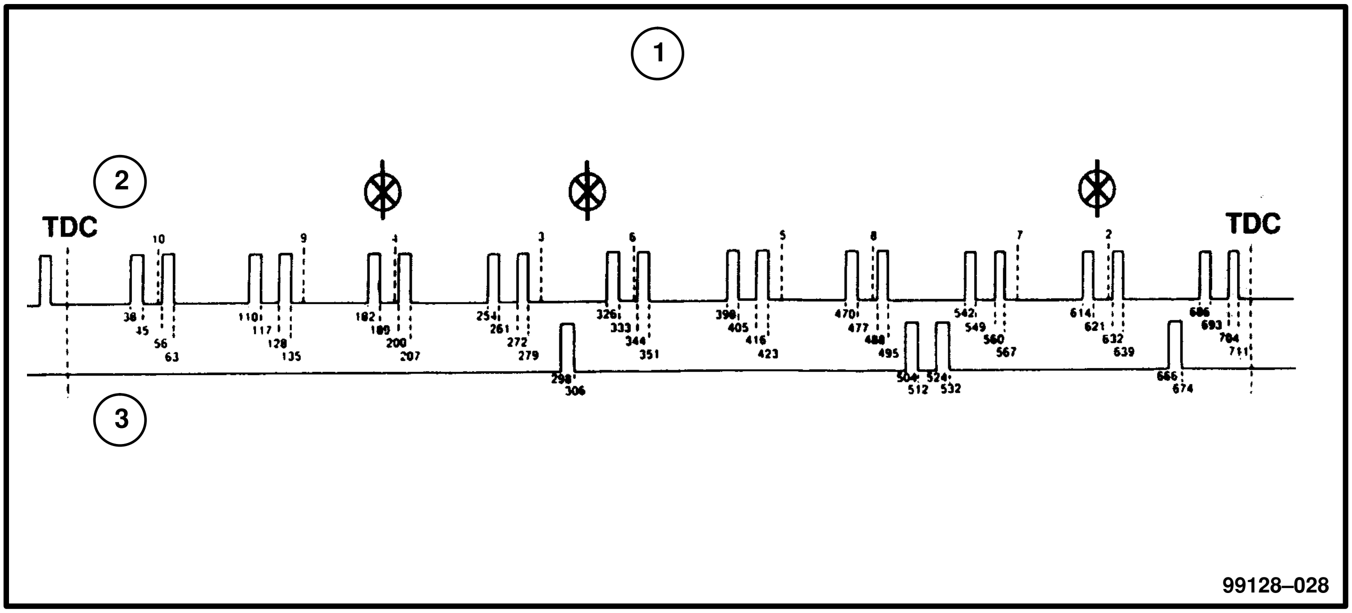


Figure 28 Synchronization

1	Synchronization	3	Camshaft
2	Crankshaft		

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The MAP signal serves as a PCM input, using a silicon–based sensing unit to provide data on the manifold vacuum that draws the air/fuel mixture into the combustion chamber. The PCM requires this information to determine injector pulse width and spark advance. When MAP voltage (engine running) equals the voltage seen when barometric pressure was learned or updated, the pulse width will be at its maximum.

Also, like the cam and crank sensors, 5 volts is supplied from the PCM and the MAP Sensor returns a voltage signal to the PCM that reflects manifold pressure (figs. 29 & 30). The MAP Sensor operating range is from 0.45 volt (high vacuum) to 4.8 volts (low vacuum). The sensor is supplied a regulated 4.8 to 5.1 volts to operate the sensor. Like the cam and crank sensors, ground is provided through the sensor return circuit.

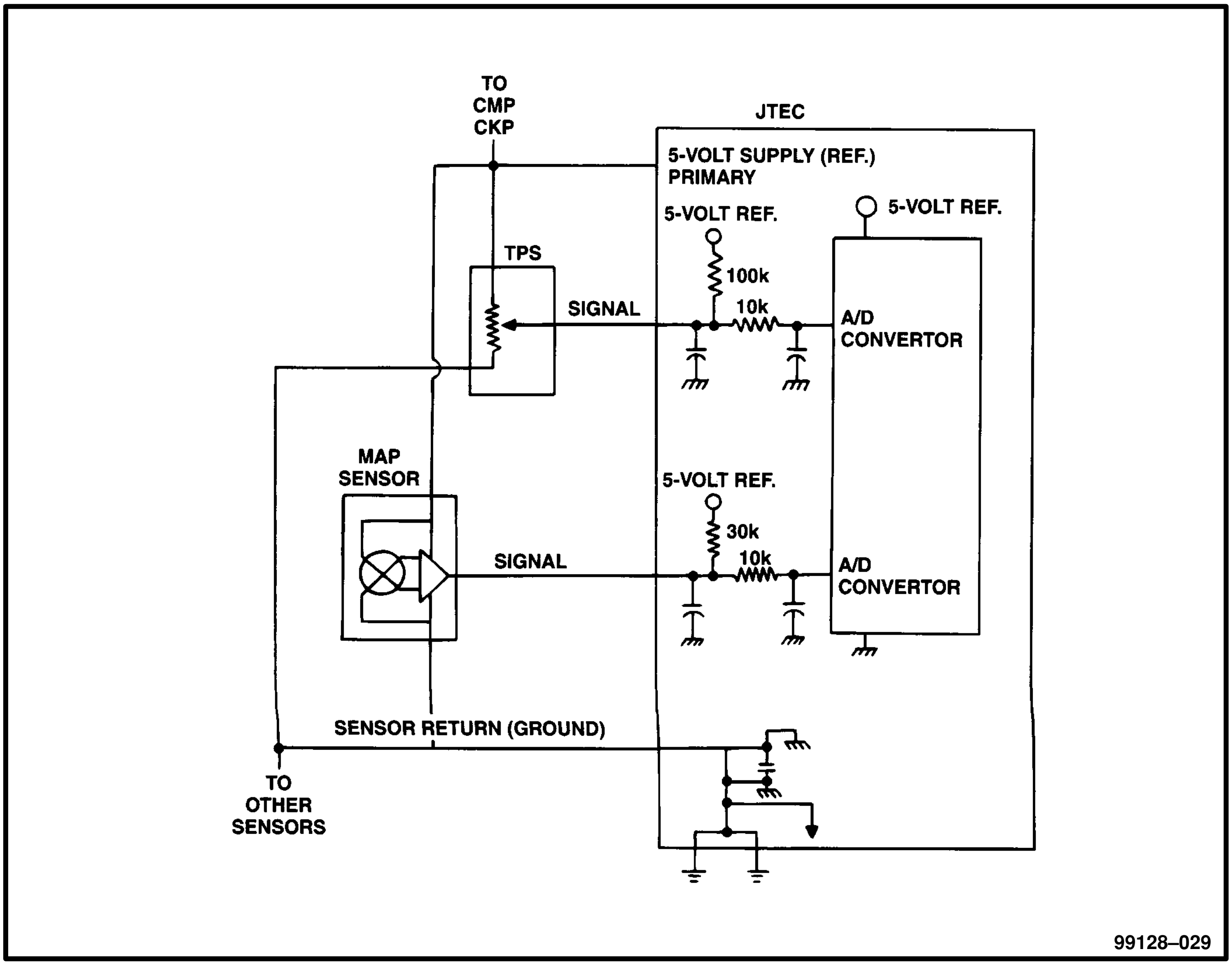


Figure 29 JTEC Manifold Absolute Pressure Sensor Circuit

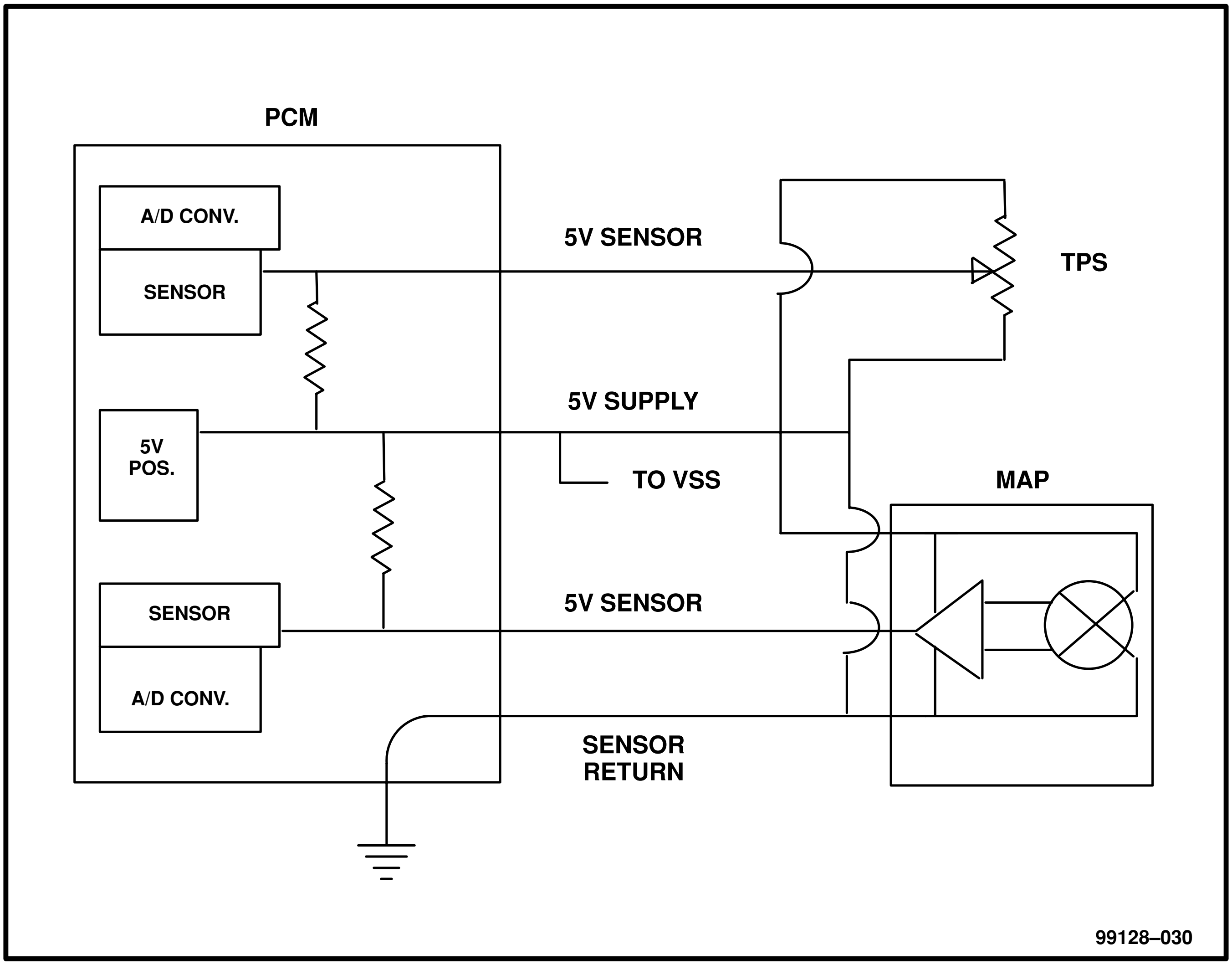


Figure 30 SBEC Manifold Absolute Pressure Sensor Circuit

The MAP Sensor input is the number one contributor to pulse width. An important function of the MAP Sensor is to determine barometric pressure (fig. 31). The PCM needs to know if the vehicle is at sea level, or in Denver at 5,000 feet above sea level, because the air density changes with altitude. It will also help to correct for varying weather conditions. This is important, because as air pressure changes, barometric pressure changes. Barometric pressure and altitude have a direct inverse correlation; as altitude goes up, barometric pressure goes down. The first thing that happens as the key is rolled on, before reaching the crank position, the PCM powers up, looks at the MAP voltage, and based upon the voltage it sees, it knows the current barometric pressure relative to altitude.

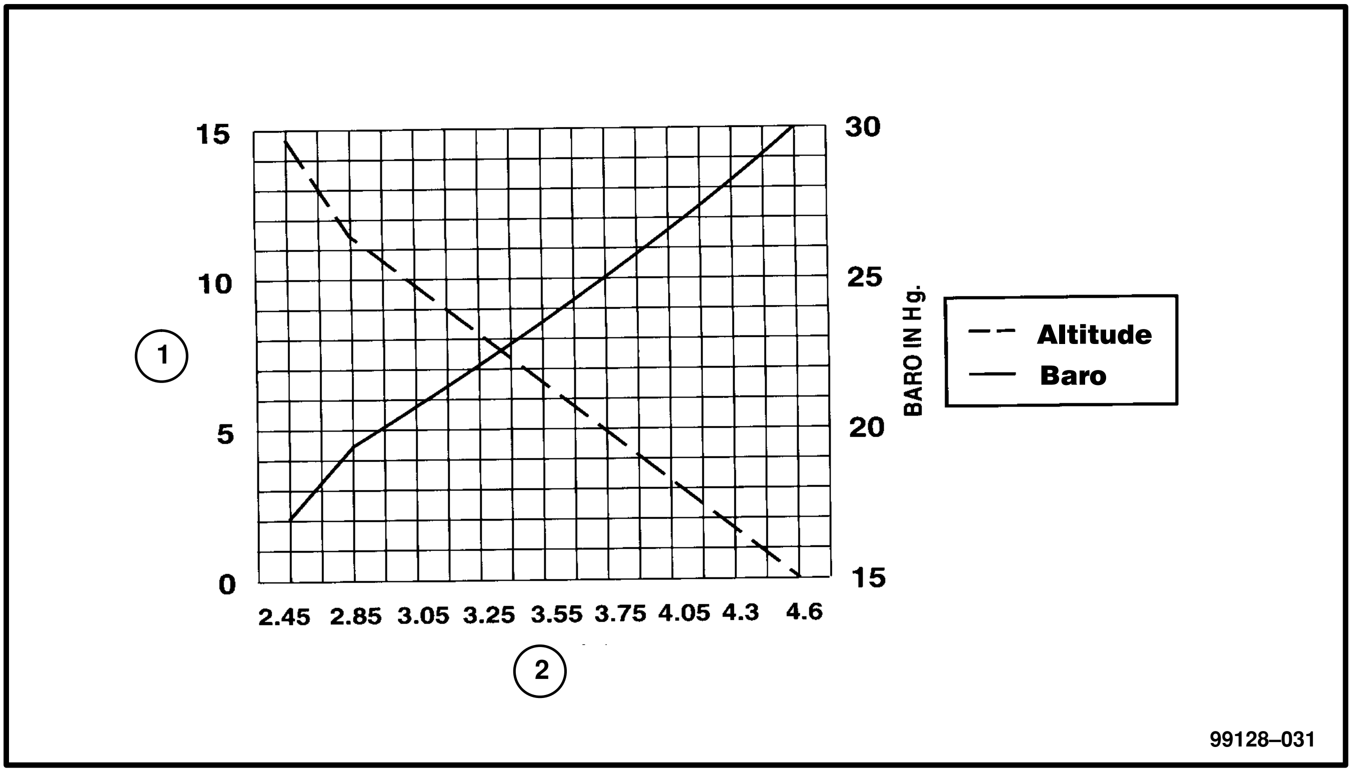


Figure 31 MAP Sensor Voltage Values

1	Altitude in Thousands	2	Voltage

Once the engine starts, the PCM looks at the voltage again at the trailing edge of the last slot on the current cylinder and the leading edge of the first slot of the next cylinder. These two values are added and then divided by 2 to get an average. It then averages these signals and compares the current voltage to what it was at key–ON. The difference between current voltage and what voltage was at key ON is manifold vacuum (fig. 32).

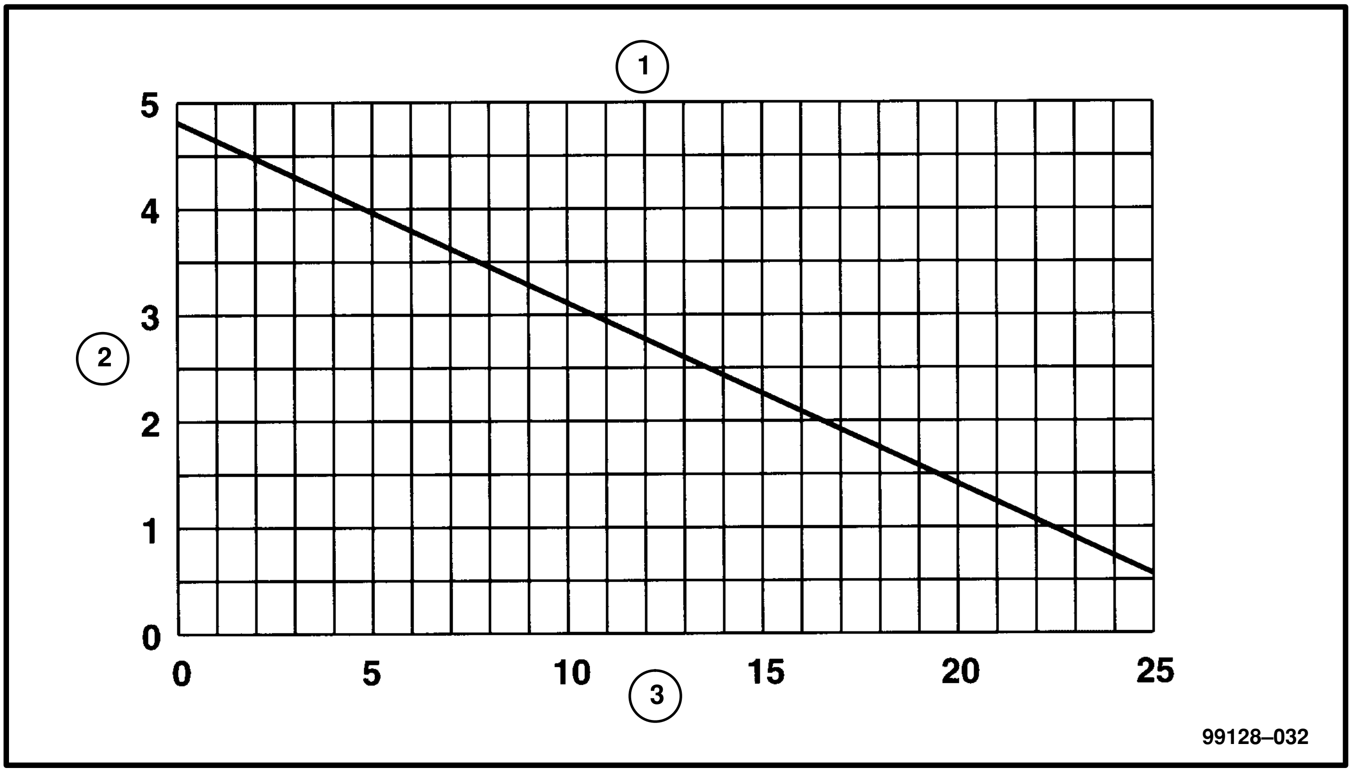


Figure 32 MAP Voltage vs. Vacuum

1	Done at 29.92 Baro at Sea Level	3	Vacuum
2	Voltage		

During key–ON (engine not running) the sensor reads (updates) barometric (Baro) pressure. A normal range can be obtained by monitoring a known valid sensor.

As the altitude increases, the air becomes thinner (less oxygen). If a vehicle is started and driven to a very different altitude than where it was at key ON, the barometric pressure must be updated. Anytime the PCM sees at least 1.8 volts above minimum TPS, and based upon rpm, it will update barometric pressure in the MAP memory cell. With periodic updates, the PCM can make its calculations more effectively. Also, if MAP is ever greater than Baro, such as coming down from a high altitude, Baro automatically updates.

The PCM uses the MAP Sensor to aid in calculating the following:

- Barometric pressure.
- Engine load.
- Manifold pressure.
- Injector pulse width.
- Spark–advance programs.
- IAC position.
- Deceleration fuel shutoff.

The PCM recognizes a decrease in manifold pressure by monitoring a decrease in voltage from the reading stored in the barometric pressure memory cell. The MAP Sensor is a linear sensor. As pressure changes, voltage changes proportionately. The range of voltage output from the sensor is usually between 4.6 volts at sea level to as low as 0.3 volt at 26 in. Hg. of manifold vacuum. Barometric pressure is the pressure exerted by the atmosphere upon an object. At sea level, on a standard day, with no storm, barometric pressure is 29.92 in. Hg. For every 100 feet of altitude, barometric pressure drops 0.10 in. Hg. A storm can either add (high pressure) or decrease (low pressure) from what should be present for that altitude. You should know the average pressure and corresponding barometric pressure for your area. Always use the Diagnostic Test Procedures Manual for MAP Sensor testing.

The MAP Sensor signal is provided from a single silicone piezoresistive element located in the center of a diaphragm. The element and diaphragm are both made of silicone. Pressure change moves the diaphragm, causing the element to deflect, which in turn stresses the silicone. When silicone is exposed to stress, its resistance changes. As manifold vacuum increases, the MAP Sensor input voltage decreases proportionally. The sensor also contains electronics that filters the signal and provides temperature compensation.

MAP Sensor Diagnostics

Note: *JTEC examples are given, SBEC are similar. Refer to the applicable Powertrain Diagnostic Manual or MDS2 for the vehicle you are servicing.*

There are three MAP Sensor diagnostic routines:

- MAP voltage too high (voltage is above 4.9 volts).
- MAP voltage too low (voltage below 2.35 volts at start–up or below 0.1 volt with engine running).
- No change in MAP voltage at start–to–run transfer.

With the engine running between 400 to 1,500 rpm, near closed throttle and MAP voltage is above 4.9 volts, the voltage high fault is set. Beginning with the 1997 model year, the MAP diagnostic range is 416 to 3,500 rpm.

There are two different ways to set the voltage low fault. If MAP voltage is below 2.35 volts at start–up, the fault will be set. The other is MAP voltage below O. 1 volt while the engine is running.

To set the rationality fault "no change in MAP from start to run", the PCM must detect too small a difference between engine MAP voltage running and Baro at key–ON. This is checked at all times. If rpm becomes close to idle speed and the throttle is closed, vacuum should be greater than a calibrated amount. If vacuum is not high, then a fault will be set.

MAP voltage is only looked at when the vehicle is near closed throttle and rpm is between approximately 400 to 1,500 rpm. This means that if a MAP sensor is faulty at an rpm above 1,500, the PCM will interpret whatever reading it gets from the MAP sensor as true. Beginning with the 1997 model year, the MAP diagnostic range is 416 to 3,500 rpm.

MAP Sensor Limp–In

The PCM stores a DTC when the MAP sensor malfunctions. When the PCM sets a DTC, the MAP sensor's information is considered inaccurate. At this point, the PCM moves into "limp–in" mode. Limp–in for the MAP sensor allows the engine to continue to function, without input to the PCM from the MAP. The PCM must calculate the amount of air being consumed by the engine, which is accomplished by calculating MAP values based upon readings from the CKP sensor (RPM) and the Throttle Position Sensor (TPS). Anytime the PCM sets a DTC for MAP, the Malfunction Indicator Light (MIL) is illuminated.

Component Locations

The MAP Sensor is located on the rear portion of the left intake manifold (fig. 33).

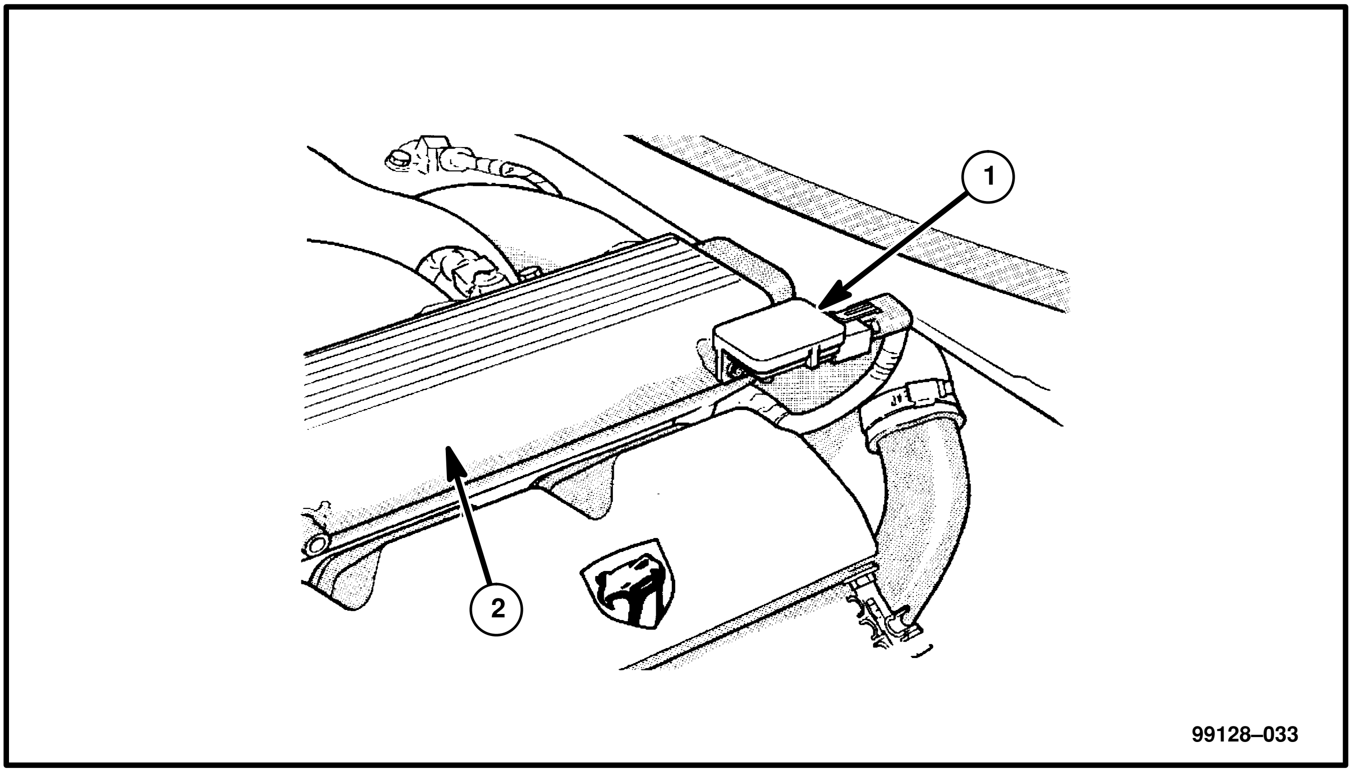


Figure 33 MAP Sensor Location

1	MAP Sensor	2	Intake Manifold

THROTTLE POSITION SENSOR (TPS)

The TPS is mounted to the side of the throttle body. The PCM needs to identify the actions of the throttle blade at all times to assist in performing the following calculations:

- Ignition timing advance.
- Fuel injection pulse–width.
- Idle (learned value or minimum TPS).
- Off–Idle (0.04 volt above minimum TPS) (0.06 volt for SBEC).
- Wide–Open Throttle (WOT) open loop (2.608 volts above learned idle voltage).
- Deceleration fuel lean–out.
- Fuel cutoff during cranking at WOT (2.608 volts above learned idle voltage).

The PCM supplies the TPS with a regulated voltage that ranges from 4.8 to 5. 1 volts (figs. 34 & 35). On SBEC, the regulated output voltage is the same voltage that the MAP Sensor uses. On JTEC, the 5–volt reference (primary) is the same voltage that the MAP, CMP, and CKP Sensors use. The TPS receives its ground from the PCM. The input of the TPS to the PCM is through a 5–volt sensor circuit.

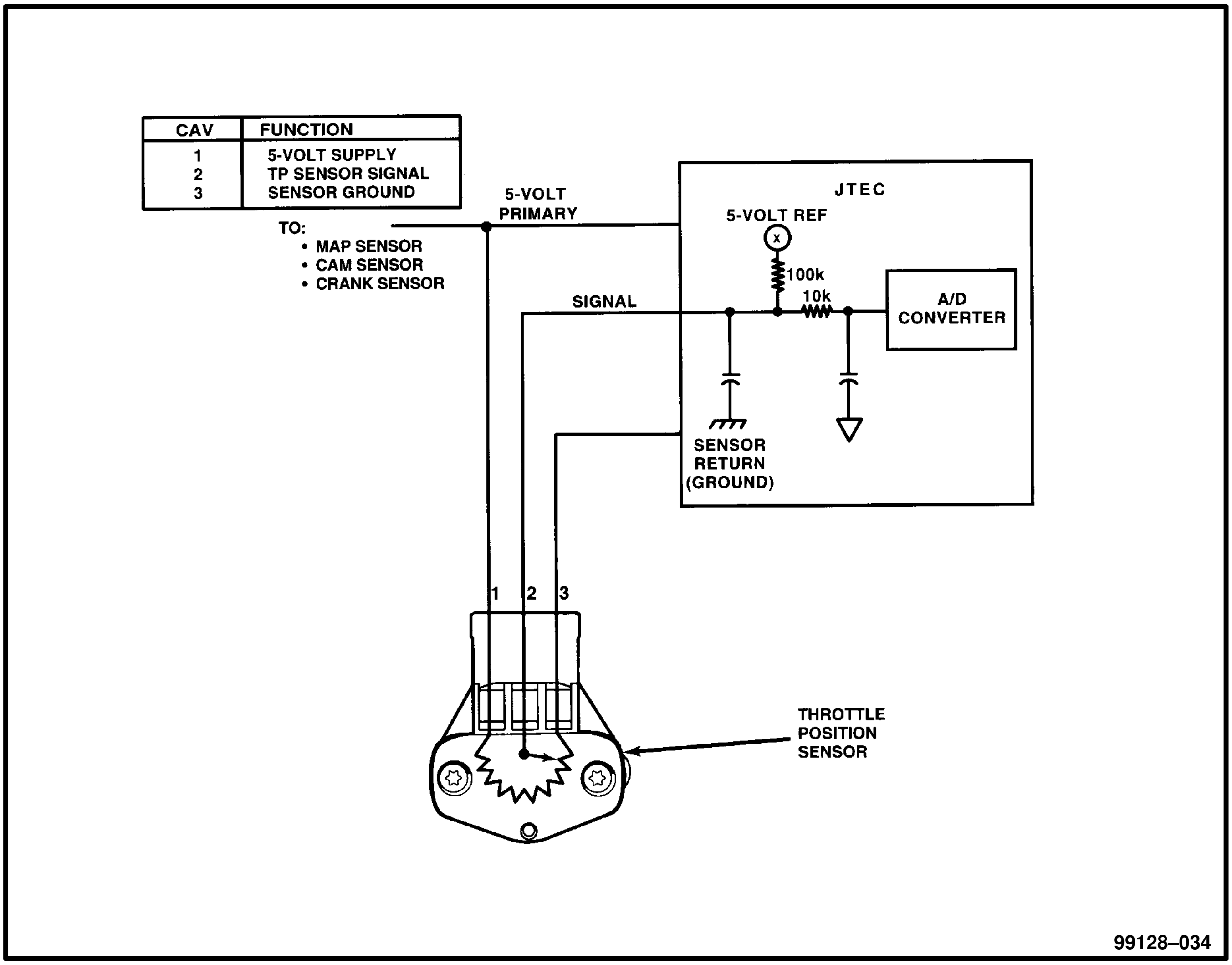


Figure 34 JTEC Throttle Position Sensor Circuit

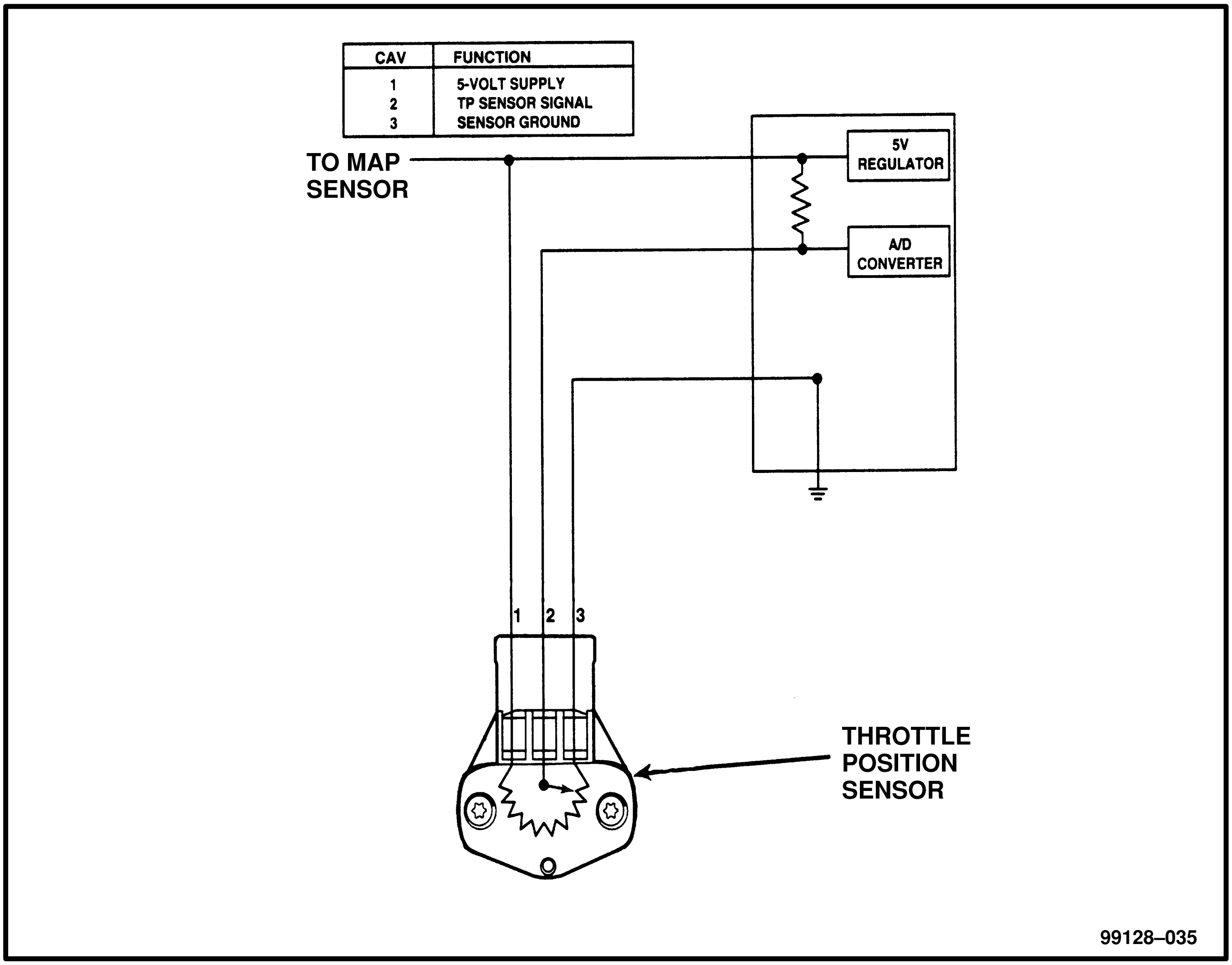


Figure 35 SBEC Throttle Position Sensor

TPS PROGRAMS

Idle

As with other Chrysler fuel–injection systems, the PCM is able to recognize an idle command based upon inputs from the TPS. Also, like other Chrysler systems, the PCM is programmed to monitor the TPS signal whenever the key is ON. While the key is ON and the engine is running, the PCM assumes that the lowest voltage it can receive, above the fault threshold, must be where the throttle blade lever hits the idle stop. Normally, this voltage range is approximately 0.5–1.0 volt. At the low–voltage position, the PCM records the signal as “idle,” better known as “minimum TPS.”

The PCM’s memory is updated anytime the sensed voltage is less than the recorded value in the memory cell. The PCM uses voltage change to determine when the throttle has returned to the previously learned value. At key ON, the PCM will raise the target voltage value in the TPS Min idle memory cell by approximately 0.04 of a volt. This new value becomes the new minimum TPS. When the engine is started, if the actual TPS voltage is lower than the new memory value, the PCM will store actual as minimum TPS.

Note: *JTEC examples given; SBEC similar.*

If the key is cycled ON without starting the engine (start–to–run transfer), the value in target memory will increase up to a maximum of approximately 1.0 volt. Once the maximum is reached, the voltage will automatically drop to approximately 0.86 volt. At the next key–on it will increment 0.04 volt and will stay in this loop until it can learn a new actual minimum with the engine running. Limiting the upper threshold of minimum TPS reduces the chance that minimum TPS would get so high that the clear flood function would not work.

Anytime the PCM receives the idle voltage signal, the PCM is programmed to maintain target idle, using timing and the Idle Air Control (IAC) motor. Idle speed may vary, based on ECT.

Spark advance curves and injection pulse–width programs are unique as they are specifically calibrated for idle conditions.

Off–Idle

Once the throttle is opened, the PCM moves into its off–idle program at approximately 0.04 volt above minimum TPS. At this point, spark scatter advance is no longer being used to control idle speed. The IAC motor has been repositioned to act like a dashpot. The dashpot function operates the IAC motor, to prevent the possibility of the engine dying out during a sudden deceleration. So, if the throttle blade is actually closed but the TPS voltage did not drop to minimum TPS (dirty throttle body), idle quality will be poor: minimum TPS with engine running cannot be learned upward (higher voltage than minimum TPS to .04). Only a lower voltage can be learned.

Acceleration

A rapid rise in TPS voltage within a specified time frame causes the injector pulse width to increase. The amount of pulse width increase is determined by the rate of voltage rise. For maximum response, the PCM will momentarily increase the pulse width for all the injectors.

Wide Open Throttle (WOT)

With the engine running, the PCM spark–advance and fuel pulse–width programs are affected during WOT conditions. The PCM is programmed to go into open loop anytime the TPS voltage exceeds 2.7 volts (80% throttle blade) above minimum idle. This enables the PCM to enrich the air/fuel ratio at WOT to allow the combustion chamber to run a little cooler.

Deceleration

Under deceleration, the PCM is programmed to “lean out” the air/fuel ratio, since engine power is not needed. One of the main components involved with the deceleration program is the TPS. If, while the vehicle is in motion (based on the Vehicle Speed Sensor), the TPS is closed, and manifold vacuum is high, the PCM narrows the pulse width, so that the air/fuel ratio becomes leaner. In some instances, the pulse width goes to 0.0 msec., at which time no fuel is supplied to the engine. This action causes extremely low vehicle emissions. During deceleration, the adaptive numerator is updated, as there is no load on the crankshaft. The adaptive numerator is explained in detail in the On Board Diagnostics II Student Workbook.

Wide Open Throttle Fuel Cut–Off During Cranking

One last function that the PCM performs from inputs delivered by the TPS is the WOT fuel cut–off while cranking. To ensure short cranking times, the PCM fires all of the injectors simultaneously once during cranking. After that, the PCM waits two revolutions, then fires the injectors sequentially. If the programmed pulse width allows too much fuel into the combustion chamber, or if circumstances do not allow the engine to start up with the programmed quantity of fuel, the driver can operate the accelerator pedal to WOT, so the PCM de–energizes all injectors. This program occurs only during cranking, and when the TPS voltage exceeds 2.4 volts above minimum TPS.

TPS Diagnostics

Note: JTEC examples given, SBEC similar.

There are three TPS diagnostic routines:

- TPS voltage high (above 4.9 volts)
- TPS voltage low (below 0.1 volts)
- TPS voltage does not agree with MAP

The diagnostic routine “TPS voltage low” is set when TPS voltage is below 0.1 volt and engine speed is greater than 1500 rpm. The “TPS voltage high” routine is set when TPS voltage is above 4.9 volts and engine rpm is as follows: above 1500 rpm for 1996, or between 416–3500 rpm for 1997. The diagnostic routine: “TPS voltage does not agree with MAP” fault is set when the PCM interprets the MAP indication as a load condition that does not agree with what the TPS indicates. This can occur in two ways: TPS voltage less than 1.16 volts with vacuum less than 2 in., or TPS voltage more than 2.16 volts and vacuum greater than 11.8 in.

TPS Limp–In

When the TPS indicates a voltage that is too low, too high or not believable, the PCM sets a DTC. When the DTC is set, the MIL is illuminated and the PCM moves into limp–in mode. Limp–in for the TPS is divided into three categories: idle, part–throttle and WOT. These limp–in values are mainly rpm–based, although the MAP sensor has an input to the program. Refer to the Diagnostic Test Procedures Manual for complete diagnostic information.

NOTES:

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

On lightweight engines, the ECT is located on the front of the driver side cylinder head, just beneath the left throttle body (fig. 36). On heavyweight engines, the ECT is located below the rear of the intake manifold near the thermostat housing (fig. 37).

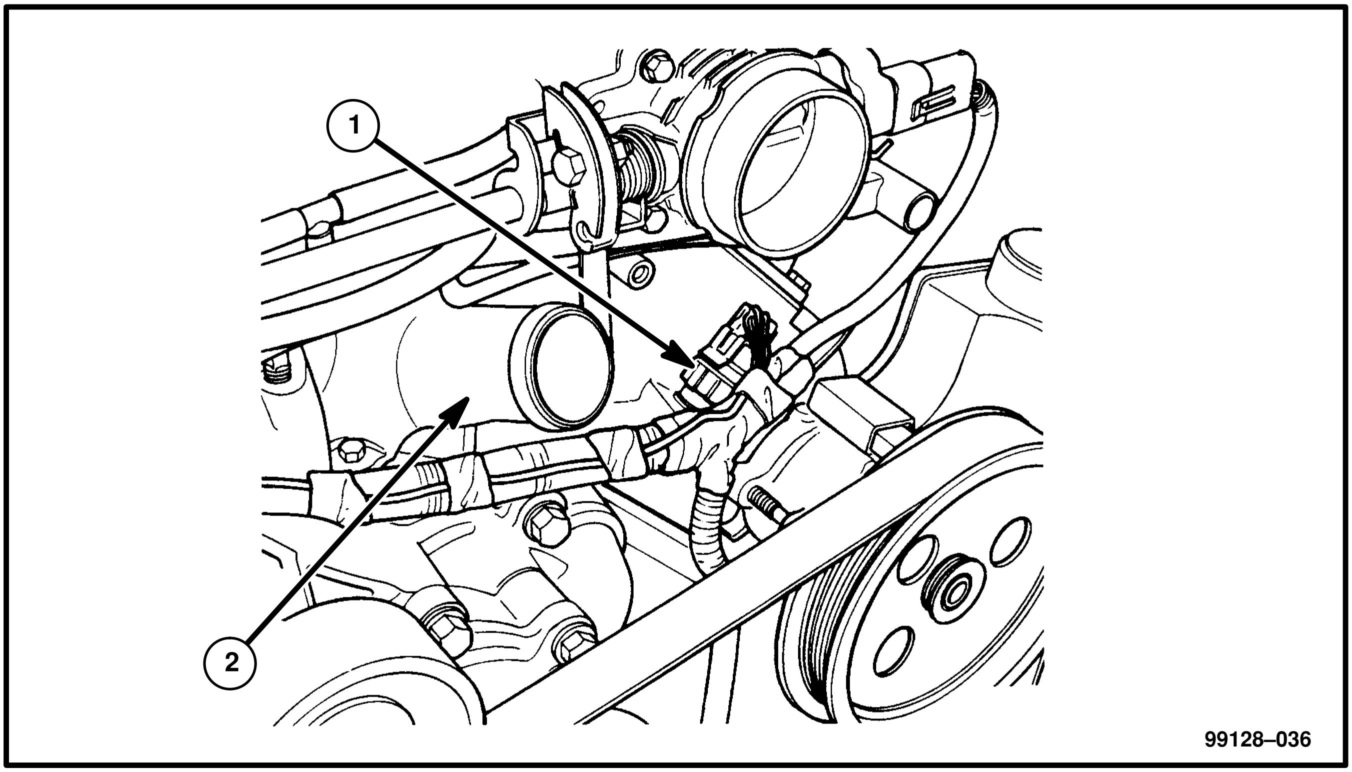


Figure 36 Lightweight ECT Location

1	ECT Sensor	2	Thermostat Housing

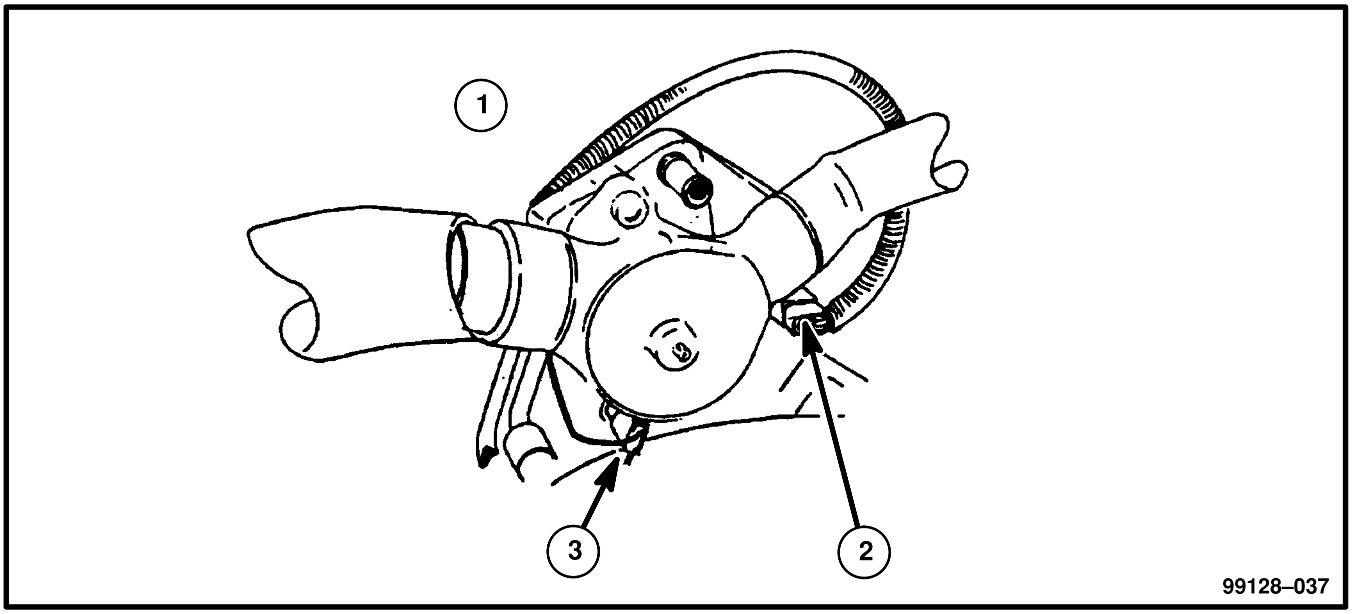


Figure 37 Heavyweight ECT Location

1	Rear of Engine	3	Temperature Gauge Sensor
2	ECT Sensor		

The PCM uses inputs from the ECT sensor to calculate:

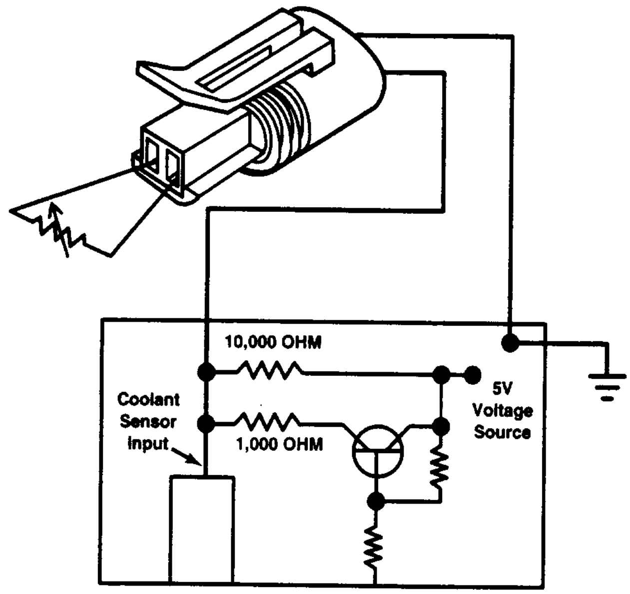
- Injector pulse width
- Spark–advance curves
- Fuel Pump Relay Latch Times (SBEC only)
- Idle Air Control (IAC) motor key–on steps
- Initial fuel injection
- O2 Sensor closed–loop times (30° and above)
- Purge solenoid on/off times
- Radiator fan relay on/off points
- Target idle speed

The ECT input is the second most powerful modifier of injector pulse width. The ECT Sensor is a Negative Thermal Coefficient (NTC) sensor. The PCM sends five volts to the sensor, and is grounded through the sensor return line (fig. 38). As temperature increases, resistance in the sensor decreases (fig. 39).

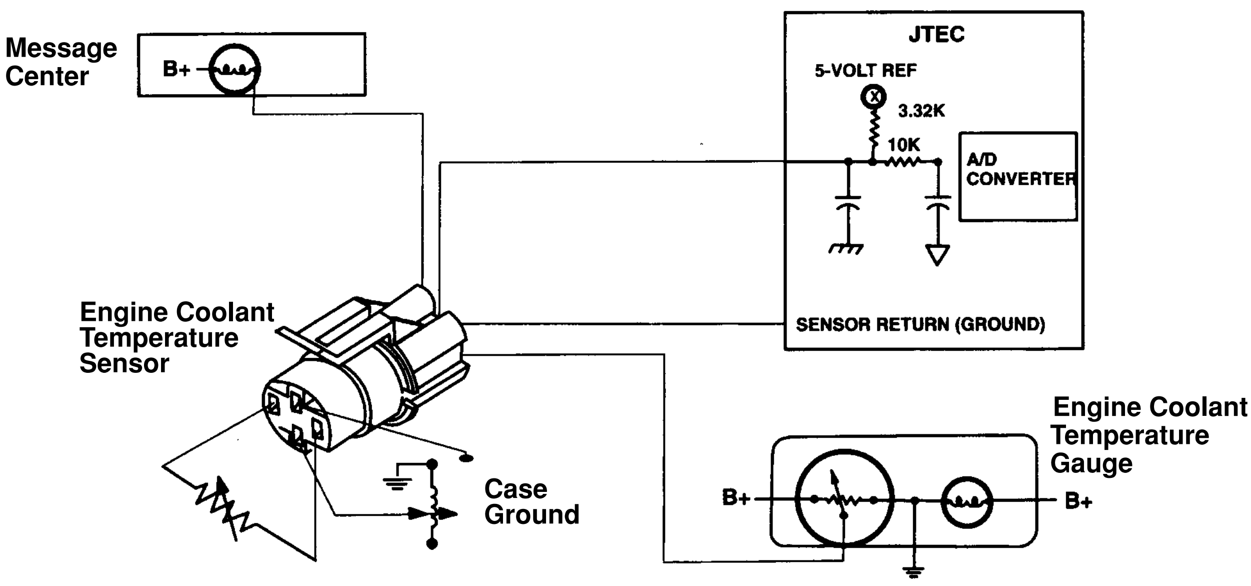
As the temperature goes up, the voltage drop increases, which causes a lower voltage at the A/D converter. Unlike SBEC, the JTEC ECT is not a dual–ranging circuit.

1996 Coupe/1997–2000 All

The ECT Sensor on these vehicles is a 4 wire sensor located in the front of the driver side cylinder head. Two wires are for the gauge and two for the sensor input to the PCM. This sensor is used as a PCM input, a message center input for the dashboard warning light, and for the water temperature gauge.



SBEC



JTEC

99128–038

Figure 38 Engine Coolant Temperature Sensor Circuits (SBEC and JTEC)

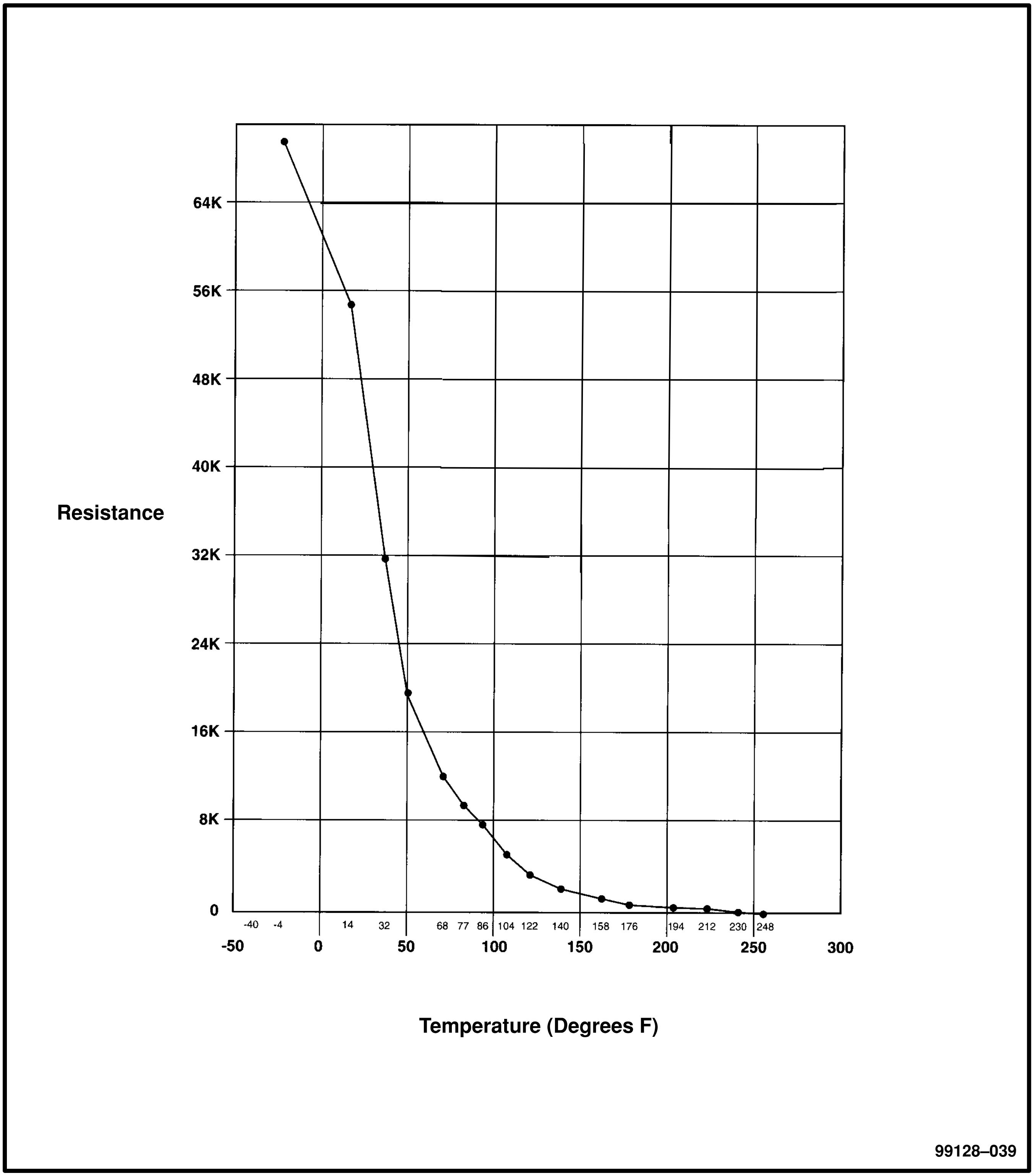


Figure 39 ECT/IAT Temperature/Resistance Curve (SBEC & JTEC)

ECT Operation

As the temperature of the coolant goes up, the voltage drop increases, which causes a lower voltage at the A/D converter (fig. 40). Unlike previous years (SBEC), this is not a dual–range circuit.

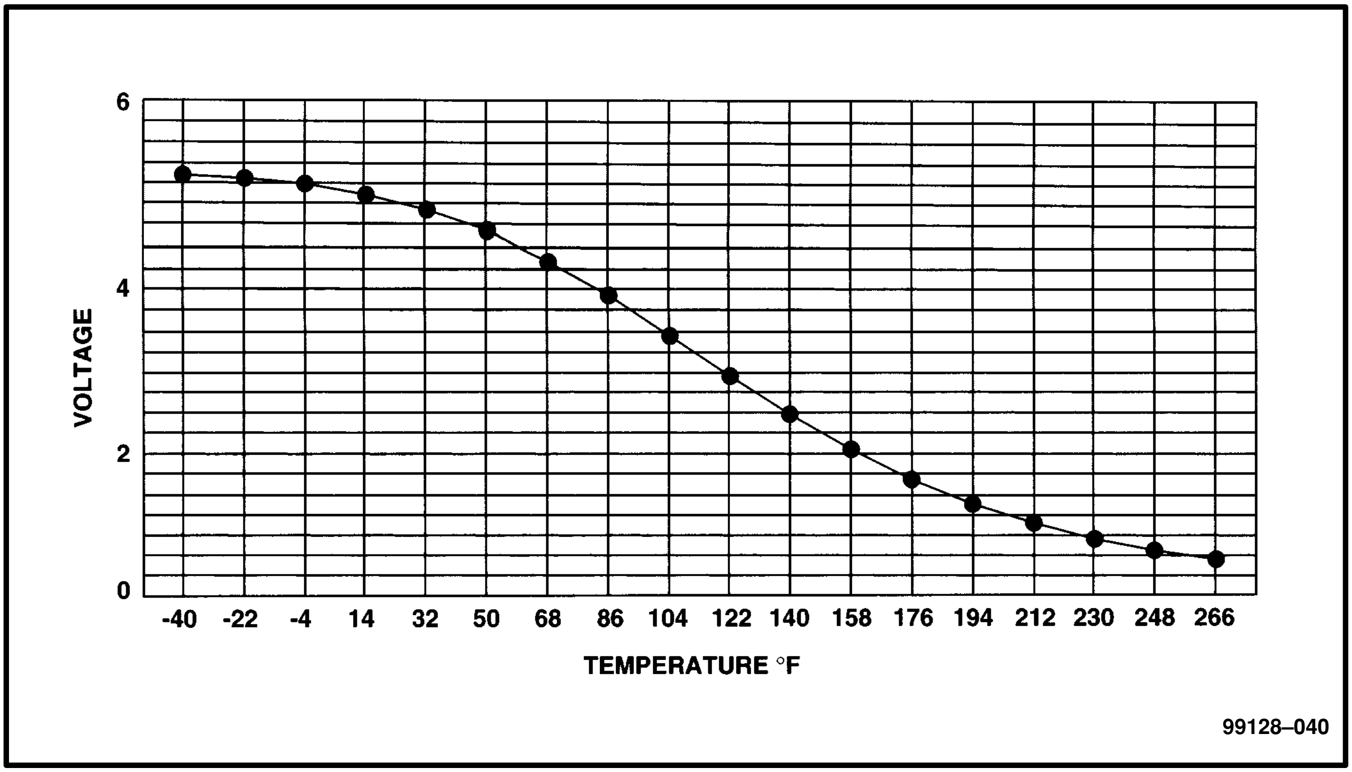


Figure 40 JTEC ECT/IAT Temperature/Voltage Curve

The SBEC PCM has a dual temperature–range program for better sensor accuracy at cold temperatures. At key–ON, the PCM sends a regulated 5–volt signal through a 10,000 ohm resistor to the ECT Sensor. The A/D converter monitors the voltage signal as it passes through the ECT Sensor to ground. The A/D converter registers the voltage drop across the ECT Sensor and then converts the signal into a binary code. When the voltage drop reaches approximately 1.25 volts, the PCM turns on a transistor. The transistor connects a 1,000 ohm resistor in parallel with the 10,000 ohm resistor. With this drop in resistance, the A/D converter recognizes an increase in voltage on the input circuit (fig. 41). The program allows the PCM to have a full binary control at cold temperatures up to approximately 120° F, and a second full binary control at temperatures over 120° F.

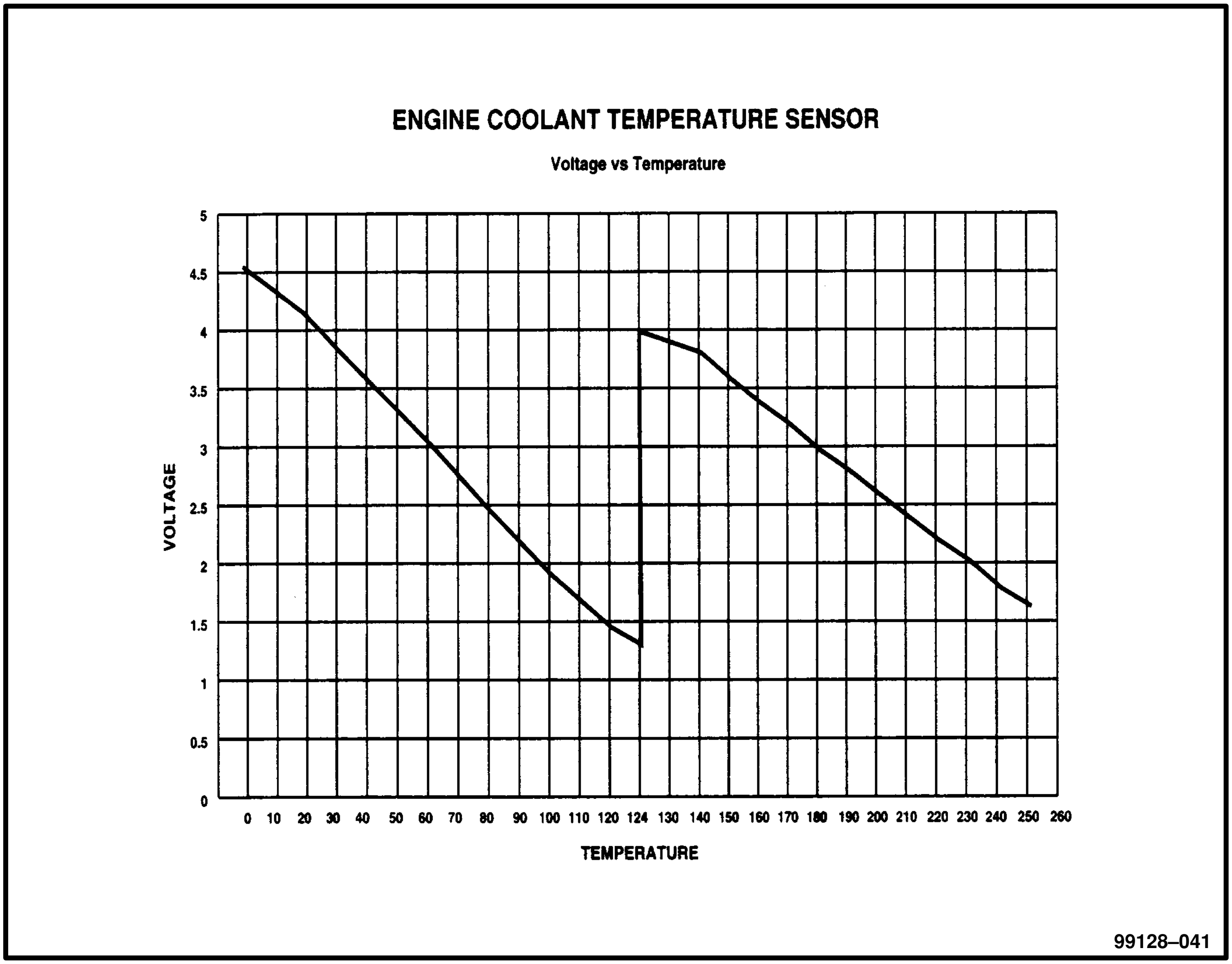


Figure 41 SBEC ECT/IAT Sensor Dual Range

At key–ON, the PCM assumes a cold engine. 5 volts is sent through the 10,000 ohm resistor out to the sensor element to ground. If the engine is cold, the resistance of the element is high, and thus there is very little voltage drop through the thermister and the corresponding sensed voltage is high. If the sensed voltage at key–ON is low, this indicates it could either be a warm engine or a short in the circuit. A transistor is turned on, adding a 1,000 ohm resistor in parallel to the 10,000 ohm resistor. Using ohms law for parallel circuits gives us a new total resistance of 909 ohms. By changing the known resistance and checking sensed voltage if the voltage increases, then the sensor is hot. If the voltage fails to increase then there is a short, and the PCM will set a fault.

This dual–ranging is done because the sensor covers a range of 300° F. The PCM requires an accuracy that cannot be achieved using a 5–volt signal with one sensor for this wide range. Therefore, this dual–curve programming allows us to get the necessary resolution using one sensor.

ECT Sensor Diagnostics

There are four ECT diagnostic routines:

- ECT Too High is set when voltage is above 4.9 volts for 3 seconds.
- ECT Too Low is set when voltage is below 0.08 volt for 3 seconds.
- ECT Too–Cold, Too–Long Fault is set when the ECT is between 19° and 212° F at start–up and the engine runs for 14 minutes under any condition, then runs another 14 minutes above 28 mph and ECT does not reach 160° F.
- (JTEC only) The closed loop temperature not reached, fault is set when the engine fails to reach a calibrated (approximately 50° F) temperature within approximately five minutes.

The two rationality faults (ECT too–cold too–long and closed–loop temperature not reached) will turn the “Check Engine” light on if the fault is present for two trips. For more information, refer to the OBD II course.

ECT Sensor Limp–In

When the ECT Sensor indicates voltage that is too high or too low, the PCM sets a DTC. When a DTC is set, the Mil is illuminated and the PCM moves into limp–in mode. Limp–in mode for the ECT Sensor is a preset value and the radiator fan operates at high speed.

NOTES:

INTAKE AIR TEMPERATURE (IAT) SENSOR

The IAT Sensor is located on the engine air cleaner (fig. 42). The IAT Sensor measures the temperature of the air that is about to enter the intake manifold through the air cleaner housing.

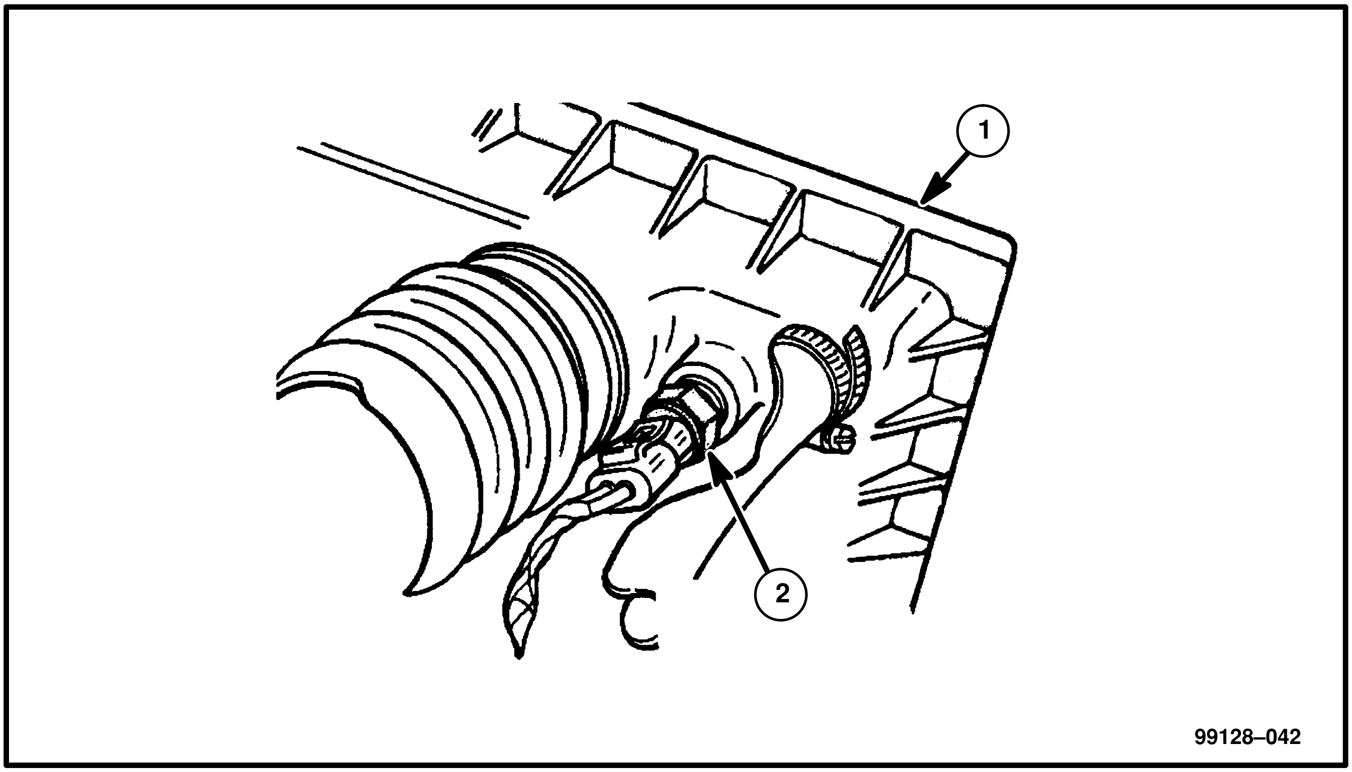


Figure 42 IAT Sensor Location

1	Air Cleaner Housing	2	IAT Sensor

The IAT Sensor sends information to the PCM on the density of the air entering the manifold, based upon temperature. The PCM uses this input to calculate:

- Injector pulse width
- ·Adjustment of spark timing (to prevent knock with high–intake air temperatures)

The IAT Sensor exerts more control at cold temperatures and during wide–open throttle (high rpm, low manifold vacuum). At a temperature of –20°F and wide–open throttle, the PCM can increase fuel injector pulse width by as much as 37%, based upon input from the IAT Sensor.

The PCM sends 5 volts to the sensor and is grounded through the sensor return line (figs. 43 & 44). As temperature increases, resistance in the sensor decreases. The resistance of the IAT Sensor is the same as for the ECT Sensor.

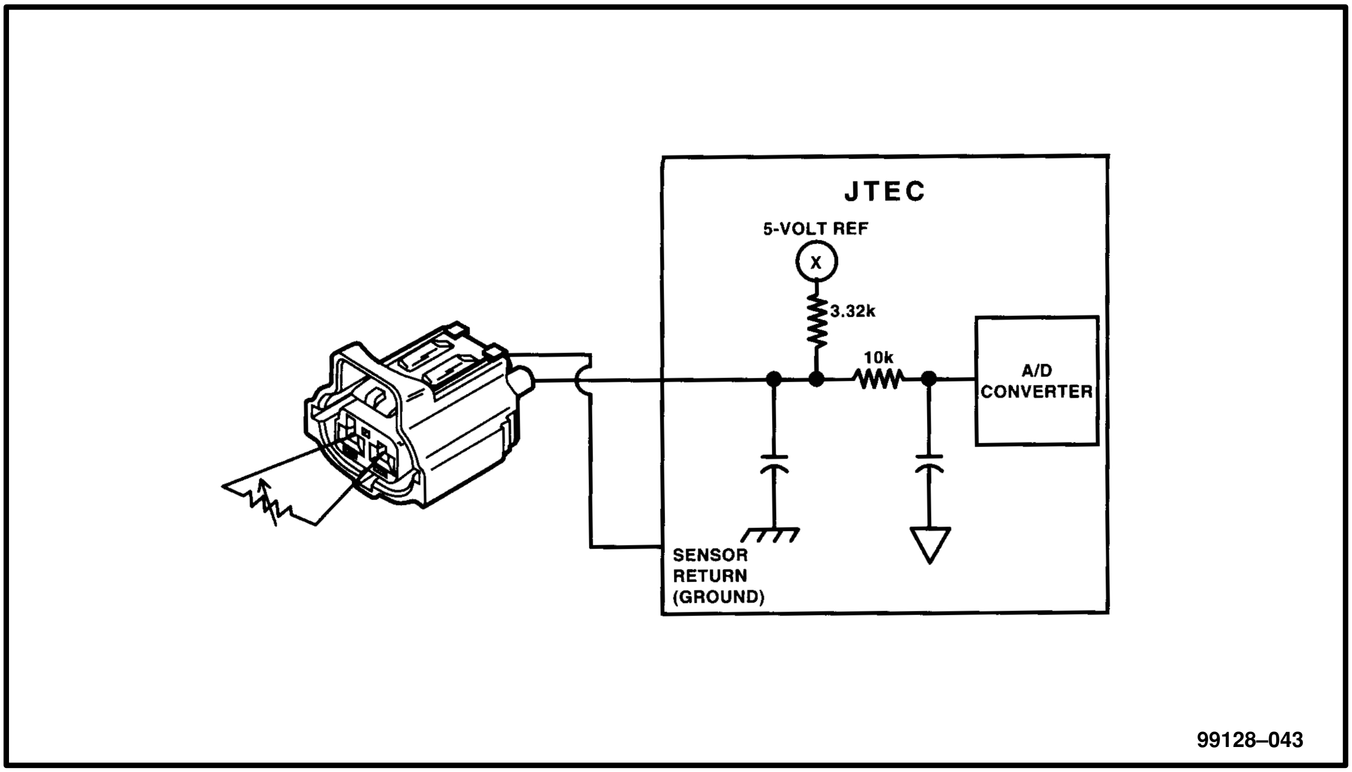


Figure 43 JTEC Intake Air Temperature Sensor Circuit

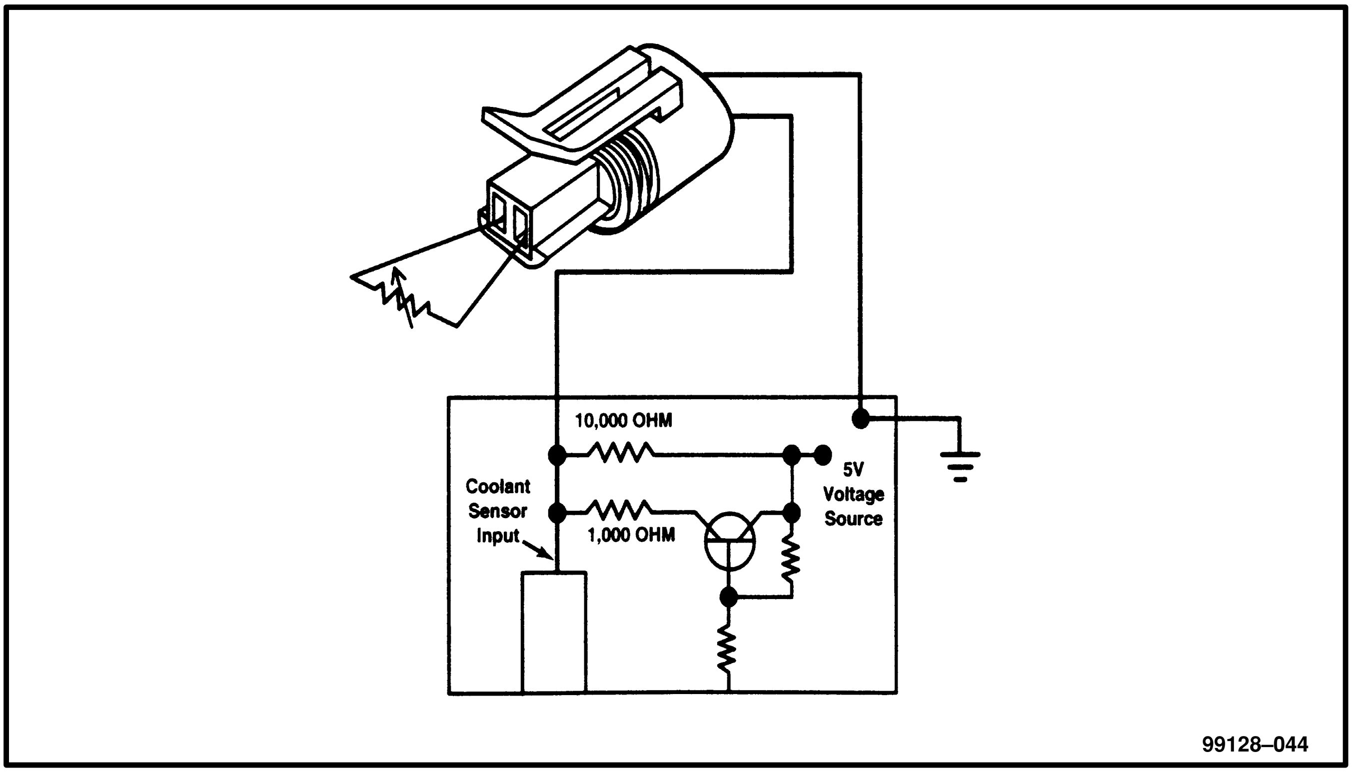


Figure 44 SBEC Intake Air Temperature Sensor Circuit

SBEC IAT Operation

The SBEC PCM has a dual temperature–range program for better sensor accuracy at cold temperatures. At key–ON, the PCM sends a regulated 5–volt signal through a 10,000 ohm resistor to the IAT Sensor. The A/D converter monitors the voltage signal as it passes through the IAT Sensor to ground. The A/D converter registers the voltage drop across the IAT Sensor and then converts the signal into a binary code. When the voltage drop reaches approximately 1.25 volts, the PCM turns on a transistor. The transistor connects a 1,000 ohm resistor in parallel with the 10,000 ohm resistor. With this drop in resistance, the A/D converter recognizes an increase in voltage on the input circuit. The program allows the PCM to have a full binary control at cold temperatures up to approximately 120° F, and a second full binary control at temperatures over 120° F.

At key–ON, the PCM assumes a cold engine. 5 volts is sent through the 10,000 ohm resistor out to the sensor element to ground. If the engine is cold, the resistance of the element is high, and thus there is very little voltage drop through the thermister and the corresponding sensed voltage is high. If the sensed voltage at key–ON is low, this indicates it could either be a warm engine or a short in the circuit. A transistor is turned on, adding a 1,000 ohm resistor in parallel to the 10,000 ohm resistor. Using ohms law for parallel circuits gives us a new total resistance of 909 ohms. By changing the known resistance and checking sensed voltage, if the voltage increases then the sensor is hot. If the voltage fails to increase then there is a short, and the PCM will set a fault.

IAT Sensor Diagnostics

- Voltage Too Low is set when voltage is below 0.1 volt
- Voltage Too High is set when voltage is above 4.9 volts

IAT Sensor Limp–In

When the IAT Sensor indicates voltage that is too high or too low, the PCM sets a DTC. When the DTC is set, the MIL is illuminated and the PCM moves into limp–in mode. The IAT Sensor uses the BTS information, as long as the information is believed to be accurate. If the BTS is already in limp–in, the PCM uses a temperature that has very little effect on fuel and spark programming.

SENSED BATTERY VOLTAGE

The direct battery circuit to the PCM is also used as a reference point to sense battery voltage.

Fuel Injectors

Fuel injectors are rated for operation at a specific voltage. If the voltage increases, the plunger will open faster and further. Conversely, if voltage is low, the injector will open slowly and not as far. Therefore, if sensed battery voltage drops, the PCM will increase pulse width to maintain the same volume of fuel through the injector.

Charging – 1996 Coupe/1997–2000 All

The PCM uses sensed battery voltage to verify that target charging voltage (determined by Battery Temperature Sensor) is being reached. To maintain the target charging voltage, the PCM will full–field the generator to 0.5 volt above target, then turn off to 0.5 volt below target. This will continue to occur at a rate of up to a 100Hz frequency, 100 times per second.

Charging – 1996 Viper Roadster

The charging system is turned on and off with the Ignition Switch. The amount of DC current produced by the generator is controlled by the voltage regulator contained within the generator. The circuitry is connected in series with the second rotor field terminal and ground.

Note: *Externally, the generators on the 1996 Viper look very similar. The generator for the Roadster has an internal voltage regulator while the Coupe is regulated by the PCM. Do not interchange the generators.*

OXYGEN (O2) SENSORS

General Information

V10 engines use an O2 Sensor for each bank. An O2 Sensor provides the PCM with a voltage signal (0–1 volt) inversely proportional to the amount of oxygen in the exhaust. In other words, if oxygen content is low, voltage output is high and vice versa. This information allows the PCM to adjust injector pulse width to achieve the air/fuel ratio necessary for proper engine operation and to control emissions.

An O2 Sensor must have a source of oxygen from outside of the exhaust stream for comparison. Current O2 Sensors receive their fresh oxygen (outside air) supply through the wire harness (fig. 45). This is why it is important to never solder an O2 Sensor connector, or pack the connector with grease.

From 1992–1995, Viper vehicles were equipped with SBEC PCMs and upstream O2 Sensors only. These vehicles were not OBD II compliant. Starting in 1996, vehicles were equipped with a JTEC PCM and downstream O2 Sensors, allowing them to conform to OBD II standards.

Note: *Information in the following pages that refers to downstream O2 Sensors refers to 1996 and later vehicles.*

The downstream sensor, located after the catalytic converter, produces an input signal similar to that of an upstream sensor, that the PCM uses to verify catalytic converter efficiency, as part of required OBD II diagnostics.

Both O2 Sensors are zirconium dioxide, four–wire, and heated. The heaters on both sensors are fed battery voltage from the ASD Relay, which is also controlled by the PCM (refer to ASD Relay for more information). Both sensor heaters use a common ground. One of the other two wires is the input to the PCM and the last wire is the sensor ground. Both circuits are isolated from each other and the sensor housing.

The O2 Sensor uses a Positive Thermal Coefficient (PTC) heater element. As temperature increases, resistance increases. At ambient temperatures around 70° F, the resistance of the heating element is approximately 6 ohms. As sensor temperature increases, resistance in the heater element increases. Even though these are heating elements, current flow is low. At 70° F, current flow is approximately 1.5 amps. As it approaches operating temperature, it drops to approximately 200 milliamps. This allows the heater to maintain the optimum operating temperature of approximately 1400°–1500° F. Although both sensors operate the same, physical differences, due to the environment in which they operate, keep them from being interchangeable.

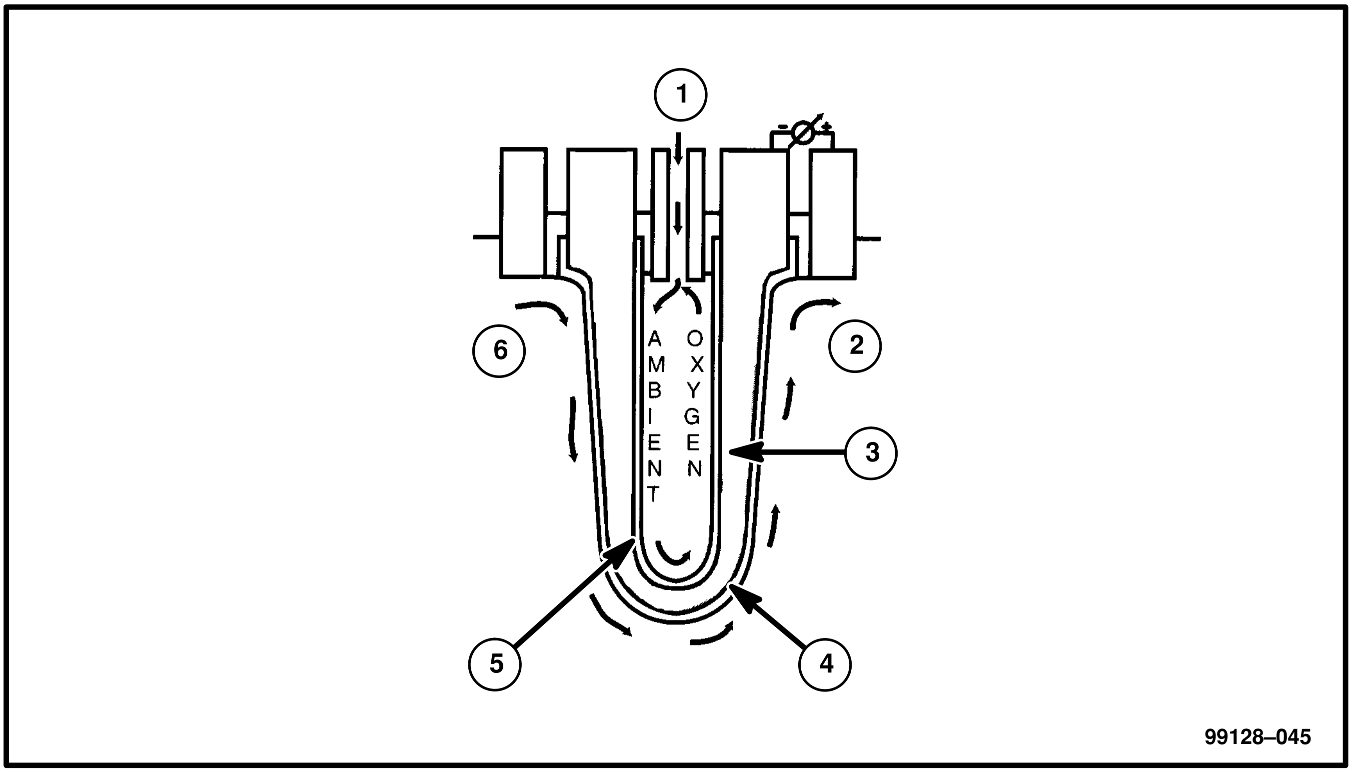


Figure 45 Oxygen Sensor Internal Operation

1	Outside Air	4	Outer Electrode
2	Exhaust Oxygen	5	Inner Electrode
3	Solid Electrolyte	6	Exhaust Oxygen

Stoichiometric Ratio

Engineers found they could maximize catalyst efficiency to a point that would minimize hydrocarbon, carbon monoxide and oxides of nitrogen emissions by controlling the air/fuel ratio. This (optimum) air/fuel ratio is 14.7 to 1 (ideal for both fuel efficiency and emission control). In other words, 14.7 units of air are mixed with every unit of fuel, to produce the minimum amount of emissions. The 14.7 to 1 ratio is called the stoichiometric (stoy–key–oh–met–rick) ratio (fig, 46).

However, conditions inside an engine's combustion chamber are not ideal. There just is not enough time in the engine's operating cycle to allow complete combustion to take place. So, even with a stoichiometric ratio, the engine's exhaust gases contain a certain percentage of pollutants in the form of HC and CO. The severe conditions (principally high temperatures) inside the combustion chamber cause some of the free oxygen and nitrogen in the air/fuel mixture to combine, forming various oxides of nitrogen (NOx). All things considered, the stoichiometric ratio is the optimum air/fuel ratio, for minimizing undesirable emissions.

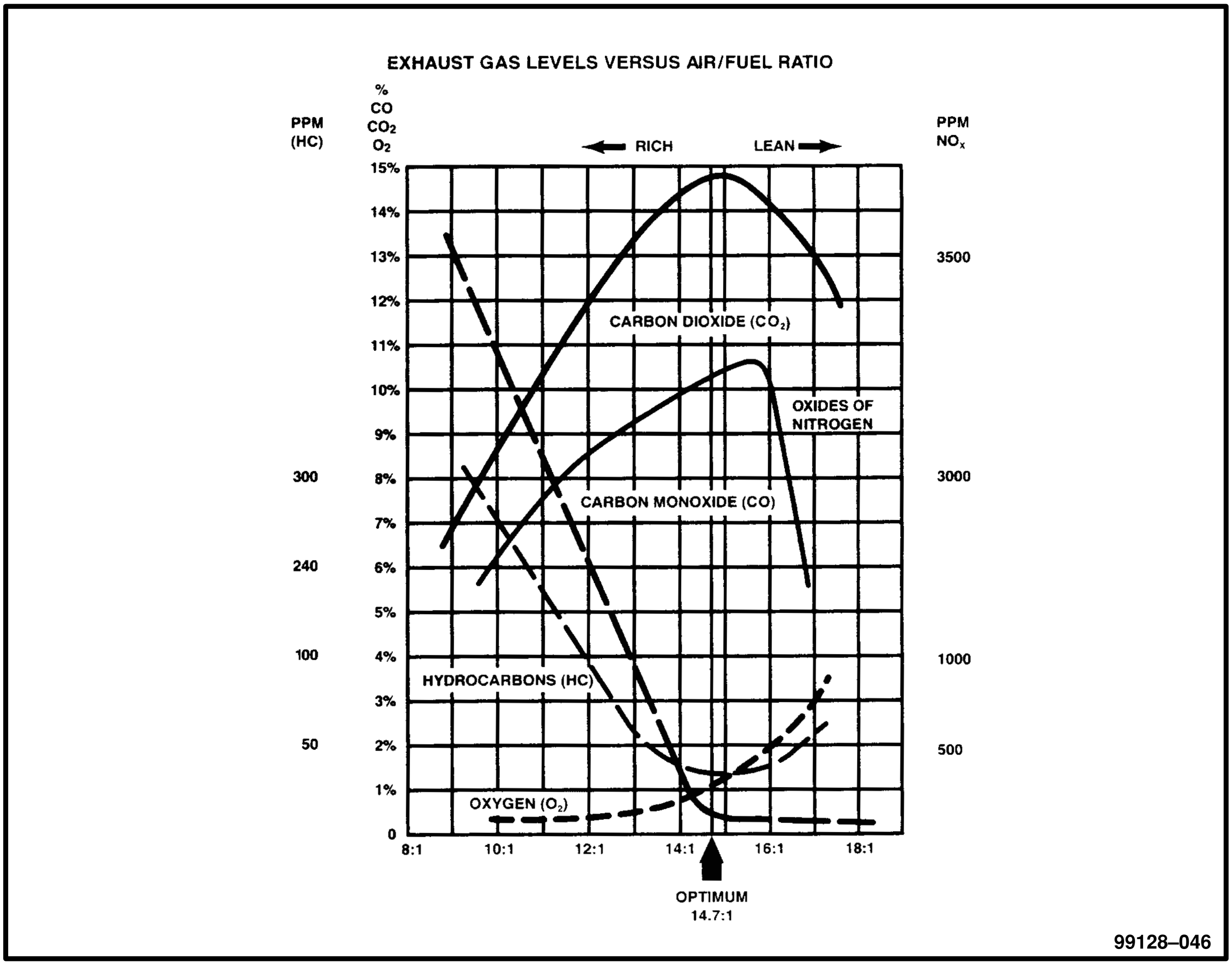


Figure 46 Exhaust Emissions vs. Air/Fuel Ratio

NOTES:

Catalyst

The latest technology provides the use of a three–way catalytic converter on most automobiles. The three–way catalyst simultaneously converts three harmful exhaust emissions into harmless gases. Specifically, HC and CO emissions are converted into water (H_2O) and carbon dioxide (CO_2). Oxides of nitrogen (NO_x) are converted into elemental nitrogen (N) and oxygen. The three–way catalyst is most efficient in converting HC, CO and NO, at the stoichiometric air/fuel ratio of 14.7:1 (fig. 47). If the mixture becomes leaner than 14.7:1 (extra oxygen), the ability to convert NOx drops. As the mixture becomes richer than 14.7:1 (less oxygen), the ability to convert HC and CO drops.

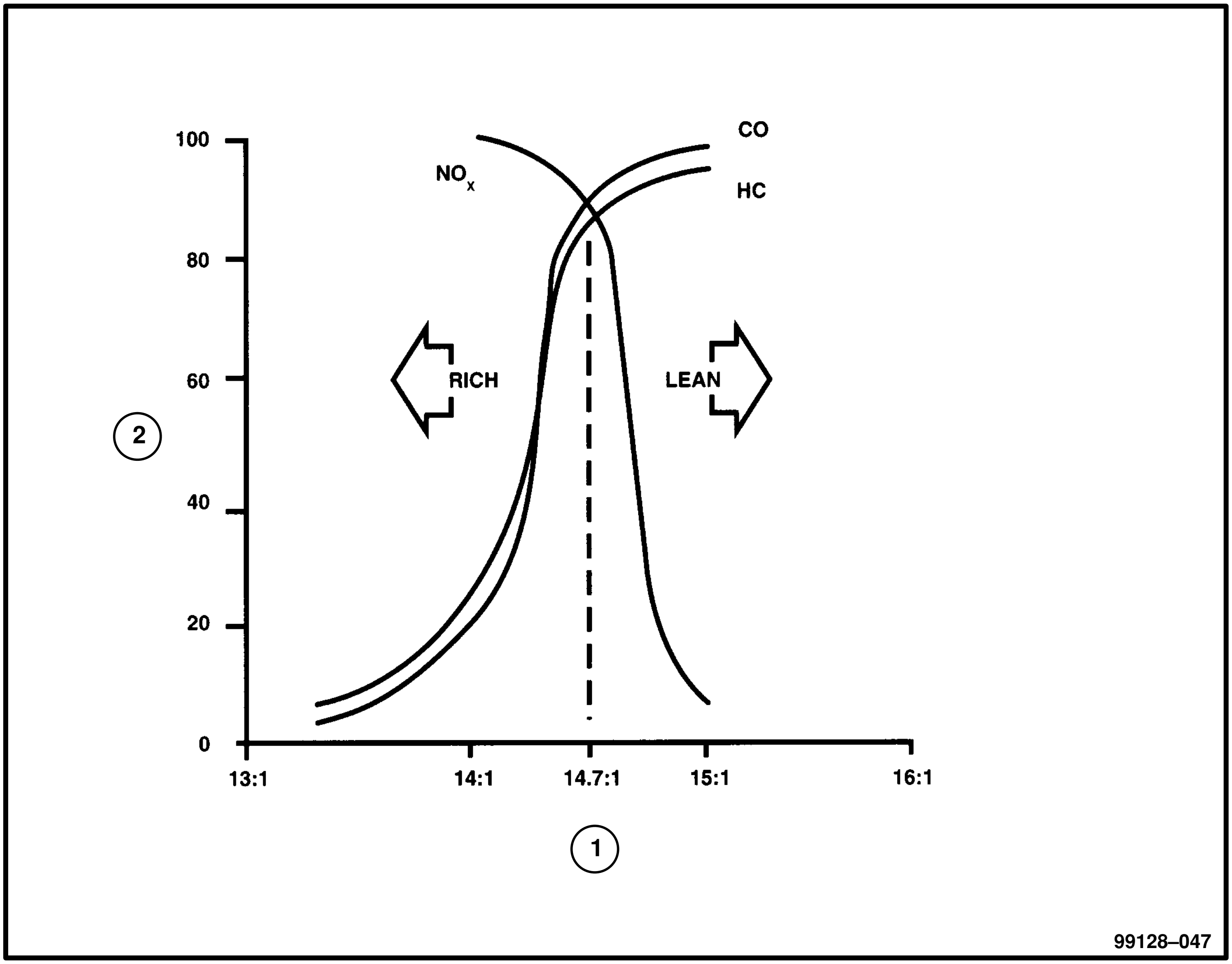


Figure 47 Conversion Efficiencies of a Three–Way Catalyst

1	Air/Fuel Ratio	2	Conversion Efficiency %

Upstream O2 Sensor

The upstream sensor is located on the exhaust manifold and is used to maintain an Air/Fuel (A/F ratio of approximately 14.7:1 (stoichiometric). This is accomplished by the fact that an O2 Sensor acts like a switch when the A/F ratio is near 14.7: 1 (fig. 48). When the A/F is lean (extra oxygen), the sensor output will be very close to O volt. As the A/F becomes richer (less oxygen), the sensor output will change rapidly to 0.5 volt and can continue movement up to 1 volt if the mixture becomes too rich (low oxygen). Based on these operating characteristics, the PCM can be programmed with switch points, to maintain the proper A/F ratio. The O2 Sensor must reach a minimum of 660°F in order to effectively monitor oxygen content in the exhaust system. To provide optimum functioning of the O2 Sensor, the PCM waits until the system goes into closed loop before it controls the air/fuel ratio; it does not attempt to control the ratio immediately after start–up.

Example of closed–loop parameters are:

- Engine temperature exceeds 35°F
- O2 Sensor is in the ready mode
- All timers have timed out, following the START to RUN transfer (the timer lengths vary, based upon engine temperature at key–ON) as follows:
  — 35°F/41 sec.
  — 50°F/36 sec.
  — 70°F/19 sec.
  — 167°F/11 sec.

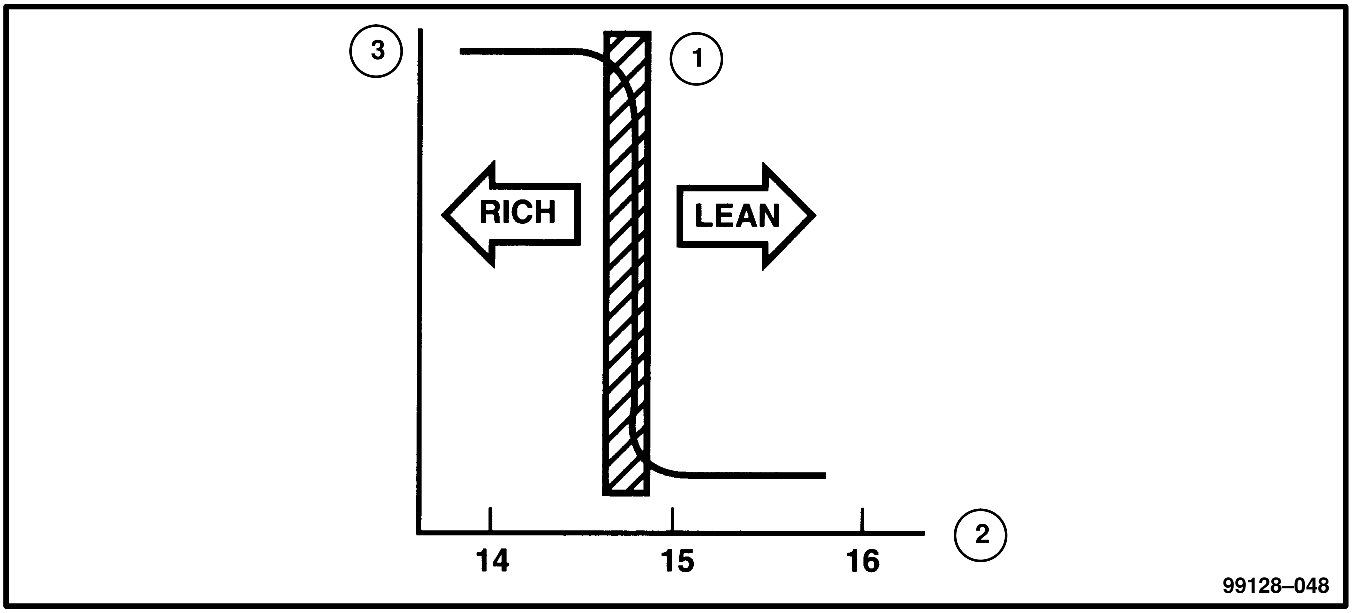


Figure 48 Oxygen Sensor Output

1	Stoichiometric Air/Fuel Ratio	3	Voltage (V)
2	Air/Fuel Ratio		

O2 Sensor Electrical Operation (JTEC)

When the O2 Sensor is cold, resistance is extremely high (infinite). As the sensor heats up, two things happen. First, the resistance of the sensors drops. Second, once it heats to a certain temperature, above 660° F, the sensor becomes a galvanic battery, actually creating a voltage output.

The PCM must be able to power up the heaters, read an input voltage and diagnose the circuit, and the operation of the sensors. To be able to do all this, the PCM uses a 5–volt diagnostic circuit (fig. 49). On a cold start, the PCM sends out 5 volts to the O2 Sensor. As the sensor heats up, resistance decreases through it. As the resistance decreases, the 5 volts should drop. After a short time delay, the PCM measures how long it takes to move from 4 volts to 3 volts. If the voltage drops to a predetermined level, the PCM knows that the heater and sensor are operating correctly. If the voltage goes too low, a short to ground will be indicated.

To detect a short to B+, the PCM waits until the O2 Sensor should be putting out a voltage between 0.5 and 1.0 volt. If the PCM reads a voltage of 1.5 volts or higher from the sensor, a shorted high fault will be set.

O2 Sensor Diagnostics

- O2 Sensor shorted to ground (low). At a cold start, BTS and ECT within 27°, ECT below 147° F, if O2S voltage is below 0.156 volt, the fault is set in one trip.
- O2 Sensor shorted to voltage (high) is set with the engine running, ECT has been above 176° F for 4 minutes and the O2 Sensor voltage is above 1.5 volts. The upstream sensor fault will set in one trip. However, the downstream sensor takes two trips to set the fault.
- There are also tests required for OBD II (JTEC only). Refer to OBD II section for test descriptions.

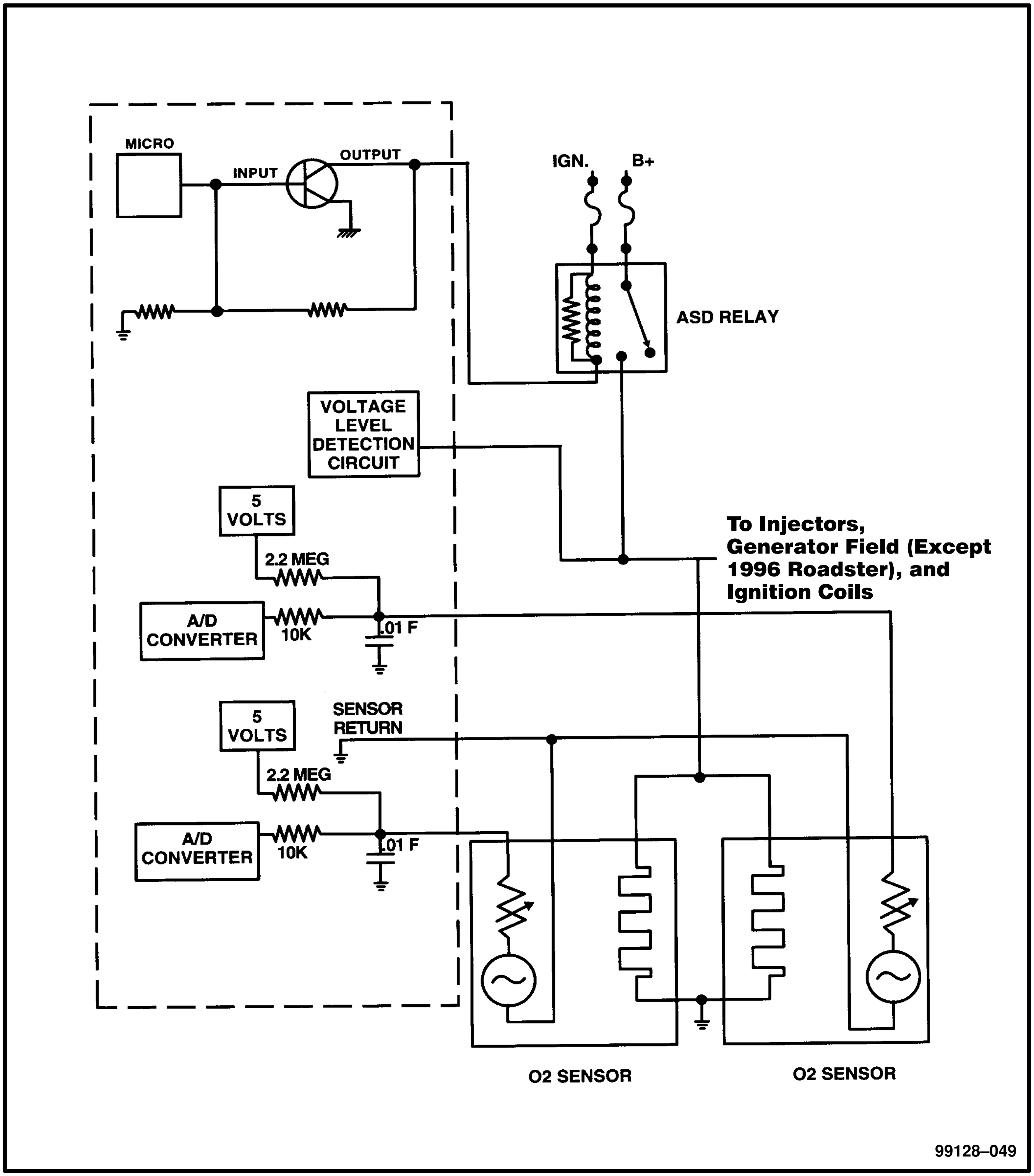


Figure 49 Typical JTEC O2 Sensor Circuit

Downstream O2 Sensor (JTEC)

The downstream O2 Sensor measures catalyst efficiency. This is an OBD II requirement. Briefly, the oxygen content of the exhaust gases leaving the converter has significantly less fluctuation than at the inlet if the converter is working properly. The PCM compares the upstream and downstream O2 Sensor switch rates under specific operating conditions to determine if the catalyst is functioning properly. Refer to the OBD II Training Course for more information.

OBD II (JTEC)

There are several OBD II tests performed by and on the O2 Sensors. A brief description of each follows.

Catalyst Monitor (JTEC)

The downstream O2 Sensor measures the content of the O2 passing through the catalytic converter. Normally, the downstream O2 Sensor switch rate is extremely slow, compared to that of the upstream sensor rate. As the converter deteriorates, the O2 Sensor switch rate increases. The PCM can compare the signals produced by the upstream and the downstream O2 Sensors to determine the operating efficiency of the catalyst.

02 Monitor (JTEC)

Even though an O2 Sensor may be switching and not exceeding the fault thresholds, it must switch with a certain frequency to allow the PCM enough time to make correction before emissions are exceeded. When certain conditions are met (at idle), the PCM checks the switch rate of the O2 Sensor. It looks for how fast it switches, as well as how many times it switches, within a calibrated time. As part of OBD II, the PCM monitors the switching frequency, under specific conditions and will set a fault if the sensor becomes slow or lazy. Refer to the OBD II course for more information.

O2 Sensor Heater Monitor

The O2 Sensor heater allows the O2 Sensor to reach operating temperature sooner after start–up. It is also necessary because prolonged idle conditions cannot maintain O2 Sensor temperature. If these fail to function, vehicle emissions can increase under certain conditions. OBD II requires monitoring these heaters for proper operation.

If certain conditions have been met at key ON, a test is performed. The heater element itself is not tested. The resistance in oxygen sensor output circuits is tested to determine (infer) heater operation. The resistance is normally between 100 ohms and 4.5 megohms. When oxygen sensor temperature increases, the resistance in the internal circuit decreases. The PCM sends a 5–volt signal through the oxygen sensors to monitor this circuit. As temperature increases, resistance decreases and the PCM detects a lower voltage at the reference signal.

The test is performed if the ECT is less than 147° F and ECT and BTS are within 27° F of one another. The PCM measures how long it takes for the voltage to change from above 4 volts to less than 3 volts.

ADAPTIVE MEMORIES

Short–Term Adaptive Memory

As mentioned earlier, when the fuel system goes into closed–loop operation, two adaptive memory systems begin to operate. The first system that becomes functional is called Short–Term Adaptive Memory or Short–Term Correction (fig. 50). This system corrects fuel delivery in direct proportion to the readings from the upstream O2 Sensor. In other words, as the Air/Fuel (AF) mixture changes, the O2 Sensor voltage tells the PCM that the AF ratio contains either more or less oxygen. The PCM then begins either to add or remove fuel until the O2 Sensor reaches its switch point. When the switch point is reached, Short–Term Correction begins with a quick change (kicks). Then it ramps slowly, until the O2 Sensor output voltage indicates the switch point in the opposite direction. Short–Term Adaptive Memory will keep increasing or decreasing injector pulse width, based upon the O2 Sensor input. The maximum range of authority for short–term memory is ± 33% of base pulse width.

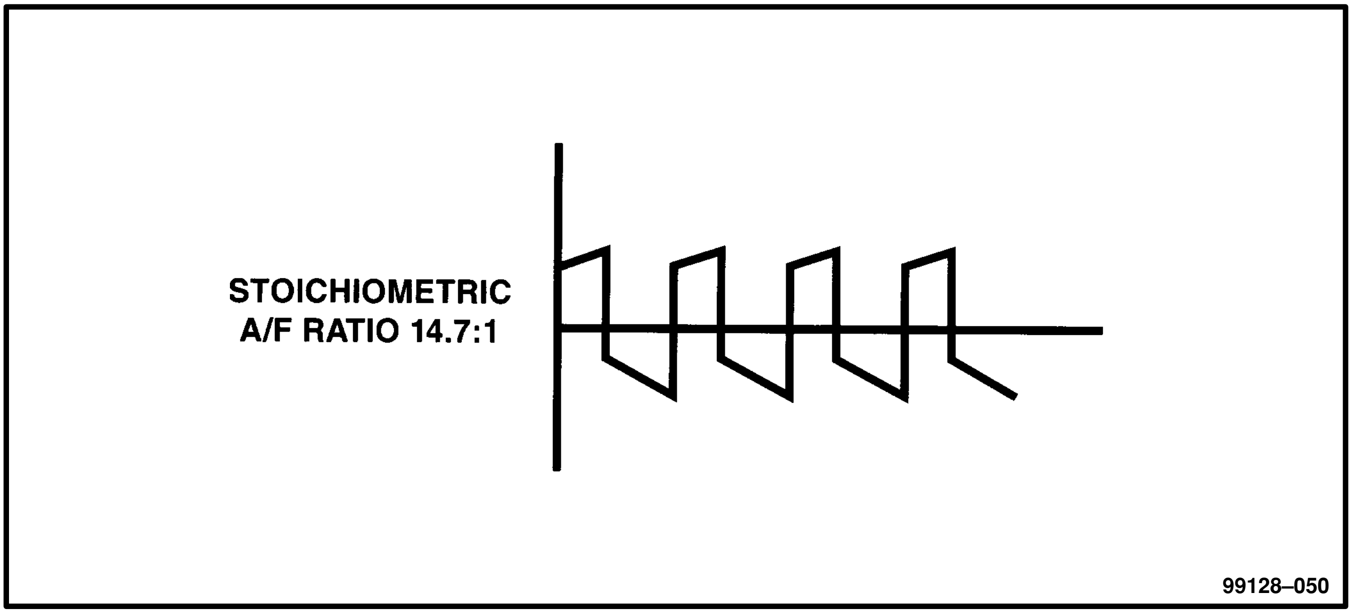


Figure 50 Short–Term Fuel Compensation

For example, if there is a low fuel–pressure problem, the O2 Sensor will start moving toward zero volt, lean mixture (excess oxygen). Short–Term Fuel Correction will begin to add fuel and continue to add (up to 33% of total pulse width), until the O2 Sensor begins switching again.

The PCM's goal is to keep the O2 Sensor switching around the goal voltage.

Long–Term Adaptive Memory

The second system is called Long–Term Adaptive Memory (fig. 53). In order to maintain correct emission throughout all operating ranges of the engine, it was decided that a cell structure, based on load and engine rpm, should be used (figs 51 & 52). There are up to 22 cells (16 on SBEC). Two are used only during idle, based upon TPS inputs. There may be another two cells used for deceleration, based on TPS, engine rpm and vehicle speed. The other 17 cells (12 cells on SBEC) represent a manifold pressure and an rpm range. On SBEC, six of the cells are high rpm and six are low rpm. Each of these cells are a specific MAP voltage range. The values shown (figs. 51 & 52) are an example only. These values are calibrated for each powertrain package. As the engine enters one of these cells, the PCM looks at the amount of Short–Term Correction being used. Because the goal is to keep Short–Term at zero (O2 Sensor switching at 0.5 volt), Long–Term will update in the same direction as Short–Term Correction was moving to bring the Short–Term back to zero. Once Short–Term is back at zero, the Long–Term Correction factor will be stored in memory.

RPM	OPEN THROTTLE						IDLE	DECEL
1121–2900	2	5	8	11	14	17		
897–1120	1	4	7	10	13	16	19	21
0–896	0	3	6	9	12	15	18	20

VACUUM (in.) 21.4 16.5 13.6 9.7 1.9

Long Term is used up to the RPM limiter, however, it is not updated above the approximate RPM shown.

99128–051

Figure 51 JTEC Adaptive Memory Cells

	OPEN THROTTLE						IDLE	DECEL*
VACUUM	20	17	13	9	5	0		
ABOVE 1984 RPM	1	3	5	7	9	11	13 NOT USED	15
BELOW 1984 RPM	0	2	4	6	8	10	12 NEUTRAL	14

MAP VOLTS. 0 1.4 2.0 2.6 3.3 3.9

* IF EQUIPPED

99128–052

Figure 52 SBEC Adaptive Memory Cells

The values stored in Long–Term Adaptive Memory are used for all operating conditions, including open loop. However, updating Long–Term Memory occurs after the engine has exceeded approximately 170° F, with fuel control in closed loop and two minutes of engine run time. This is done to prevent any transitional temperature or start–up compensations from corrupting Long–Term Fuel Correction.

Using the low fuel–pressure example, the PCM had stored a fuel correction in Long–Term Memory to compensate for the low fuel pressure. At key–ON, cold engine, when the PCM does its pulse–width calculation, the Long–Term factor will be added, because it knows there was a problem in that cell. Long–Term Adaptive can change the pulse width by as much as 33% (25% on SBEC), which means it can correct for all of Short–Term. It is possible to have a problem that would drive Long–Term to 33% (25% on SBEC) and Short–Term to another 33% (25% on SBEC) for a total change of 66% (50% on SBEC), away from base pulse–width calculation.

Short– and Long–Term is expressed as a percentage of pulse–width change. Idle Adaptive is an additive fuel correction factor.

Idle Adaptive Memory (1992–1995 SBEC Only)

Idle Adaptive Memory is uniquely different than Short–Term and Long–Term memories. Short– and Long–Term Adaptive Memories are multiplicative in nature. This means that the pulse width calculation will be changed by either a positive or negative percentage of time. Idle Adaptive Memories are additive in nature. This means that their values are actual time values that the pulse width will be changed by.

Idle Adaptive Memory is expressed in microseconds (µsec). Because this is such a short time interval (1000 microseconds=1 millisecond), Idle Adaptive is used to affect changes in the idle fuel mixture when injector pulse width is short, but has minimal effects under other operating conditions when pulse width is longer.

Idle Adaptive Memory is only calculated after the purge–free idle cell is updated. This means that the most this value changes is once per (key–on) drive cycle if the proper conditions have been met. Therefore, the Idle Adaptive and Short–Term/Long–Term Adaptive Memory values may appear to contradict each other because they are looking at different windows of operation.

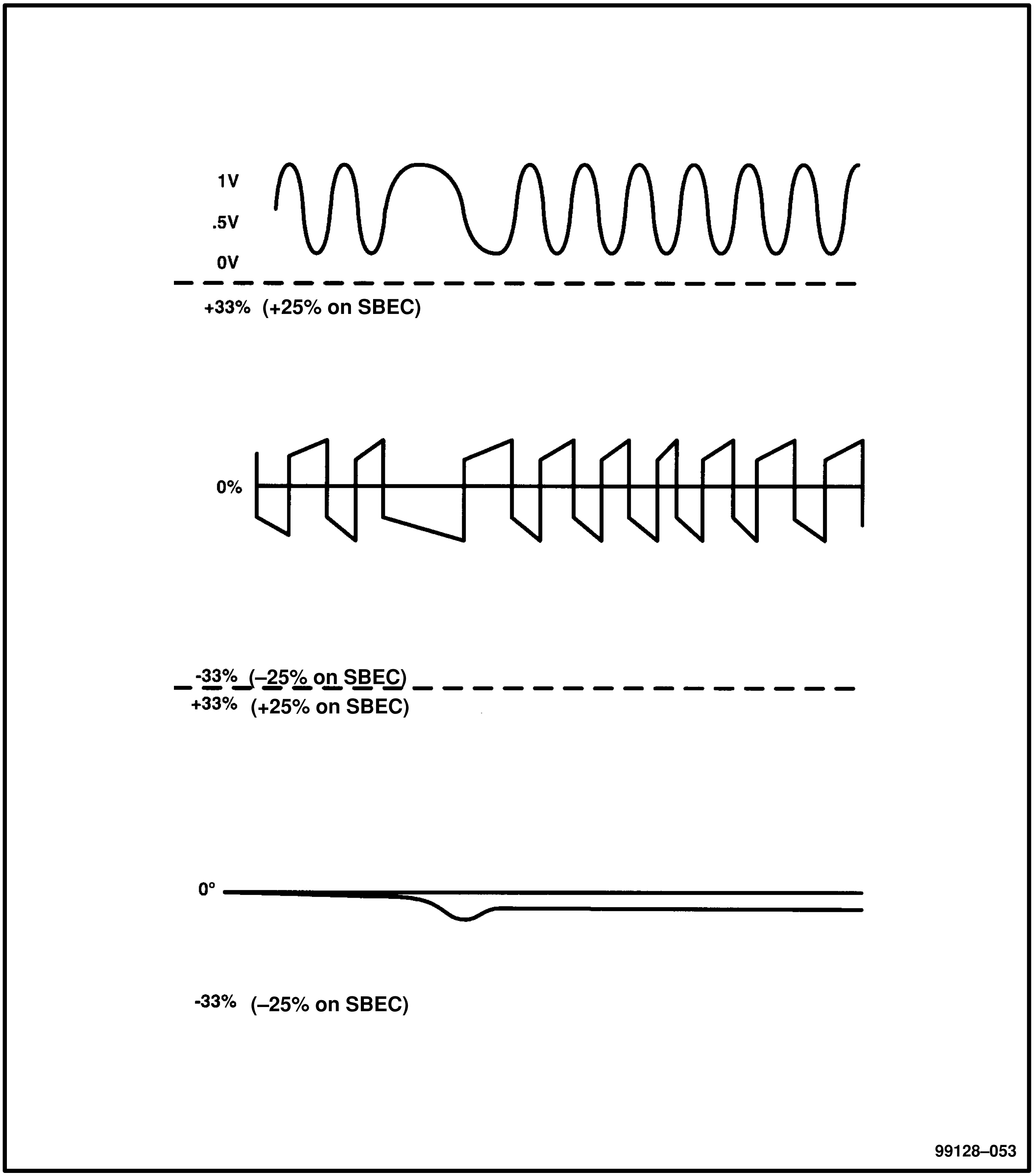


Figure 53 JTEC and SBEC Long Term Fuel Compensation

Purge–Free Cells (JTEC)

Purge–free memory cells are used to identify the fuel vapor content of the evaporative canister. Since the evaporative canister is not purged 100% of the time, the PCM stores information about its vapor content in a memory cell. The construction of purge–free cells is similar to that of certain purge–normal cells. For example: The 8.0L SR purge–free cells have the same rpm and MAP structure of cells 7, 8, 11 and 20.

The purge–free cells can be monitored by the DRBIII® scan tool. They are represented by the Purge–Free Cells "PF7, PF8, PF11 and PF20." The only difference between the purge–free and normal adaptive cells is that in purge–free cells, the purge is turned off completely. This gives the PCM the ability to compare purge and purge–free operation.

Purge Corruption Reset Feature (JTEC)

At a cold start (ECT and BTS within 20° F of each other), the PCM compares the value of the purge–free cell to the value in Long–Term Memory (fig. 54). If the difference is too large, the PCM will replace the value in long–term memory with the corresponding purge–free cell value. The cells that do not have corresponding purge–free will be replaced with the largest purge–free value. If a cell is already higher than the highest purge–free, it will not be changed.

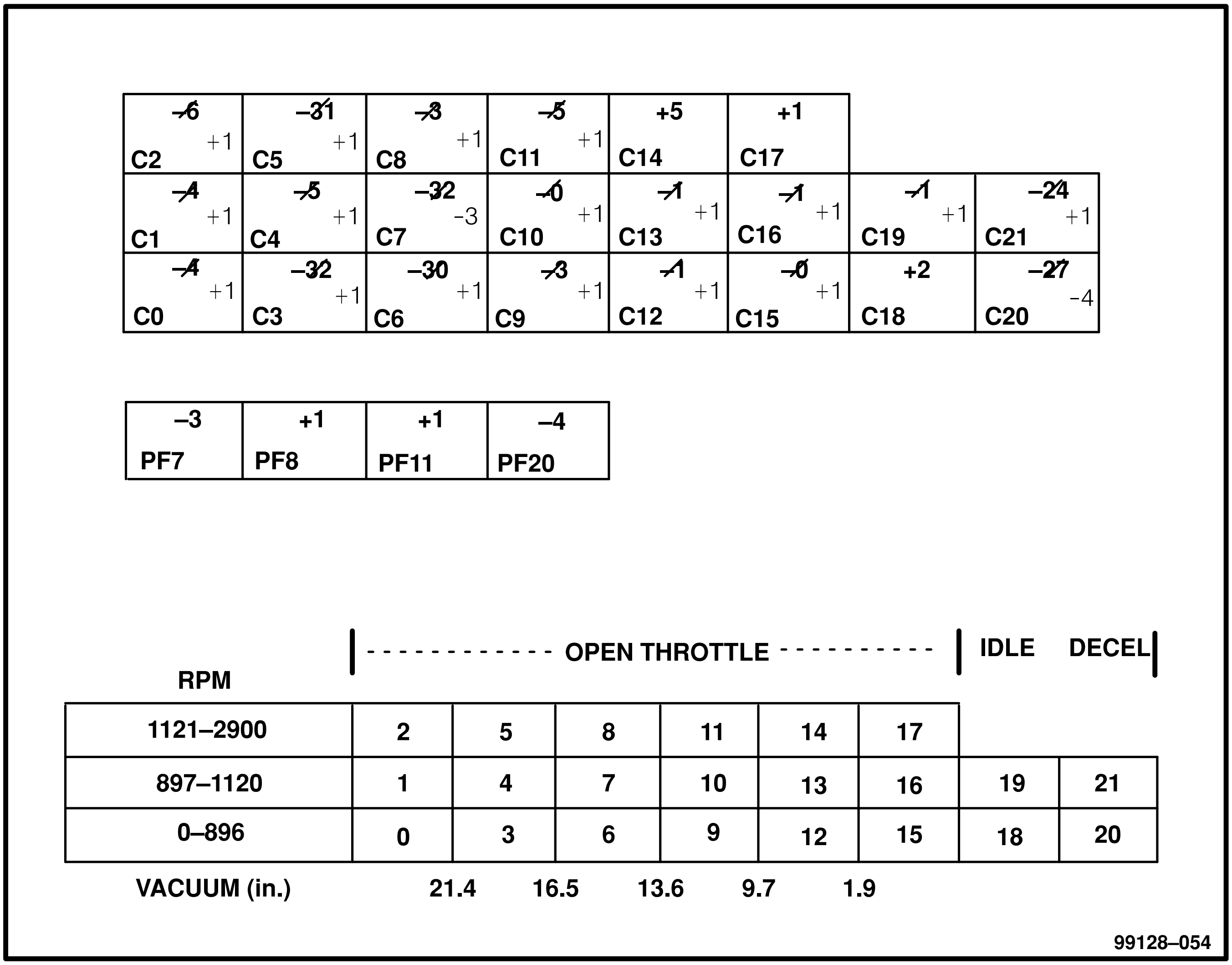


Figure 54 Purge Corruption Reset (JTEC shown, SBEC similar)

DRBIII® Display

The DRBIII® can be used to display both of these systems. The Long–Term Memory cells are shown with the Long–Term correction factor in each cell. The Short–Term correction is always changing and is displayed above the Long–Term Memory cells. The DRBIII® displays Long–Term Adaptive Memory cells similar to Figures 51 & 52.

BRAKE SWITCH

When the brakes are applied, the brake switch provides an input to the PCM for deceleration fuel management. The brake switch is equipped with three sets of contacts, one normally open and the other two normally closed (brakes disengaged). The PCM sends a 12–volt signal to one of the normally closed contacts in the brake switch, which is connected to a ground (fig. 55). With the contacts closed, the 12–volt signal is pulled to ground, causing the signal to go low. The low–voltage signal, monitored by the PCM, indicates that the brakes are not applied. When the brakes are applied, the contacts open, causing the PCM's output voltage to go high.

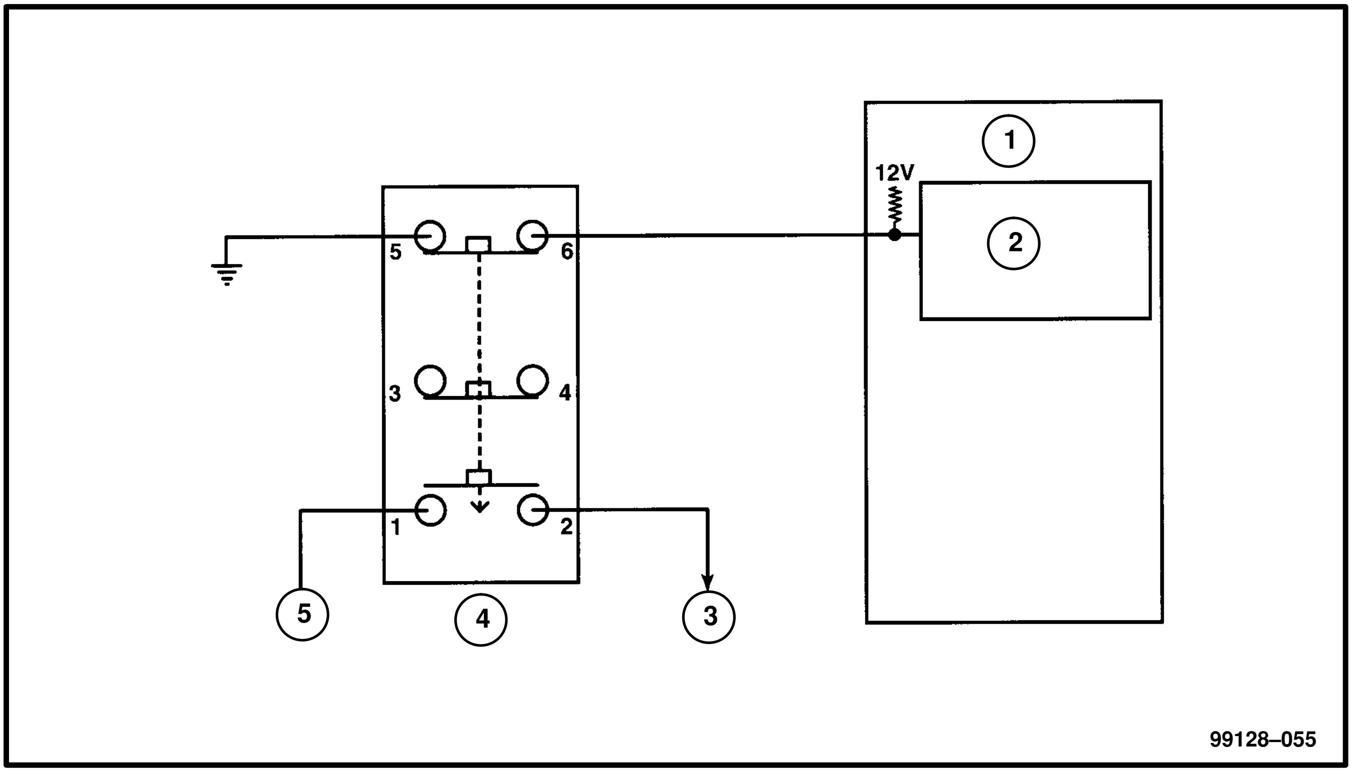


Figure 55 Brake Switch Circuit

1	Powertrain Control Module	4	Brake (Stop Lamp) Switch
2	Voltage Level Detection Circuit	5	From Battery
3	To Stop Lamps		

Component Location

The brake switch is located rearward of the brake pedal and is attached to the brake pedal sled (fig. 56).

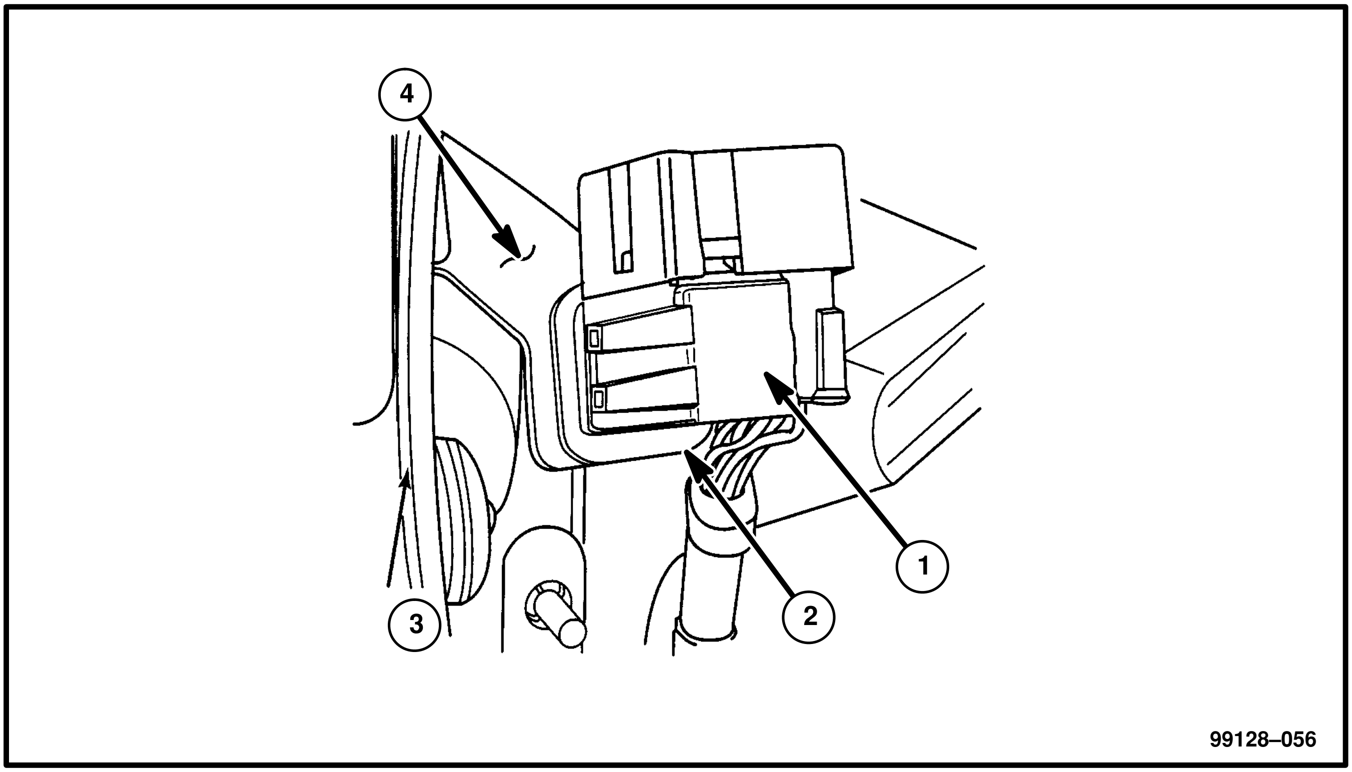


Figure 56 Brake (Stop Lamp) Switch

1	Brake (Stop Lamp) Switch	3	Brake Pedal
2	Switch Bracket	4	Striker

CLUTCH PEDAL POSITION (CPP) SWITCH

The CPP Switch is installed in series between the ignition switch and the coil battery terminal of the starter relay. This normally open switch prevents the Starter Relay from being energized unless the clutch pedal is depressed. This prevents starter operation while the clutch disc and flywheel are engaged. The Starter Relay is always grounded.

VEHICLE SPEED SENSOR (VSS)

Vehicle speed is transmitted to the PCM via the VSS, which is located in the transmission extension housing. The PCM requires the VSS to control the following programs:

- IAC motor (during deceleration)
- Injection pulse width (during deceleration)
- OBD II diagnostics (JTEC only)
- PCM mileage EEPROM
- Road speed shutdown
- Speedometer/Odometer

Note: *Road speed shutdown is the PCM shutting off fuel injectors above a preset vehicle speed and rpm.*

The VSS is a Hall–effect sensor. This sensor is mechanically driven by a pinion gear that is located on the output shaft of the transmission. The Hall–effect sensor switches a 5–volt signal sent from the PCM from a ground to an open circuit at a rate of ten pulses per transmission output shaft revolution. When the PCM counts a specific number of pulses (10,000), it assumes it has traveled one mile. The JTEC sythesizes the signal from the VSS input to feed the speedometer, EES system, and radio.

Like all Hall–effect sensors, the sensor electronics need a power source. On JTEC, this power source, the secondary 5–volt supply, is provided by the PCM (fig. 57). On SBEC, this power source is the same 9–volt supply that is used by the CMP and CKP sensors (fig. 58).

Vehicle Speed Sensor Diagnostics

If the ECT indicates a warm engine while MAP and engine indicate vehicle movement and there is no VSS signal, a rationality fault will be set.

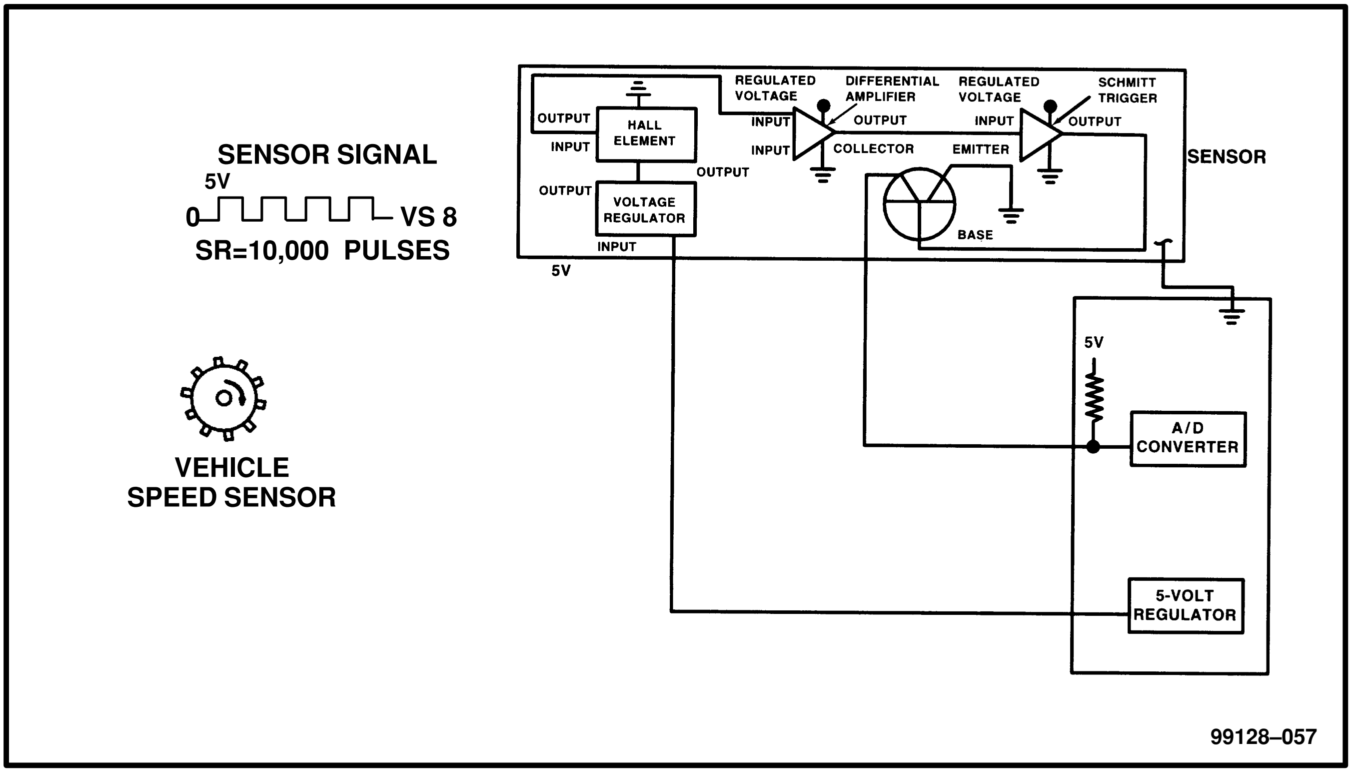


Figure 57 JTEC Vehicle Speed Sensor Circuit

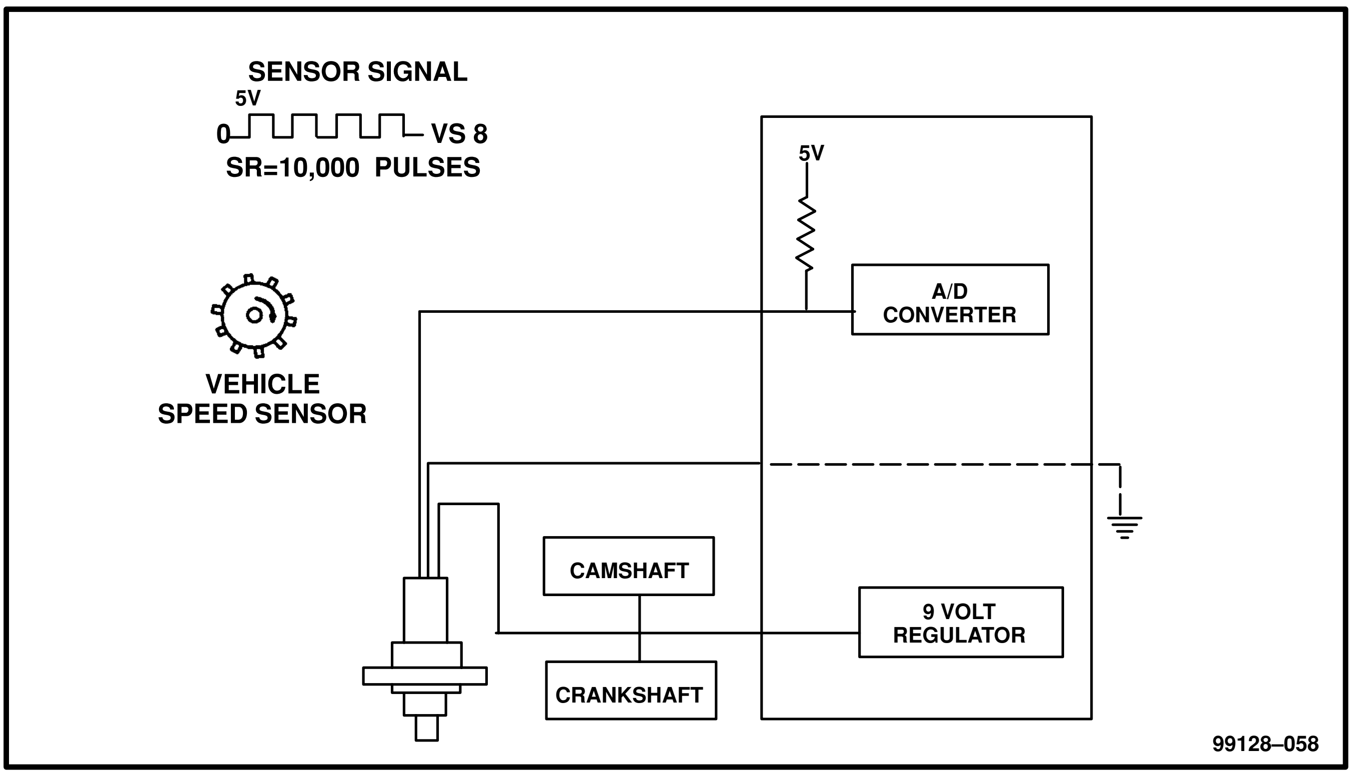


Figure 58 SBEC Vehicle Speed Sensor Circuit

FUEL–LEVEL SENSOR INPUT

Fuel level is an input that is used as a disabler for OBD II (JTEC). From 1996–1997 there is a low fuel level switch. From 1996–2000 the fuel level is input directly to the PCM (fig. 59).

12 volts is supplied from the dash gauge to the fuel level sensor and the PCM. The PCM measures the voltage drop across the resistor of the sensor.

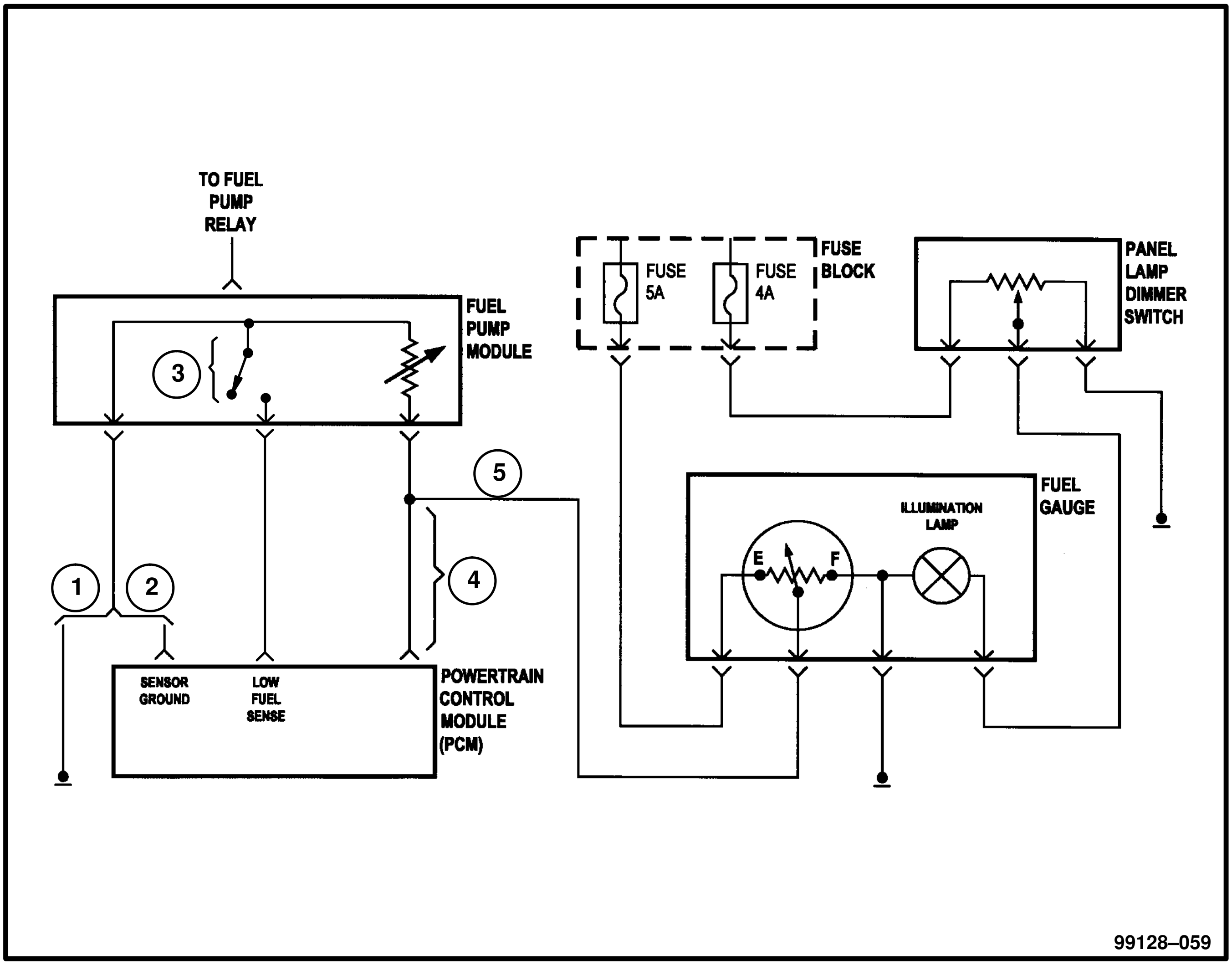


Figure 59 Fuel Level Gauge Circuit

1	1992–1995	4	1998–2000 Only
2	1996–2000	5	All Years
3	1996–1997 Only		

BATTERY/AMBIENT TEMPERATURE SENSOR

1996 Coupe/1997–2000 All Vipers

The PCM uses an input from the Battery/Ambient Temperature Sensor (BTS) located on the battery tray. The function of the BTS is to enable control of the generator output, based upon ambient temperature. As temperature increases, the charging rate should decrease (Table 4). As temperature decreases, the charging rate should increase. The PCM maintains the maximum output of the generator by monitoring battery voltage and controlling battery voltage to a range of 13.5–14.7 volts.

The BTS is also used for OBD II diagnostics. Certain faults and OBD II monitors are either enabled or disabled, depending upon BTS input (for example, disable purge and EGR (if equipped) enable LDP and O2 heater test). Most OBD II monitors are disabled below 20°F.

If the BTS indicates a voltage that is too high or too low, the PCM sets a DTC. When the DTC is set, the MIL is illuminated and the PCM moves into limp–in mode. In limp–in, the PCM will substitute a preset value. Using this substitute temperature, the PCM changes to a preset target–charging system voltage.

Table Four Charging Rates

Battery Temperature (°F)	Target Charging Rate
–4	15.19 – 14.33
32	14.82 – 13.96
68	14.51 – 13.65
104	14.08 – 13.22
144	13.77 – 13.04

1996 Viper Roadster

These vehicles use an Ambient Temperature Sensor as part of OBD II diagnostics. The ambient sensor is located behind the front fascia toward the drivers side. Refer to the OBD II training course for more information. The charging systems on these vehicles are not controlled by the PCM and therefore a battery temperature sensor is not needed. The generator on SBEC vehicles has an internal voltage regulator that is not controlled by the PCM.

Battery Temperature Sensor Diagnostics

- Batt Temp Sensor Voltage Low is set if the sensor voltage is below 0.08 volt (fig. 60).
- Batt Temp Sensor Voltage High is set if sensor voltage is above 4.9 volts (fig. 60).

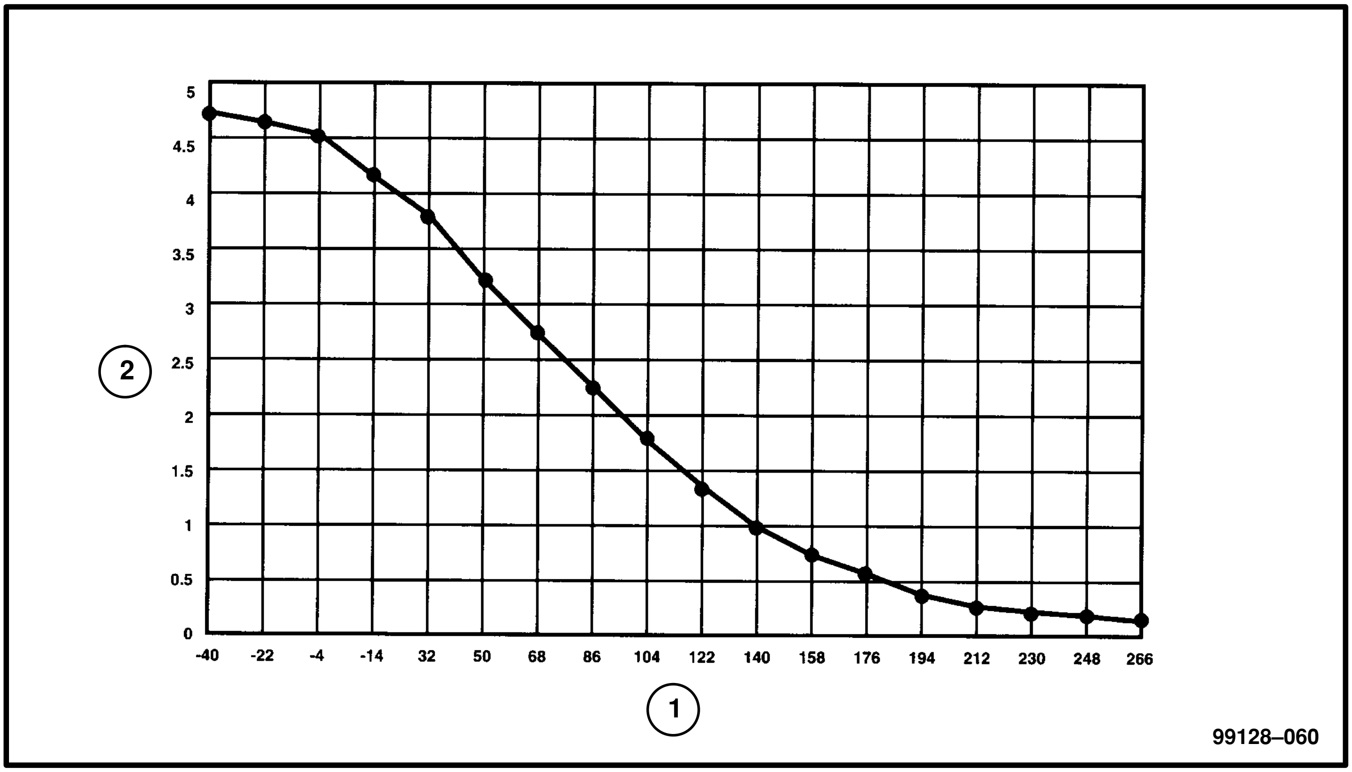
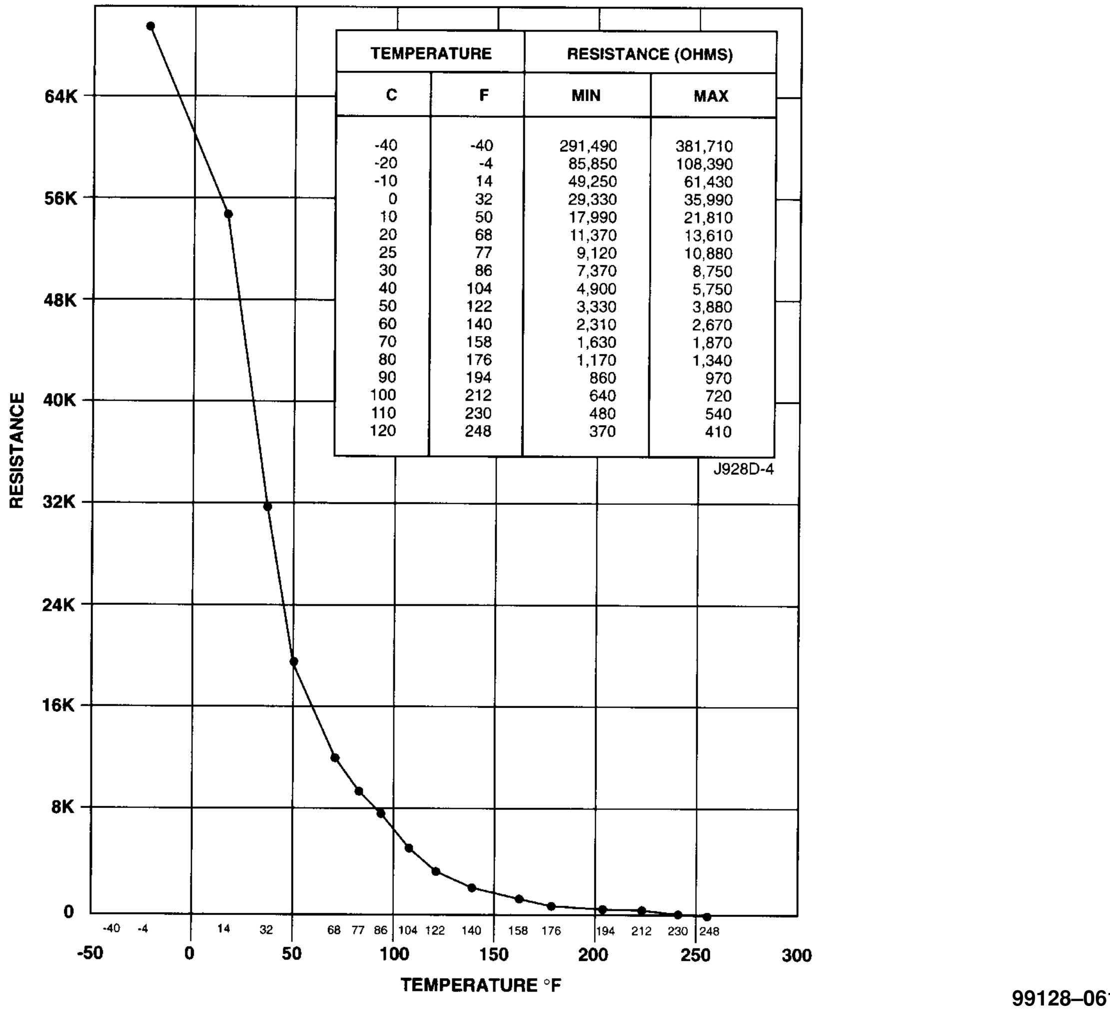


Figure 60 Battery Temperature Sensor – Temperature vs. Voltage

1	Temperature	2	Voltage



TEMPERATURE		RESISTANCE (OHMS)	
C	F	MIN	MAX
-40	-40	291,490	381,710
-20	-4	85,850	108,390
-10	14	49,250	61,430
0	32	29,330	35,990
10	50	17,990	21,810
20	68	11,370	13,610
25	77	9,120	10,880
30	86	7,370	8,750
40	104	4,900	5,750
50	122	3,330	3,880
60	140	2,310	2,670
70	158	1,630	1,870
80	176	1,170	1,340
90	194	860	970
100	212	640	720
110	230	480	540
120	248	370	410

Figure 61 Battery Temperature Sensor – Resistance vs. Temperature

AIR CONDITIONING SWITCH

When the A/C–heater control switch is moved to an A/C position or the Defrost position, the PCM A/C select circuit is pulled low when ground is provided through the dash panel switch (figs. 62 & 63). The PCM request circuit is also pulled low if the A/C Pressure Switches and Thermostatic Switch are closed. Refer to the Body Electrical book for more information on A/C Operation.

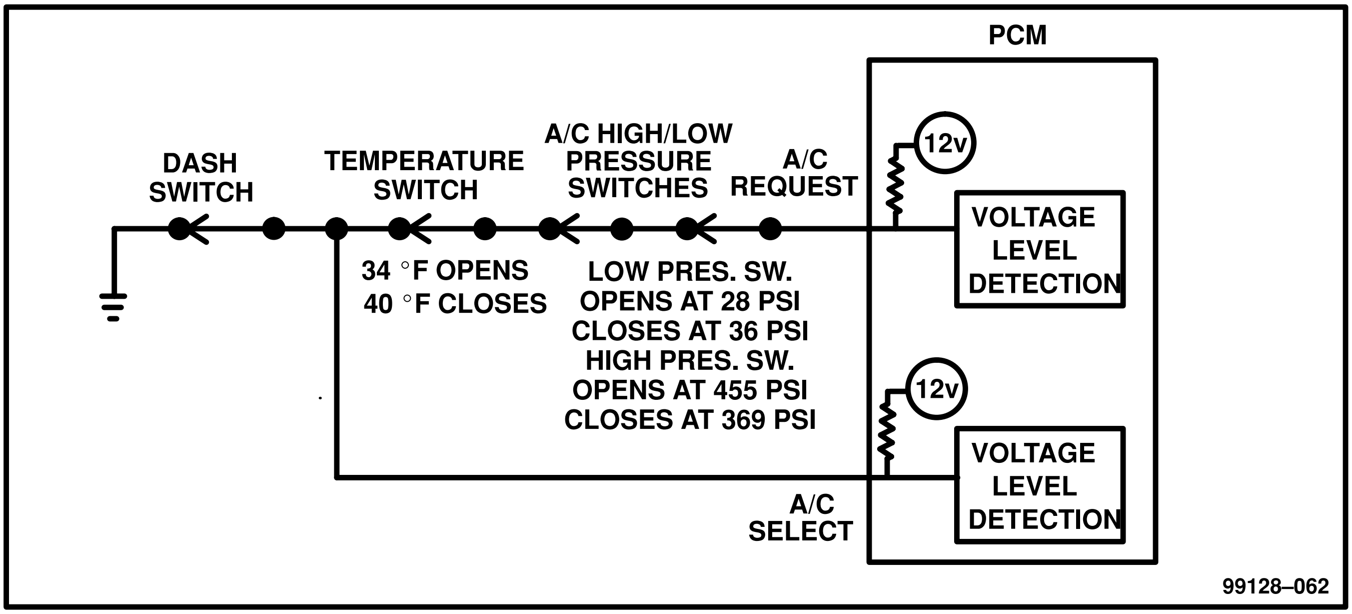


Figure 62 JTEC A/C Switch Circuit

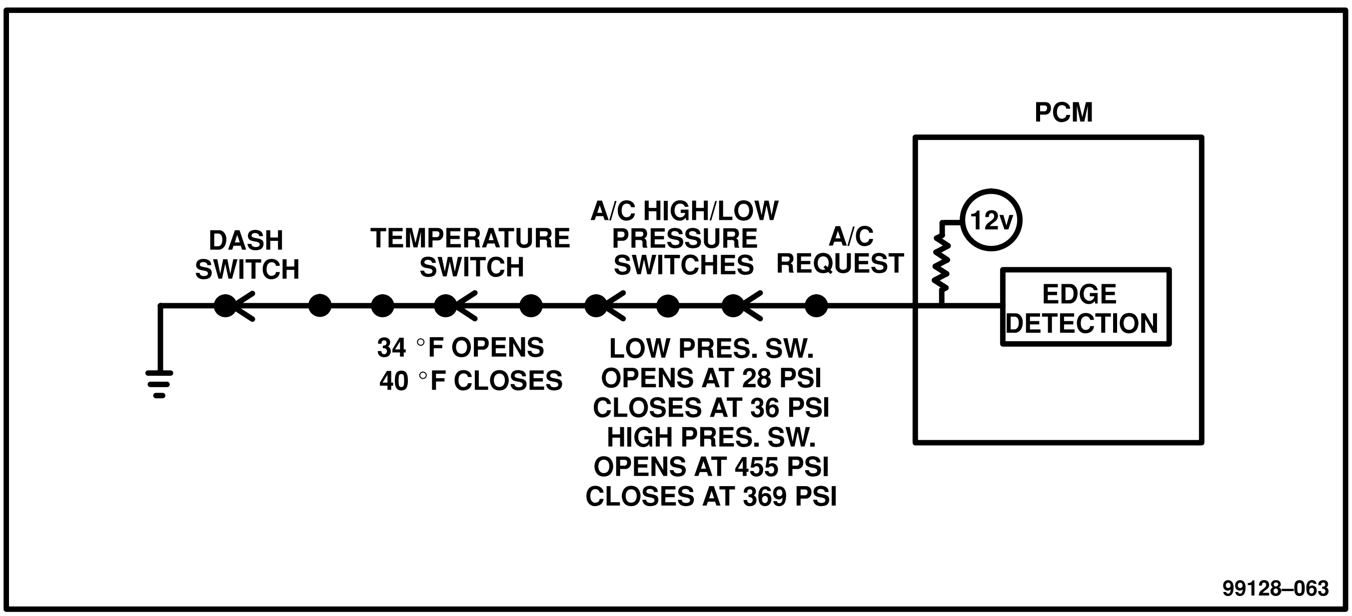


Figure 63 SBEC A/C Switch Circuit

NOTES:

FUEL INJECTION SYSTEM – PCM OUTPUTS

SOLENOID AND RELAY CONTROL (JTEC)

Most of the output relays and solenoids are controlled by quad drivers. A quad driver is a single microchip that contains four separate driver circuits that are used for controlling high current output devices.

A voltage divider circuit has been added to diagnose the operation of the driver circuit. This voltage divider is located between the output of the driver and the input command (from microprocessor) to the driver.

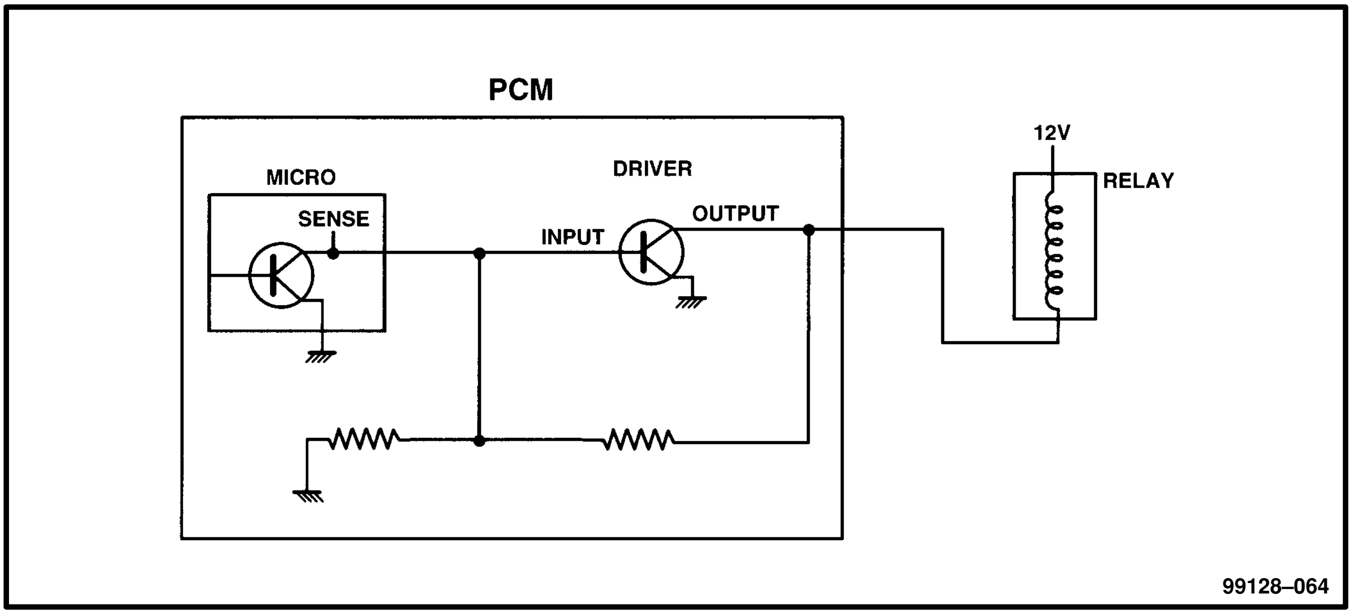


Figure 64 JTEC Sense Circuit

There is a sense circuit located at the microprocessor on the input command line to the driver. When the command is OFF, the 12 volts from the relay coil will go through the voltage divider leaving 6 volts at the sense point. Therefore, an OFF command will look for voltage to be high (fig. 64).

When the command is ON, the micro closes a circuit allowing the 6 volts to go to ground. This energizes the driver. When the driver is energized, the 12 volts are allowed to go to ground through the driver. Once this occurs, the voltage at the sense point goes low. Therefore, an ON command will look for voltage to be low.

Because of this design, the PCM is capable of continuous diagnostics, without the need for a request to change state.

When the key is first turned on, some relays and solenoids are actuated very quickly (before engine starts) to verify the circuitry.

Once the key is turned on, the sense point is continuously monitored. If a circuit opens or a short to ground occurs when the requested state is off, a fault will be set. However, if a circuit should open or short to ground when the requested state is ON, this will not be detected until the state is changed to OFF. This is due to the fact that when the state is ON, the circuit is already low, so it is not possible to know that an open has occurred.

***Caution**:* *Both diode– and resistor–suppressed relays have been used, If an incorrect relay is used, damage may occur to the relay, circuit or PCM.*

SOLENOID AND RELAY CONTROL (SBEC)

Most of the output relays and solenoids are controlled by a serial peripheral interface/output (SPIO) circuit. This circuit, within the PCM, is used for controlling high current output devices. The SPIO has the added advantage of being able to provide diagnostics.

The SPIO circuit gives the PCM the ability to determine whether the actual state of the relay or solenoid matches the PCM's expected state.

The PCM performs diagnostics only when a change of state has been requested. This means that the circuit could go bad and the PCM would not know it until it was told to change the state.

***Caution**:* *Both diode– and resistor–suppressed relays have been used. If an incorrect relay is used, damage may occur to the relay, circuit or PCM.*

AUTOMATIC SHUTDOWN RELAY (ASD) (JTEC)

When energized, the ASD Relay provides power to operate the injectors, ignition coil, generator field (1996–2000) and O2 Sensor heaters (upstream and downstream). It also provides a sense circuit to the PCM for diagnostic purposes. The PCM energizes the ASD:

- Anytime there is a Crankshaft Position Sensor signal that exceeds a predetermined value.
- For approximately 1.8 seconds during the initial key–ON cycle.

The ASD Relay electromagnet is provided with battery voltage from the ignition switch (fig. 65). The PCM provides the ground.

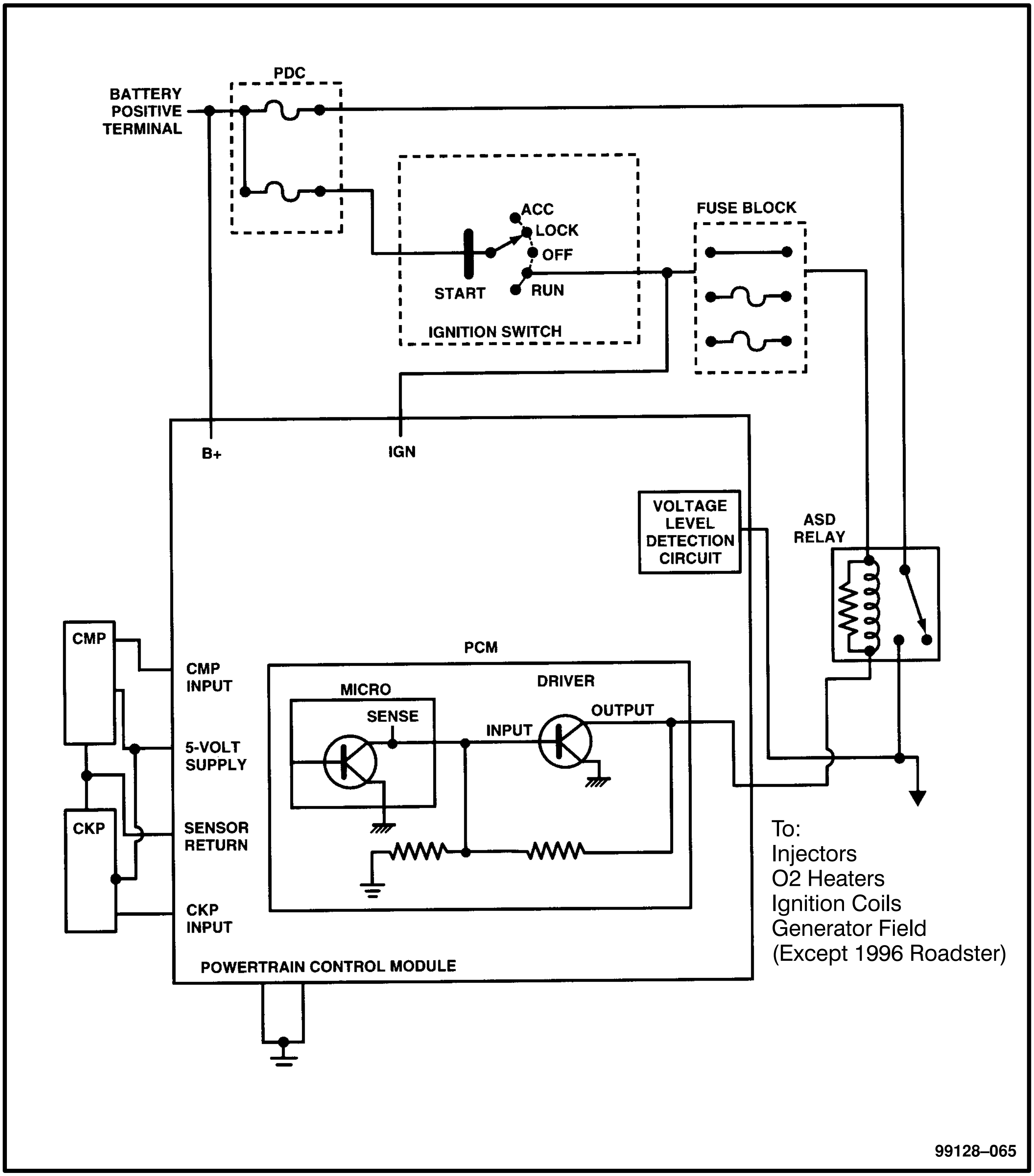


Figure 65 JTEC ASD Relay Circuit – Typical 1996–2000 Viper

AUTOMATIC SHUTDOWN RELAY (ASD) (SBEC)

When energized, the ASD Relay provides power to operate the injectors, ignition coil, O2 sensor heaters, and also provides a sense circuit to the PCM for diagnostic purposes. The PCM energizes the ASD Relay:

- Anytime there is a CKP Sensor signal that exceeds a predetermined value.
- For approximately 0.7 to 1.5 seconds during the initial key–ON cycle. The determining factor for the latch time is ECT. A cold engine will allow a longer latch time to overcome slower cranking speed.

The ASD Relay's electromagnet is fed battery voltage, not ignition voltage (fig. 66). The PCM still provides the ground. As mentioned earlier, the PCM energizes the ASD Relay during an O2 sensor heater test. This test is performed only after the engine has been shut off. The PCM still operates internally to perform several checks, including monitoring the O2 heaters. This and the other DTC tests are explained in detail in the On–Board Diagnostic II Student Reference Book.

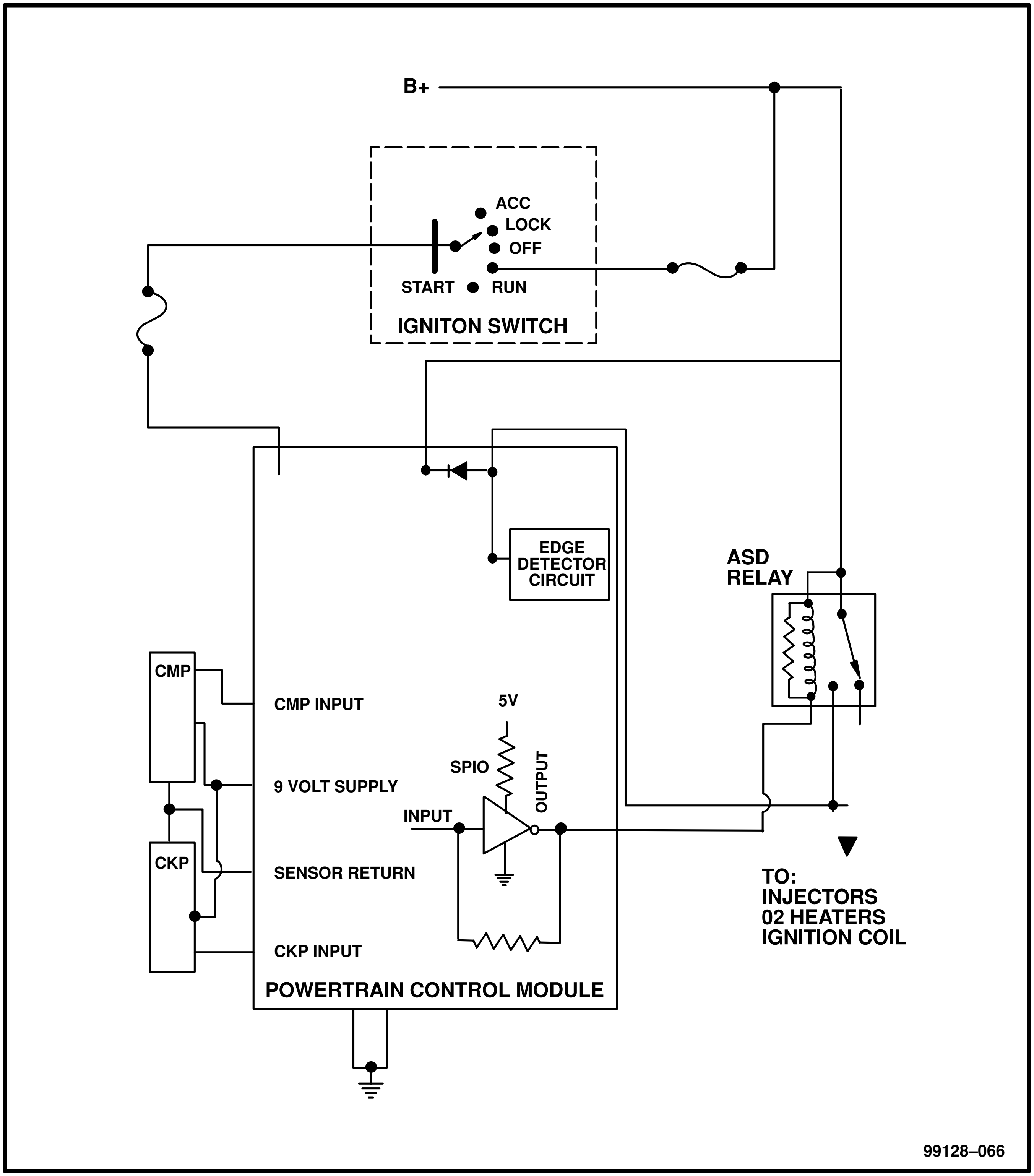


Figure 66 SBEC ASD Relay Circuit

FUEL PUMP RELAY

The Fuel Pump Relay is energized to provide power to operate the fuel pump under the following conditions:

- For approximately 1.8 seconds during the initial key–ON cycle.
- While the CKP Sensor is providing an rpm signal that exceeds a predetermined value.

Ignition voltage is provided to the Fuel Pump Relay electromagnet any time the key is in the RUN position (fig. 67). The PCM provides the ground control to energize the relay. Unlike previous Chrysler systems, the Fuel Pump Relay does not provide power to operate the O2 Sensor heaters.

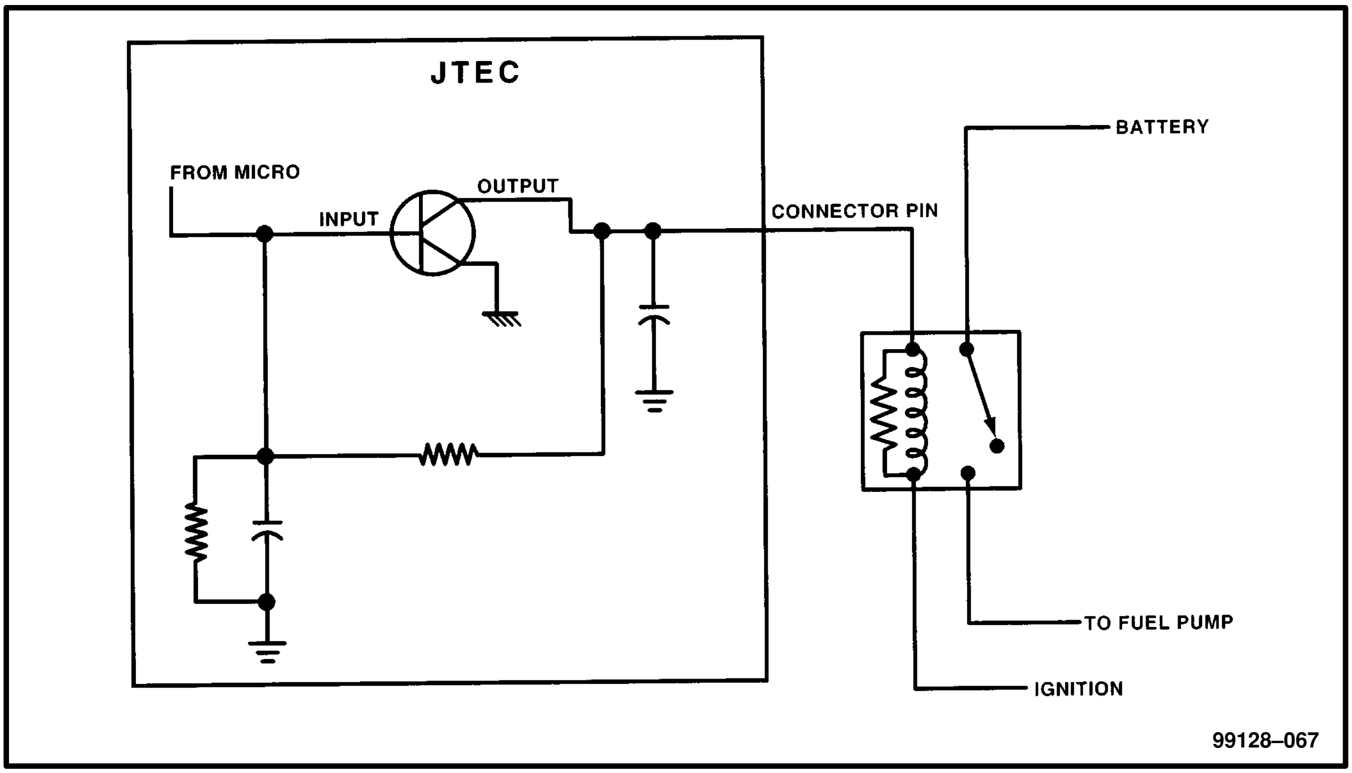


Figure 67 Fuel Pump Relay Circuit

The relay is energized when the key is cycled to RUN in order to prime the fuel rail with liquid fuel, allowing for a quick start–up. Anytime the CKP Sensor indicates that there is an rpm signal that exceeds a predetermined value, the relay is energized to ensure proper fuel pressure and volume during engine cranking and running conditions. Anytime the CKP Sensor signal is lost (engine has been shut off, or the sensor indicates no rpm), the Fuel Pump Relay is de–energized.

NOTES:

FUEL INJECTORS

The PCM provides battery voltage to each injector through the ASD Relay (figs. 68 & 69). Injector operation is controlled by a ground path, provided for each injector by the PCM. Injector on–time (pulse width) is variable, and is determined by the duration of the ground path provided.

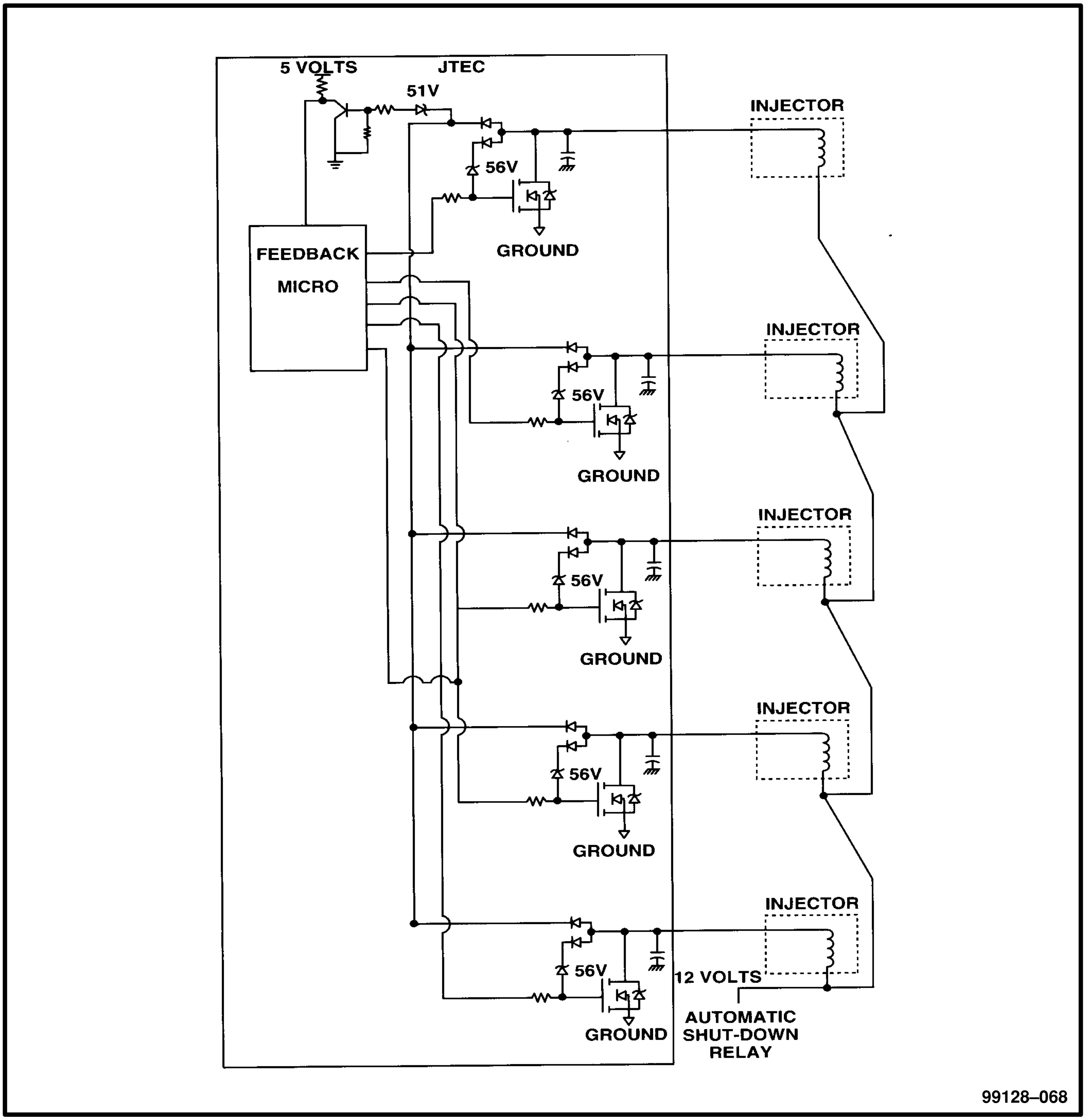


Figure 68 JTEC Fuel Injection Circuit

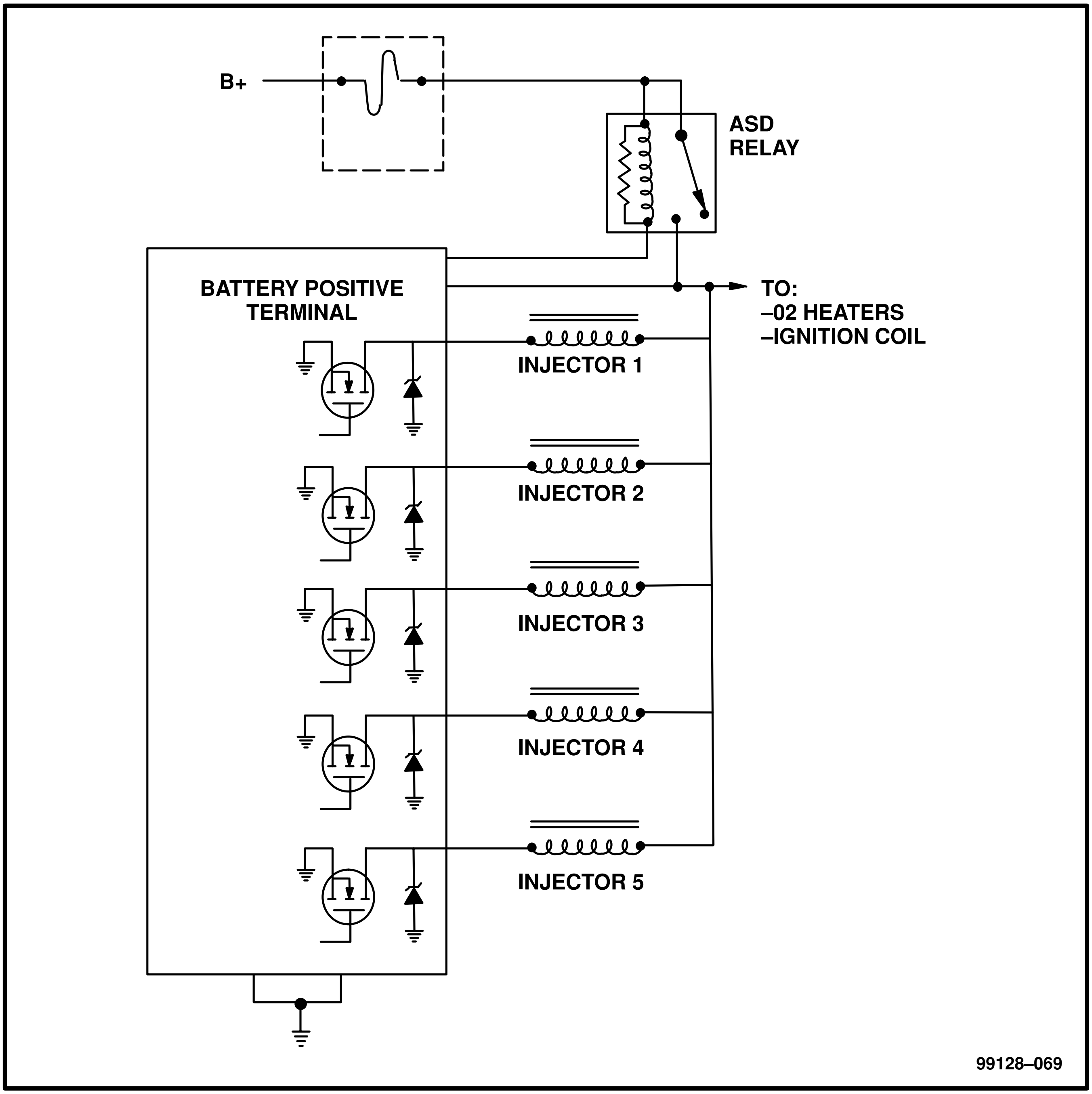


Figure 69 SBEC Fuel Injection Circuit

Fuel Injector Diagnostics

To diagnose an injector, the PCM monitors the voltage spike created by the collapse of the magnetic field through the injector coil. The inductive kick is approximately 60 volts (fig. 70). Any condition that restricts maximum current flow would not allow the kick to occur, resulting in an injector fault.

See the description of fuel injectors in the Fuel System Components Section of this reference guide, for further information.

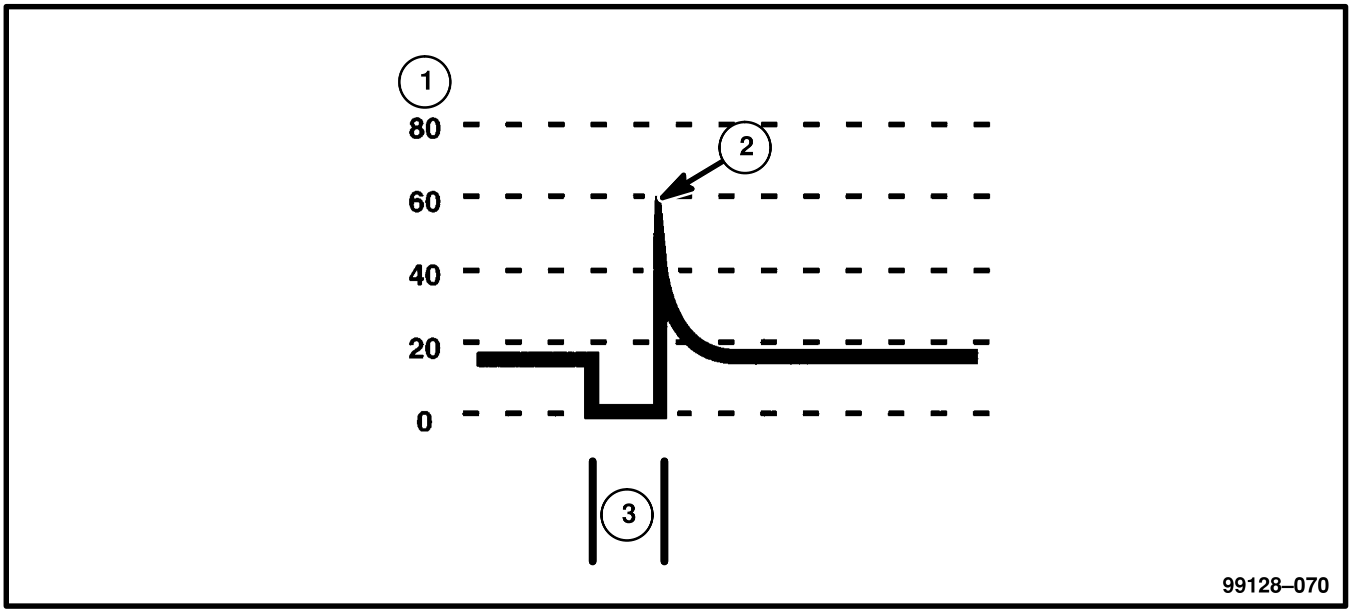


Figure 70 Injector Spike

1	Volts	3	Pulse Width
2	Kick		

IGNITION COILS

Note: *On SBEC/VIC vehicles, the ignition coils are controlled by the VIC. On JTEC vehicles, the ignition coils are controlled by the PCM.*

The PCM provides battery voltage to the ignition coils through the ASD Relay (fig. 71). Coil operation is controlled by a ground path provided to the coil by the PCM. The ignition coil fires a spark plug at every power stroke.

The PCM determines when to fire the coil, based on CMP and CKP Sensor inputs. The ignition coil primary is joined to the power wire from the ASD Relay. The ASD Relay provides battery feed to the ignition coil, while the PCM provides a ground contact for energizing the coil. When the PCM breaks the ground contact, power transfers from the primary to the secondary, causing the spark.

Resistance on the primary side of the coil should be between 0.51 and 0.61 ohms. The resistance of the secondary side is between 11,500 and 13,500 ohms. The coil has the ability to provide up to 40,000 volts, if needed.

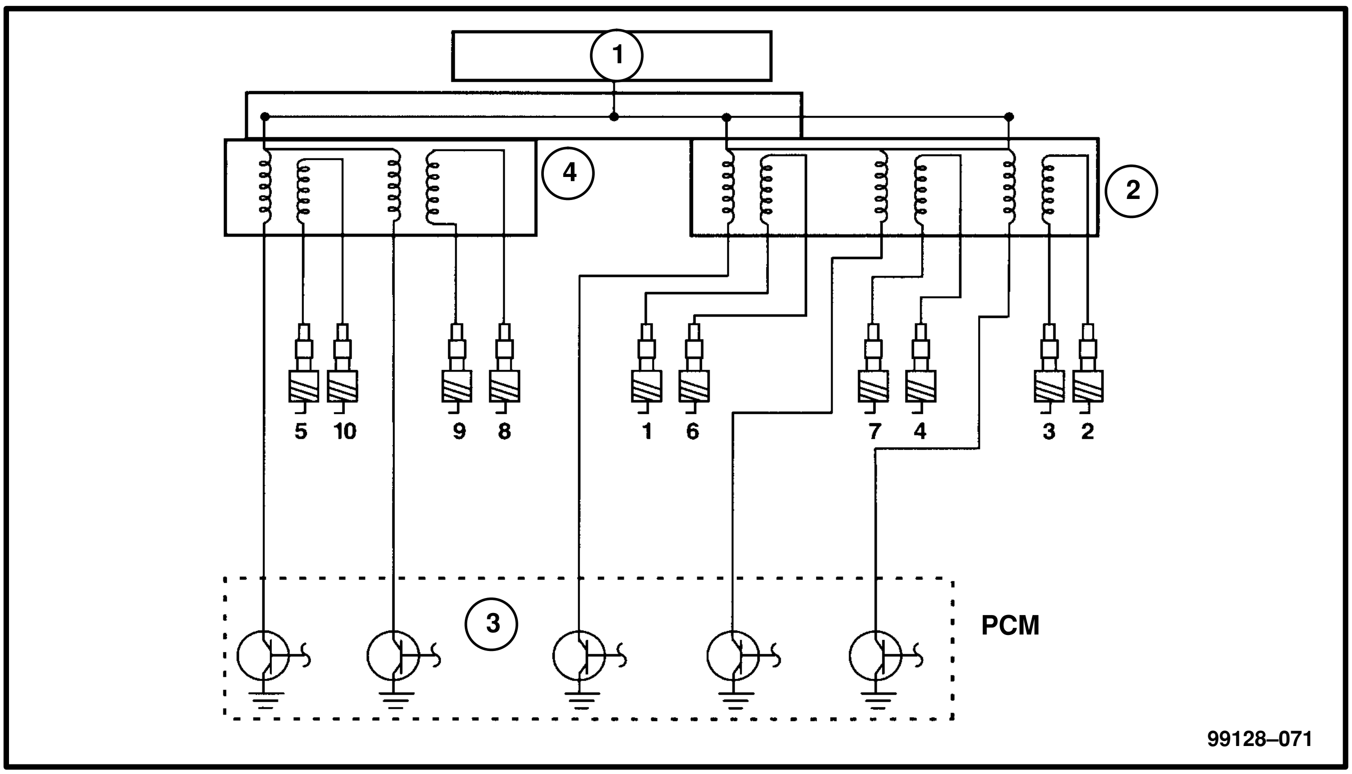


Figure 71 Ignition Control Circuit

1	12V From ASD Relay	3	Coil Drivers
2	Ignition Coil Pack	4	Ignition Coil Pack

Coil Operation

When a conductor is formed into a coil, the magnetic field is many times stronger than that of a single straight connector. To increase the strength of the magnetic field, you must either increase the number of loops in the coil, increase the amount of current flowing in the coil, or use a low–reluctance material for the core of the coil.

If one coil is placed near another coil, and the first coil is connected to a current, the expanding magnetic field induces a current into the second coil. The current induced into a coil is much higher than a current induced into a straight conductor. The coil that carries current: into this type of induction system is the primary winding of the coil. The coil into which electromotive force is induced, is the secondary winding of the coil. This mutual induction is the principle behind automotive ignition coils.

To induce a current, the magnetic field must be moving. Once the magnetic field has stabilized and is not expanding through the secondary conductor, no current is induced in the secondary conductor. As the field collapses, the lines of force pass through the secondary winding, which now induces a current in the opposite direction. When the field has completely collapsed, current flow in the secondary conductor stops.

The amount of secondary voltage generated depends on the amount of flux, the number of turns in the secondary coil, and the speed at which the primary current is interrupted. “Flux” refers to the lines of force in motion, which create a magnetic field. The amount of flux depends on the primary circuit. More current in this circuit means more flux. The flux moves through the windings of the secondary coil, so, more turns in the secondary coil result in more voltage. Flux collapses through the secondary coil when the primary current is interrupted. A quick interruption causes the flux to cut through the secondary windings faster. A quicker interruption results in more secondary voltage than a slow interruption.

DIS coils can be arranged in various alternations of polarity. It really does not matter if a spark fires positive or negative, as long as there is enough charge to jump the spark plug gap. The V10 engine uses 2 separate coil packs. One coil pack is for cylinders 1 & 6, 7 & 4, and 3 & 2 while the other coil pack is for cylinders 5 & 10 and 9 & 8.

The spark from a DIS coil moves from tower to tower using the block as a piece of wire to complete the circuit. This means that if any part of the circuit opens, both spark plugs will not fire. A spark will jump across the tip of the spark plug still connected to a coil tower. However, this spark is created by a capacitance effect and will not support a load on the engine.

PCM Operation

The PCM toggles the ignition coil current driver ON, and then at some point before the CKP Sensor indicates TDC, toggles it off. The amount of ON time (dwell), and the point at which the PCM toggles the driver OFF, is determined by several inputs to the PCM. To achieve the best spark advance program, the PCM calculates when to energize and de–energize the ignition coil.

These calculations require inputs from:

- CKP Sensor
- MAP Sensor
- ECT Sensor
- IAT Sensor
- TPS
- Engine rpm
- Battery voltage

Base timing is non–adjustable, but is set from the factory at approximately 10° BTDC when the engine is warm and idling.

Note: *JTEC examples given, SBEC similar.*

Dwell is a constant at low rpm based on battery voltage. The constant dwell allows for a constant voltage at the coil for a consistent spark. However, at higher rpm there isn't enough time for full saturation, so the PCM changes to an 80–20 duty cycle. By allowing current to flow 80% of the time, a sufficient magnetic field can be built regardless of rpm. This duty cycle allows for sufficient spark to operate.

As mentioned previously, the resistance of the coil primaries have a resistance of only .5 ohms. These are known as low impedance coils. Because of the low resistance the coils can allow significant current flow in excess of 15 amps. A rapid high current flow means a faster moving magnetic field which means a quicker coil saturation. To protect the PCM from damage due to high current flow, there is a current sensing device in the coil output circuit. As dwell time starts, the PCM allows full current flow. When the sensing device registers 8 amps, the PCM begins to regulate current flow to maintain and not exceed 8 amps for the remainder of the dwell time.

IDLE AIR CONTROL (IAC) STEPPER MOTOR

Description

The IAC stepper motor is mounted to the front of the intake manifold, and regulates the amount of air bypassing the control of the throttle plate (figs. 72 & 73). As engine loads and ambient temperatures change, engine rpm also changes. A pintle on the IAC stepper motor protrudes into a passage connected to both intake manifold plenums, controlling airflow through the passage. The IAC is controlled by the PCM to maintain the target engine idle speed.

At idle, engine speed can be increased by retracting the pintle and allowing more air to pass through the port, it can be decreased by restricting the passage with the pintle and diminishing the amount of air bypassing the throttle plate.

When engine rpm is above idle speed, the LAC is used for the functions listed below.

- Off–idle dashpot
- Deceleration airflow control

A/C compressor load control (also opens the passage slightly before the compressor is engaged so that the engine rpm does not dip down when the compressor engages).

The PCM can control polarity of the circuit to control direction of the stepper motor.

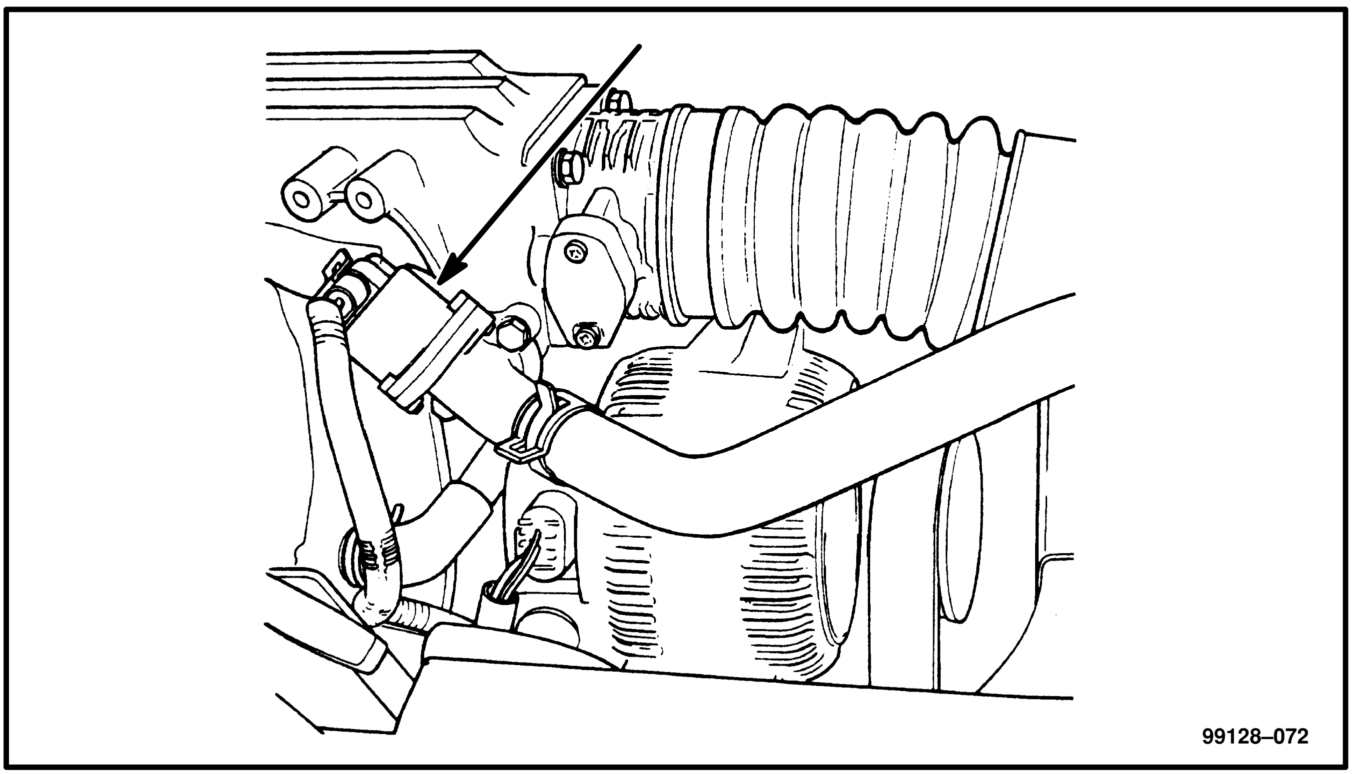


Figure 72 IAC Stepper Motor (1994–2000)

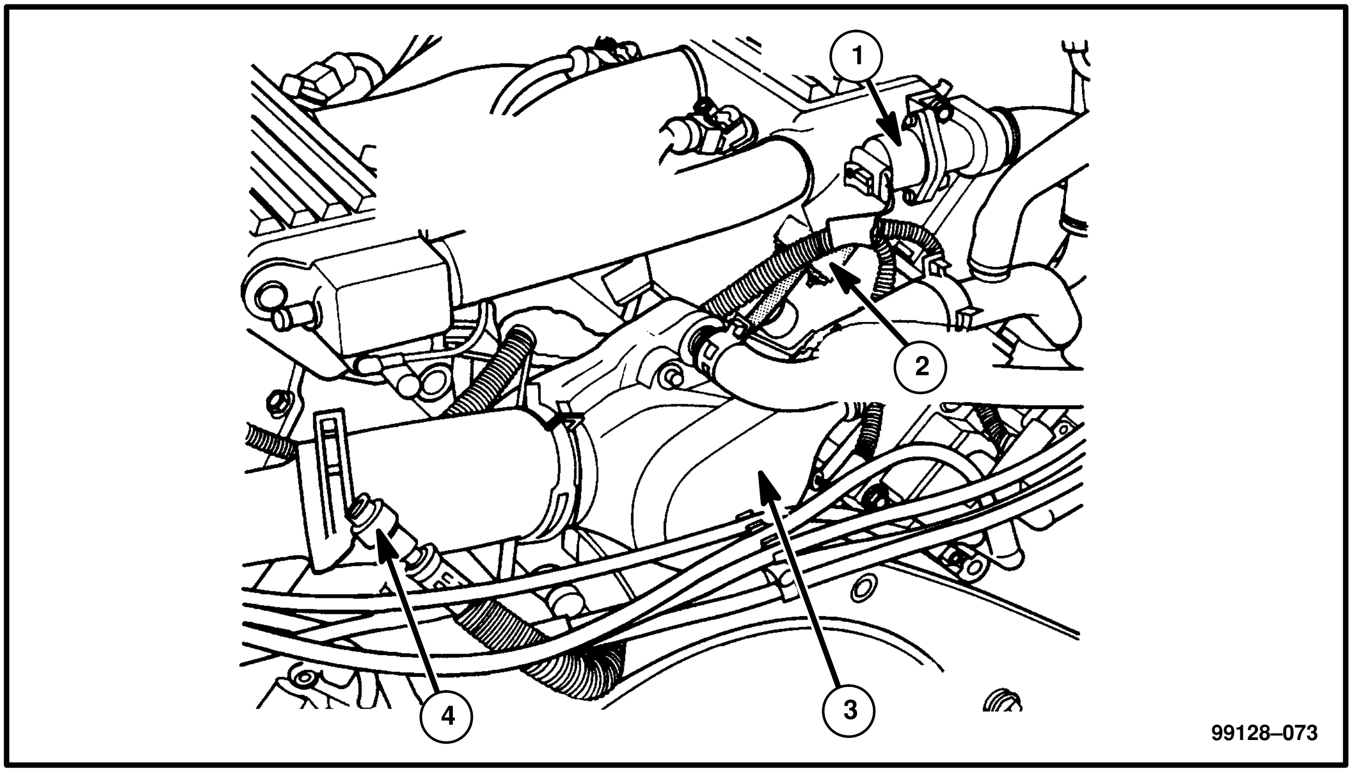


Figure 73 IAC Stepper Motor (1992–1993)

1	IAC Motor	3	Thermostat Housing
2	Fuel Rail Inlet	4	Fuel Pressure Line

Operation

The IAC is called a stepper motor because it is moved in "steps." The IAC motor is capable of 255 total steps, from fully closed to fully open. Opening the IAC in turn opens an air passage around the throttle blade which increases rpm.

The PCM uses the IAC motor to control idle speed (along with timing) and to reach a desired MAP during decel (keep engine from stalling).

The stepper motor has four wires (figs. 74 & 75). Two wires are for 12 volts. The other two wires are for ground. The stepper motor is not really a motor at all. The pintle that moves in and out can be thought of as a bolt with threads (fig. 76). The "nut" is a permanent magnet. There are two windings by the permanent magnet. When the PCM energizes one set of windings, this makes an electromagnet. The permanent magnet, which is allowed to rotate, is attracted to the electromagnet and rotates until the north and south poles line up. Once the poles line up, the nut stops turning. At this time, the PCM will energize the other winding. This moves the "nut" one more step. As the nut turns, the pintle (bolt) moves out or in.

To make the IAC move in the opposite direction, the PCM just reverses polarity on both windings. If only one wire is open, the IAC can only be moved one step in either direction.

Note: *To keep the IAC motor in position when no movement is needed, the PCM will energize both windings at the same time. This locks the IAC motor in place.*

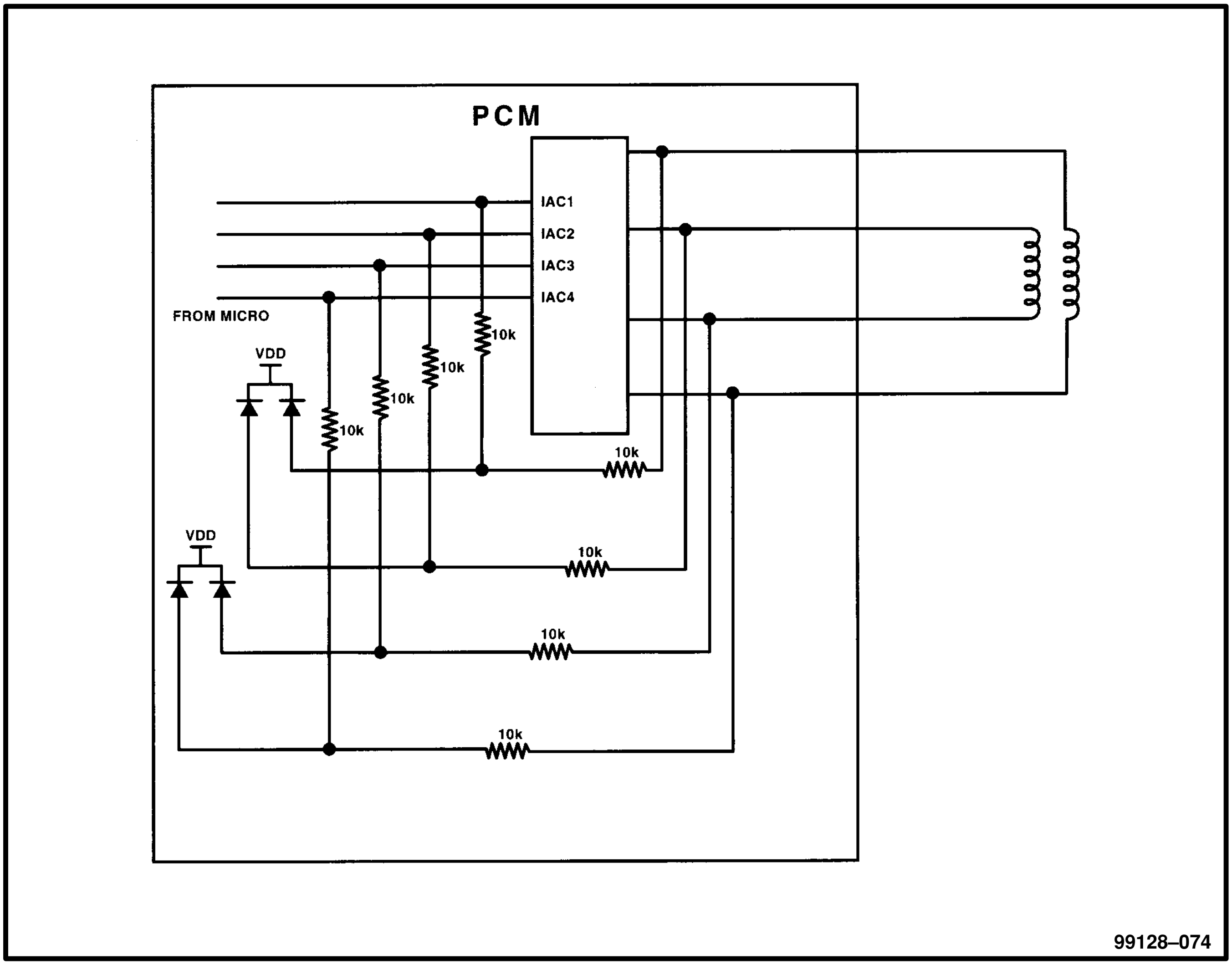


Figure 74 JTEC IAC Motor Control Circuit

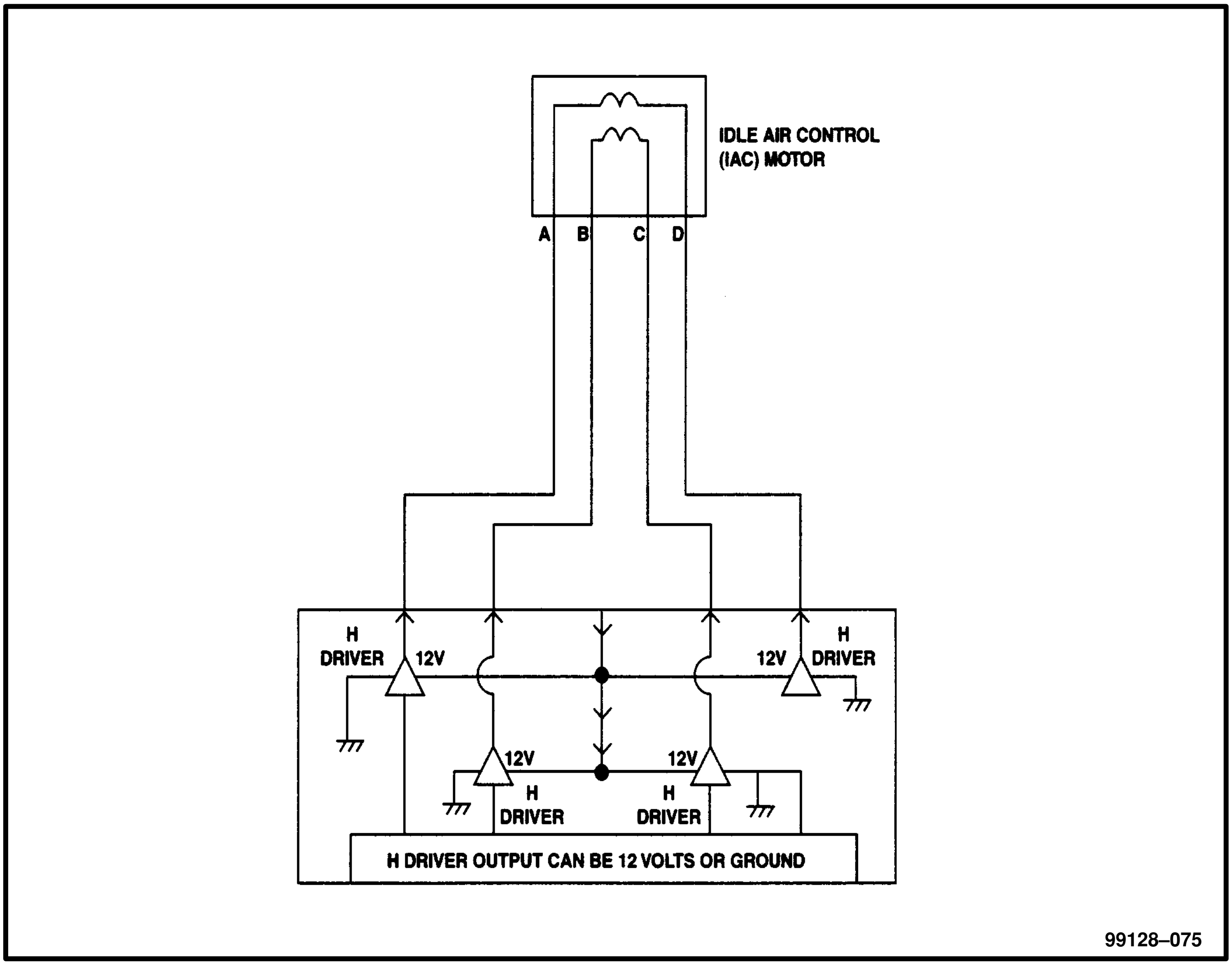


Figure 75 SBEC IAC Motor Control Circuit

In the IAC motor system, the PCM will count every step that the motor is moved. This allows the PCM to "know" the motor pintle position. If the memory is cleared, the PCM no longer knows the position of the pintle. So, at the first key–ON, the PCM drives the IAC motor closed, regardless of where it was before. This "zeros" the counter. From this point, the PCM will back out the IAC motor and keep track of its position again.

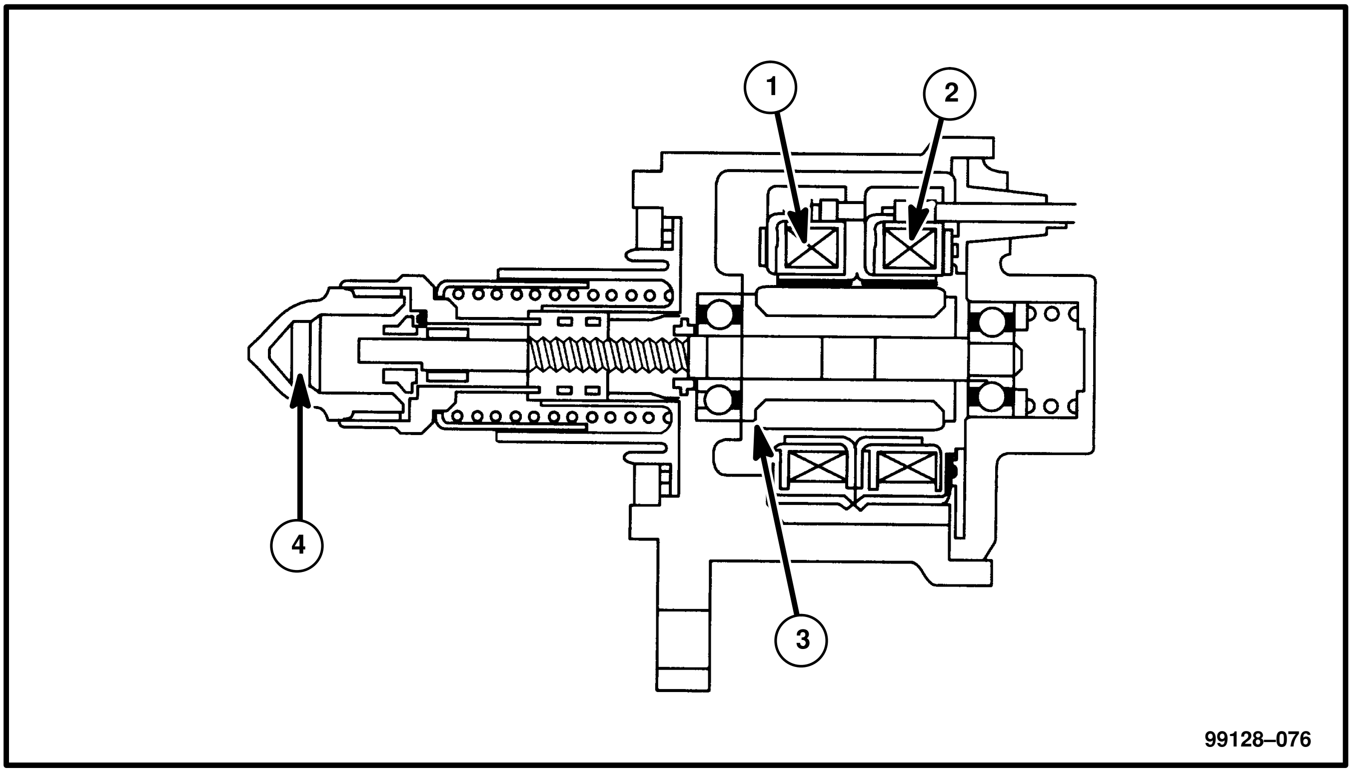


Figure 76 IAC Internal View

1	Coil A	3	Rotor Magnet
2	Coil B	4	Pintle Seat

NOTES:

IAC Stepper Motor Program

When the pintle has completely blocked the air passage, the IAC stepper motor is at step zero (fig. 77). The PCM has the authority to increase the opening by approximately 255 steps. The IAC stepper motor cannot identify in exactly which position the pintle is, so the PCM has a program that enables it to learn the position of the IAC pintle.

The program begins by learning step zero. This is accomplished by the PCM driving the IAC stepper motor closed for several seconds (when the key is first turned to the RUN position, after a battery disconnect). The PCM assumes, at the end of the cycle, the IAC stepper motor should be at step zero. Once the stepper motor finds step zero, the PCM backs the motor to the open position. The number of steps needed to arrive at the open position is based upon information delivered by the ECT sensor. The program can be updated by the DRBIII®, or by disconnecting battery voltage from the PCM and then reconnecting it.

The PCM is also equipped with a memory program that records the number of steps the IAC stepper motor most recently advanced to during a certain set of parameters. For example: The PCM was attempting to maintain a 750 rpm target during a hot start–up cycle. The last recorded number of steps for that may have been 27. That value would be recorded in the memory cell, so that the next time the PCM recognizes the identical conditions, the PCM recalls that 27 steps were required to maintain the target. This program allows for greater customer satisfaction due to greater control of engine idle.

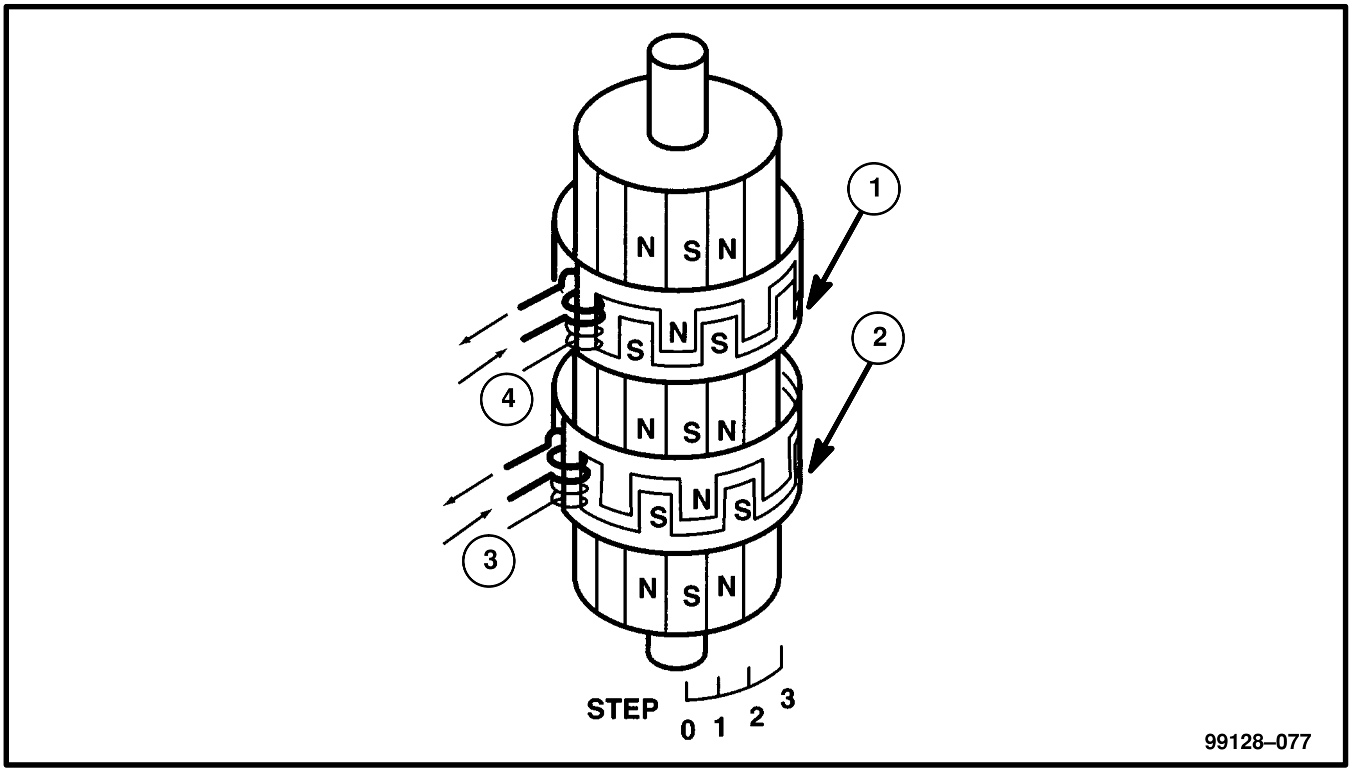


Figure 77 IAC Motor

1	Stator I	3	Coil B1
2	Stator II	4	Pintle Seat

Another function of the memory program during the key cycle occurs when the A/C request circuit requires the IAC stepper motor to control engine rpm. This is the recording of the last targeted steps.

As mentioned earlier, the PCM can "anticipate" compressor loads. This is accomplished by delaying compressor operation for approximately 0.5 second, until the PCM moves the IAC stepper motor to the recorded steps that were loaded into the memory cell. Using this program helps eliminate idle–quality changes as loads change.

Target Idle

Target idle is determined by the ECT Sensor.

IAC Motor Position

The IAC motor position is determined by the following inputs:

- ECT Sensor
- Battery Voltage
- Vehicle Speed (VSS)
- Throttle angle (TPS)
- MAP
- RPM
- A/C Compressor

IAC Stepper Motor Service

Anytime the IAC stepper motor or its circuit is serviced, the IAC memory cell must be updated. Use the DRBIII® to "Reset IAC." This ensures that the PCM can identify step zero. Also, be sure that when the IAC stepper motor is installed into the throttle body, the passage is clear of debris and that the pintle does not protrude too much. Before installing an IAC motor, make sure that the pintle is in a retracted position. This will ensure that the pintle and seat are not damaged when the IAC motor is installed.

IAC Diagnostics (JTEC)

IAC Diagnostics have changed with the use of JTEC. Open circuits are diagnosed if they are present at key–ON. However, if a driver circuit opens while the engine is running, it will not be diagnosed until the next key–ON cycle.

Short circuits to B+ and ground are diagnosed at key–ON and also while the engine is running.

RADIATOR FAN RELAYS

The fan(s) are turned on by the temperature of the coolant which is sensed by the ECT Sensor which sends the message to the PCM. The PCM turns on the fan through the Fan Relay(s). Switching through the PCM provides fan control for the following conditions:

- The fan(s) will not run during cranking until the engine starts no matter what the coolant temperature is.
- The low speed fan will run when the A/C is ON.
- The high speed fan will run when the PCM is in limp mode.
- Fan control is accomplished based on coolant temperature. Refer to Table 5 for fan operation data related to coolant temperature.
- Fan control is also dependent upon vehicle speed. On vehicles from 1992–1993, the fan will run at vehicle speeds above 40 mph only if coolant temperature reaches 110° C (230° F). It will turn off when the temperature drops to 104° C (220° F). At speeds below 40 mph, the fan switches on at 99° C (210° F) and off at 93° C (200° F).
- To help prevent steaming, the fan will run only below 16° C (60° F) ambient. Between 38° C (100° F) to 97° C (195° F) coolant temperature, at idle, and then only for three minutes.

Table Five Radiator Fan On/Off Values

A/C OFF	**Low Speed**	**High Speed**
Fan On	97° C (207° F)	102° C (216° F)
Fan Off	93° C (199° F)	97° C (207° F)
A/C ON		
Fan On	0° C (32° F)	101° C (214° F)
Fan Off	–4° C (25° F)	96° C (205° F)

Note: *The values shown above are approximate, and may vary between vehicles. On vehicles with dual radiator fans, both fans operate at the same time at slightly different speeds.*

1992–1995 SBEC Radiator Fans

From 1992–1993, Vipers were equipped with a dual–fan, single–speed radiator fan system (fig. 79). The Radiator Fan Relay on these vehicles was mounted on the heater housing, just below the blower motor (fig. 78). From 1994–1995, Vipers received a single–fan, dual speed radiator fan system (fig. 80). This change made the addition of a High Speed Fan Relay necessary.

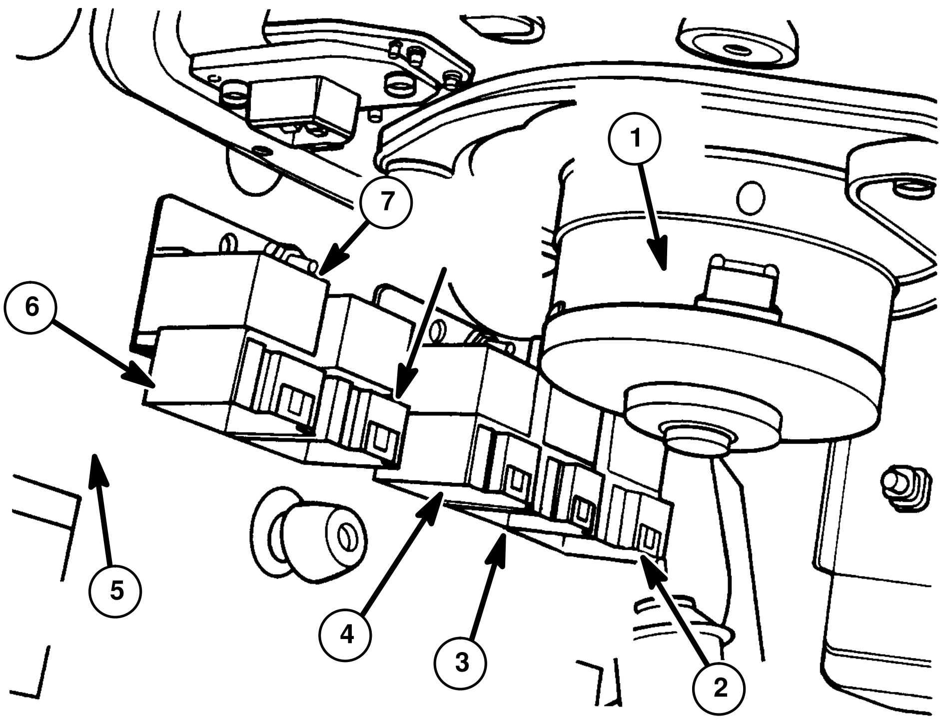


Figure 78 Radiator Fan Relays

1	Heater Blower Motor	5	Heater Housing
2	A/C Relay (1994 only)	6	A/C Relay (1993 only)
3	Starter Relay	7	Radiator Fan Relay (1994 only)
4	ASD Relay		

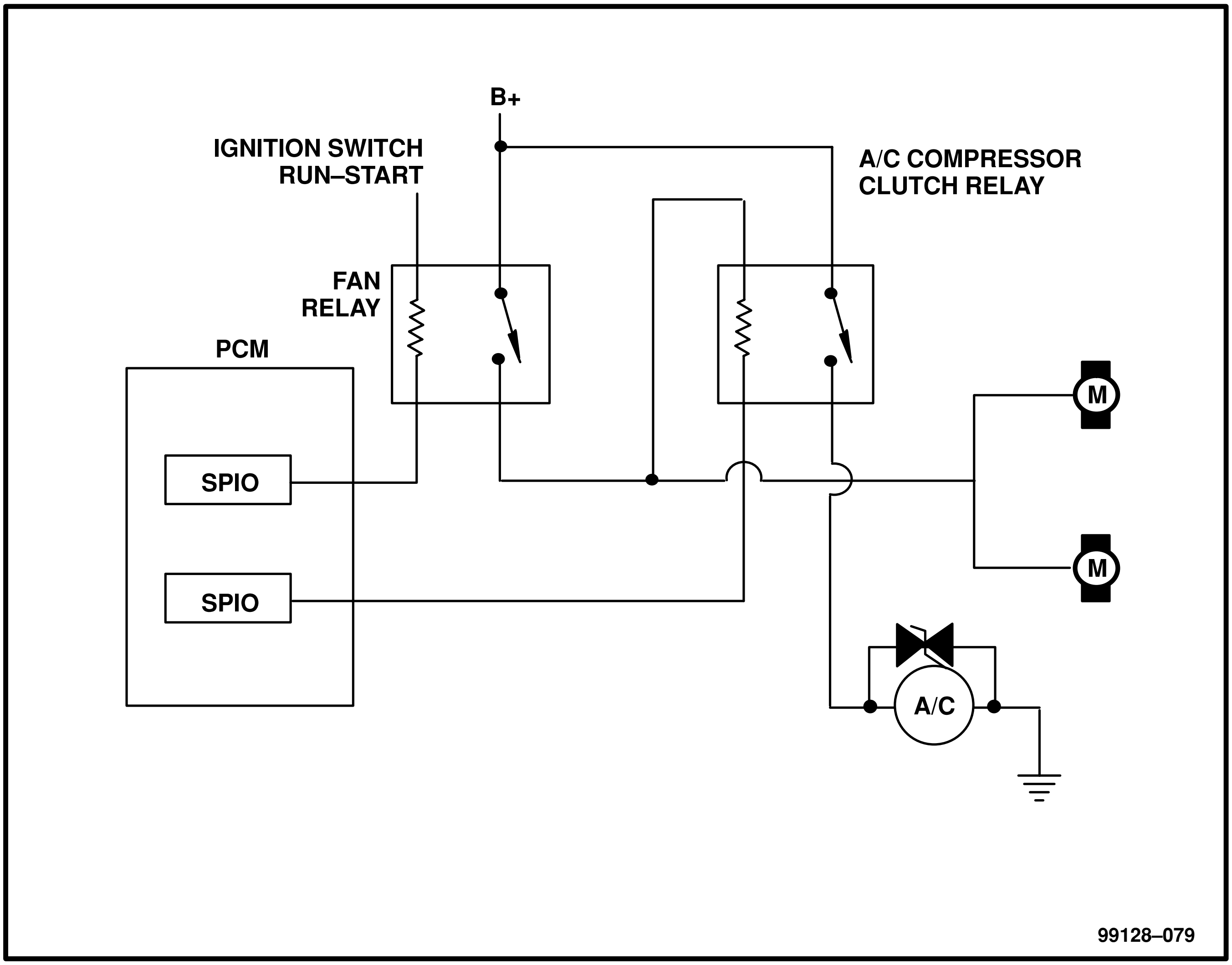


Figure 79 1992–1993 Dual Radiator Fan Circuit

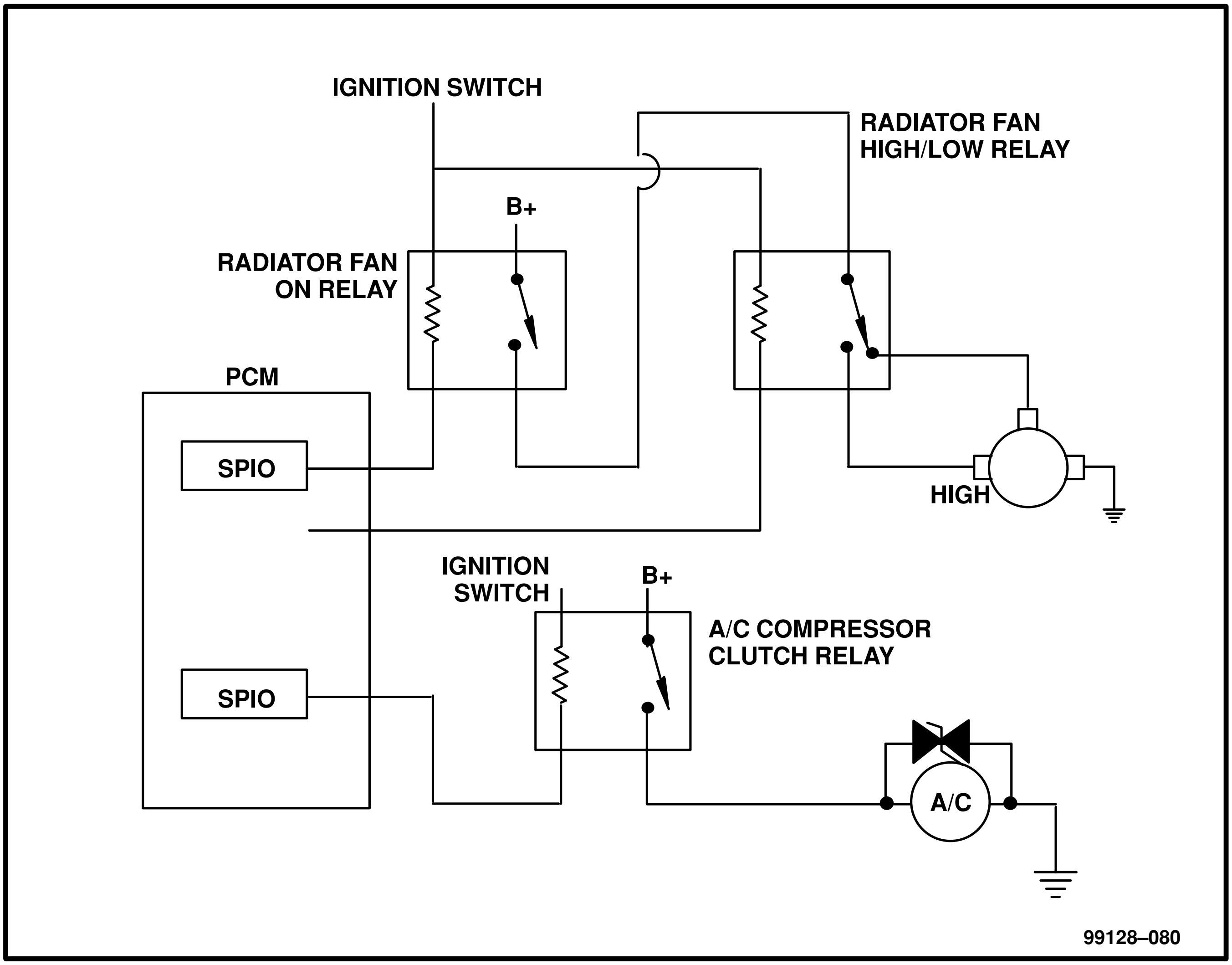


Figure 80 1994–1995 Single Radiator Fan Circuit

1996–2000 JTEC Radiator Fans

The two Radiator Fan Relays on the 1996 Roadster are located in the same spot as the 1992–1995 Roadsters (right hand side of engine compartment). On 1996 Coupes, and all Vipers from 1997 forward, the Radiator Fan Relays are located in the Power Distribution Center (PDC).

Radiator Fan ON Relay

The Radiator Fan ON Relay energizes when the PCM provides a ground to the relay.

In 1996, the cooling fan was turned off at 62 mph during acceleration and turned back on at 52 mph during deceleration. In 1997, the fan is turned off at 77 mph during acceleration and turned back on at 67 mph during deceleration.

Radiator Fan Low/High Relay

The Radiator Fan LOW/HIGH Relay works in conjunction with the Radiator Fan ON Relay (fig. 81). If the coolant temperature is below 102° C (216° F) the current flow for the fan is through the normally closed contacts of the LOW/HIGH relay. If the coolant temperature is above 102° C (216° F), the PCM grounds the LOW/HIGH Relay and the radiator fan changes to high speed. The PCM turns off high speed fan operation when coolant temperature drops to 102° C (216° F). The low speed will continue until temperature drops below 94° C (120° F).

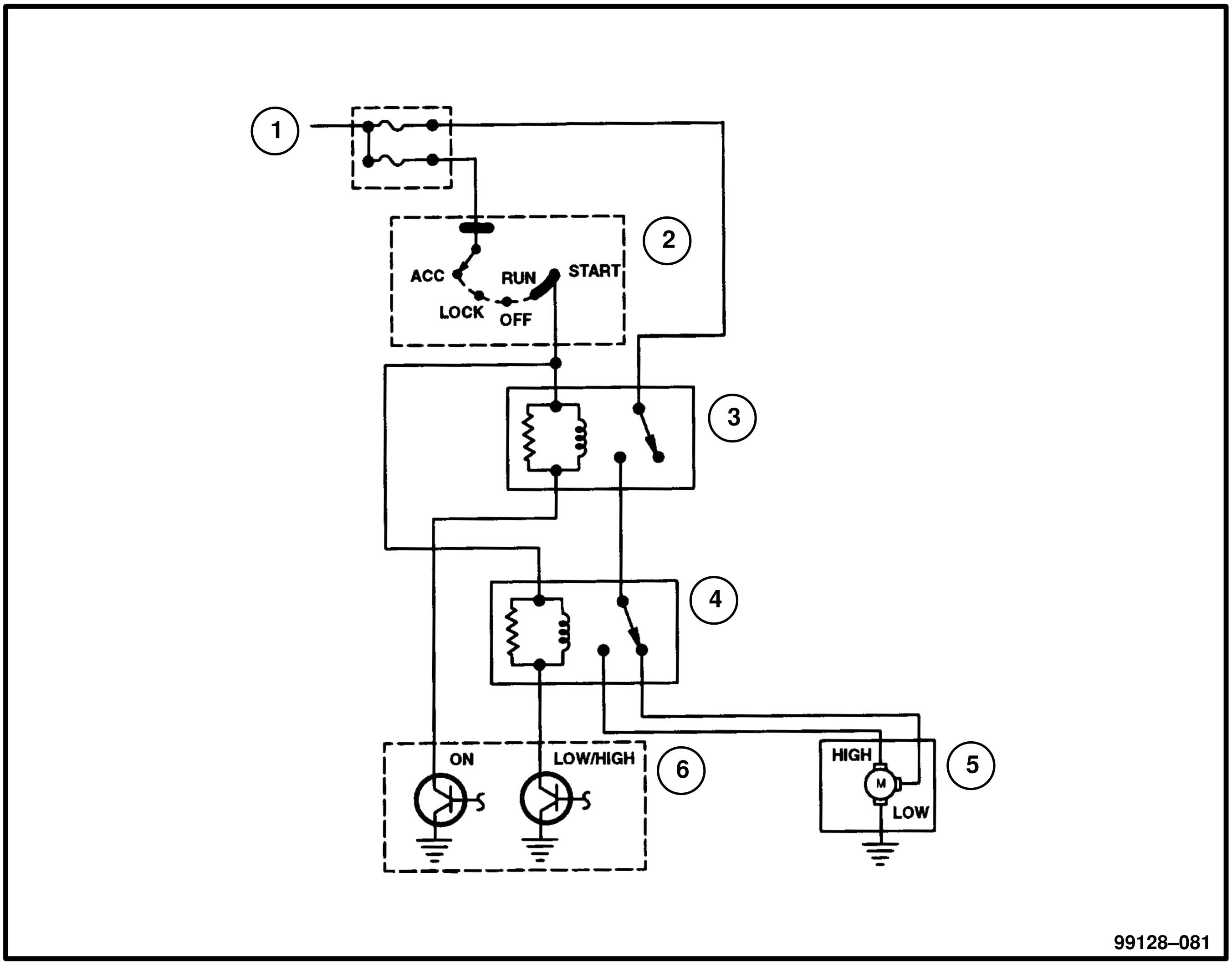


Figure 81 1996–2000 Radiator Fan Circuit

1	Battery Positive Terminal	4	Radiator Fan LOW/HIGH Relay
2	Ignition Switch	5	Radiator Fan Motor
3	Radiator Fan ON Relay	6	PCM

GENERATOR FIELD CONTROL – 1992–1996 ROADSTER

Generator field control is accomplished through the use of a voltage regulator which is internal to the generator. The charging system voltage on these vehicles is not controlled by the PCM.

GENERATOR FIELD CONTROL – EXCEPT 1992–1996 ROADSTER

The PCM regulates charging system voltage and determines the final goal or "target charging voltage." The target charging voltage is controlled mainly by the battery temperature sensor, which is located under the battery tray. Power to the generator field wiring is supplied by the ASD Relay (fig. 82).

The PCM monitors battery voltage. If it senses that battery voltage is more than 0.5 volt lower than the target voltage, the PCM grounds the field winding until sensed battery voltage is 0.5 volt above target voltage. A circuit in the PCM cycles the ground side of the generator field up to 100 times per second (100 Hz), but has the capability to ground the field control wire 100% of the time full field, to achieve the target voltage. If the charging rate cannot be monitored (limp–in), a duty cycle of 25% is used by the PCM in order to have some generator output.

Note: *Externally, the generators on the 1996 Viper look very similar. The generator for the Roadster has an internal voltage regulator while the Coupe is regulated by the PCM. Do not interchange the generators.*

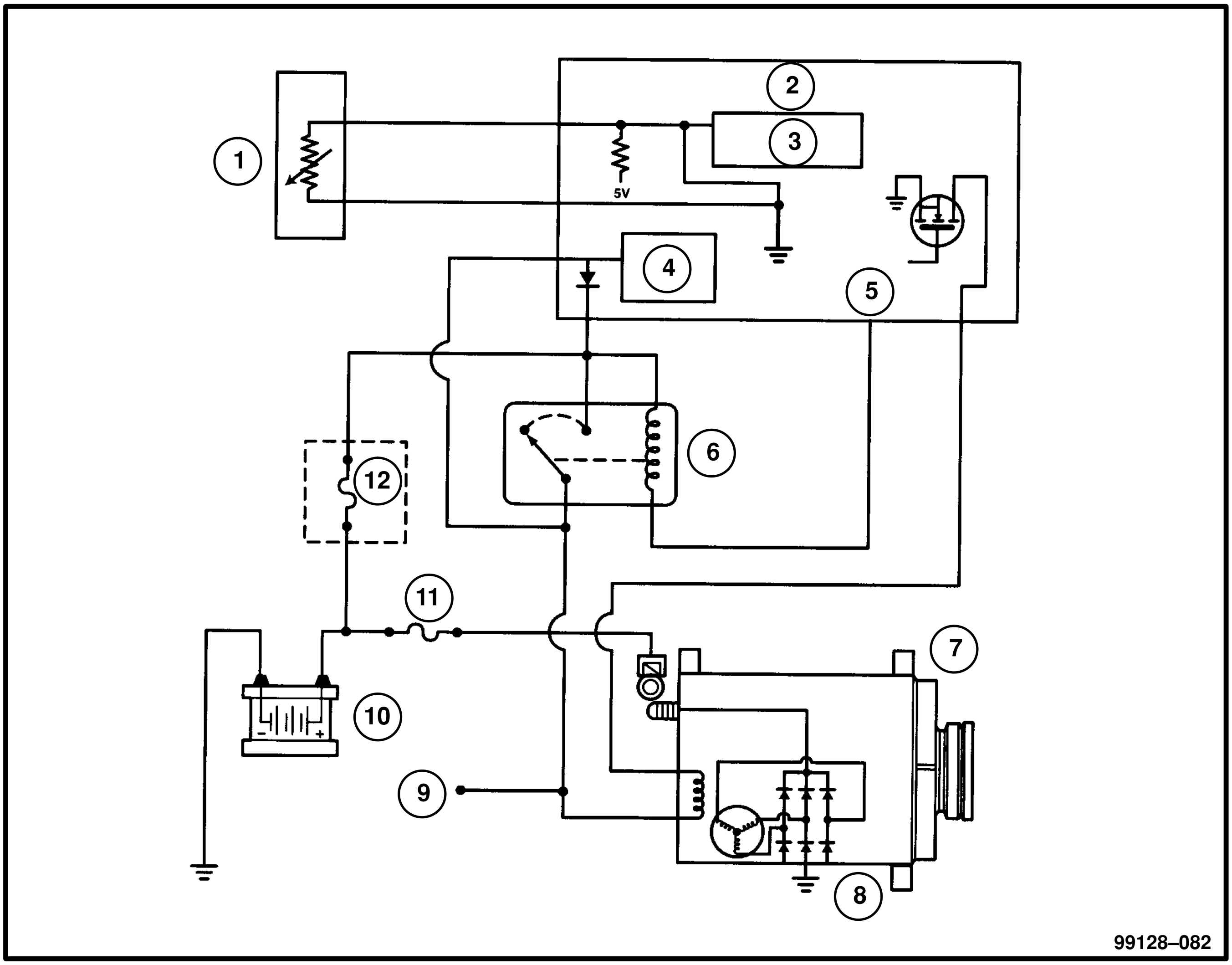


Figure 82 Generator Field Control Circuit (1996 Coupe, 1997–2000 All)

1	Battery Temperature Sensor	7	Generator
2	PCM	8	Case Ground
3	A/D Converter	9	To Ignition Coil, Injectors, O2 Heaters
4	Voltage Level Detection Circuit	10	Battery
5	ASD Relay Control	11	Fuse Link
6	ASD Relay	12	PDC Fuse

CHARGING SYSTEM INDICATOR LIGHT – 1992–1996 ROADSTER

As mentioned earlier, generator field control is accomplished through the use of an internal voltage regulator in the generator, which is not affected by the PCM. The charging system indicator light is controlled directly by the generator.

CHARGING SYSTEM INDICATOR LIGHT – 1996 COUPE, 1997–2000 ALL

The PCM controls the operation of the charging–system indicator light, located in the vehicle's instrument cluster. The PCM provides a ground to complete the lamp circuit if a charging system fault is set (fig. 83).

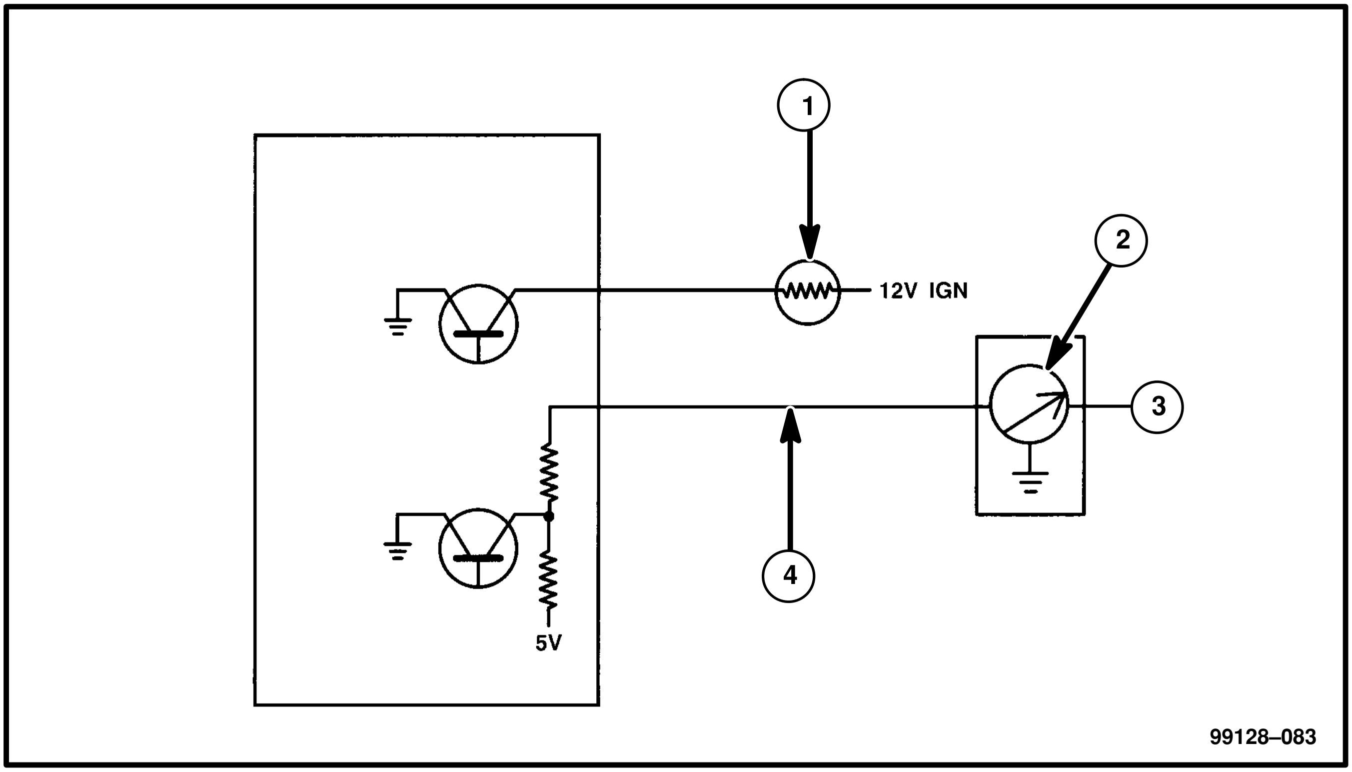


Figure 83 Charging System Indicator Light (1996 Coupe, 1997–2000 All)

1	Under/Over Charge Indicator Light	3	Ignition Voltage
2	Tachometer	4	Tachometer Output

TACHOMETER

The PCM operates the tachometer which is located in the instrument panel. The PCM provides duty–cycle output voltage to the tachometer. The frequency of the duty cycle is based upon engine speed which is calculated from inputs from the CKP Sensor.

REVERSE LOCKOUT SOLENOID

The reverse lockout solenoid is located at the rear of the transmission housing. The reverse lockout solenoid prevents the operator from shifting into reverse when the vehicle speed is greater than 5 mph. When vehicle speed is less than 5 mph, the PCM provides a ground for the solenoid (energized) and allows shifting (fig. 84). When vehicle speed is greater than 5 mph, the solenoid is deactivated and prevents the transmission from being shifted into reverse.

SKIP SHIFT SOLENOID AND INDICATOR LAMP

The skip shift solenoid is also located at the rear of the transmission housing. The skip shift solenoid prevents the operator from shifting from first gear into second and third gear during certain conditions. The PCM controls the skip shift solenoid and the skip shift indicator lamp (fig. 84). The lamp informs the driver that the shift lever will be redirected to fourth gear, “skipping” 2nd and 3rd completely. The PCM locks out second and third gear and illuminates the skip shift lamp when all of the following conditions are met:

- Engine coolant exceeds 41° C (106° F)
- Vehicle speed is between 12 and 18 MPH
- Engine operating above 608 RPM
- The PCM verified first gear speed/RPM
- Throttle position sensor (TPS) signal is less than 0.68 volt above close throttle (23 percent throttle opening)

The program resets when vehicle speed drops below 2 MPH and is considered completed once the conditions have exceeded, whether the trans was shifted or not.

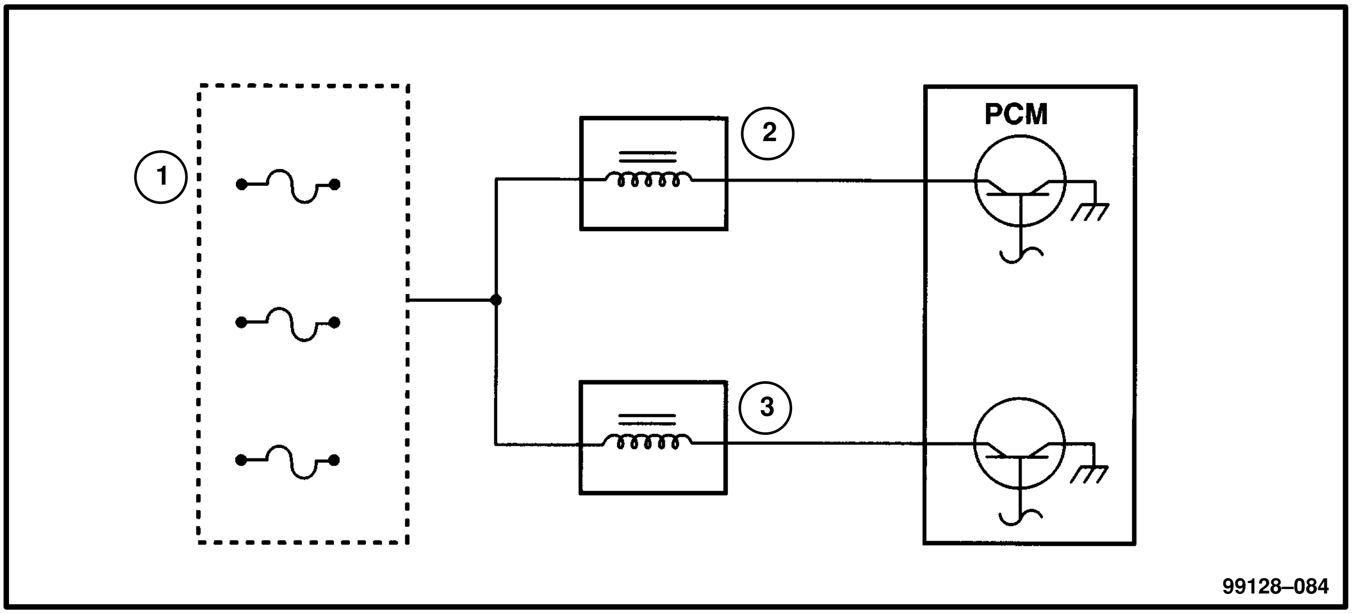


Figure 84 Skip Shift and Reverse Lockout Solenoids

1	Fuse Block	3	Reverse Lockout Solenoid
2	Skip Shift Solenoid		

MALFUNCTION INDICATOR LAMP (MIL)

Note: *Only Vipers equipped with a JTEC PCM (1996 and Up) are OBD II compliant.*

The MIL (CHECK ENGINE) lamp is located in the instrument cluster. The PCM operates the MIL which illuminates for a three–second bulb test whenever the ignition is turned ON. The MIL lamp remains continuously illuminated when an emissions component fails, or when the vehicle enters a limp–in mode. In limp–in mode, the PCM provides programmed inputs to keep the vehicle operational.

Because the vehicle is equipped with OBD II diagnostic capabilities (JTEC only), the MIL flashes if the onboard diagnostic system detects engine misfire severe enough to damage the catalytic converter. The vehicle should not be driven if this occurs.

Anytime the MIL is illuminated, a DTC is stored and the PCM must meet certain criteria to extinguish the lamp. On vehicles equipped with OBD I diagnostics (1992–1995 Vipers), the MIL would normally extinguish after the problem that caused the MIL to illuminate was no longer present, and the key had been cycled from OFF to ON one time. However, on ALL JTEC vehicles, three consecutive “good” trips must occur to extinguish the MIL.

If a problem occurred with one of the main OBD II monitors, the PCM must pass the test of the monitor that failed three consecutive times. On the fourth key–ON register, the MIL is extinguished.

DTCs that were stored can be erased automatically only after the MIL has been extinguished and 40 warm–up cycles have occurred or with the DRBIII®.

Trip Definition – 1996–2000 Only

The term “trip” has different meanings depending on the circumstances. If the MIL (Malfunction Indicator Lamp) is OFF, a trip is when the Oxygen Sensor Monitor and the Catalyst Monitor have been completed in the same drive cycle.

When any emission DTC is set, the MIL on the dash is turned ON. When the MIL is ON, it takes three “good” trips to turn the MIL OFF. In this case, it depends on what type of DTC is set to know what a trip is. The minimum requirement is engine running for 2 minutes with no faults detected.

For the Fuel Monitor or Misfire Monitor (continuous monitor), the vehicle must be operated in the “Similar Condition Window” for a specified amount of time to be considered a good trip.

Non–continuous OBD II monitors include:

- Oxygen Sensor
- Catalyst Monitor
- Purge Flow Monitor
- Leak Detection Pump Monitor (if so equipped)
- Oxygen Sensor Heater Monitor

If any of these monitors fail twice in a row on two separate key cycles, turn on the MIL, and successfully rerun on the next start–up, it is considered a good trip.

Other examples of good trips are:

- Completion of 02 Sensor and Catalyst monitors after an emissions DTC (not an ODB II monitor) is set.
- Engine run–time of two minutes if the Oxygen Sensor Monitor or Catalyst Monitor have been stopped from running.

It can take up to two failures in a row to turn on the MIL. After the MIL is ON, it takes three good trips to turn the MIL OFF. After the MIL is OFF, the PCM will self–erase the DTC after 40 warm–up cycles. A warm–up cycle is counted when the ECT (Engine Coolant Temperature) sensor has crossed 160° F and has risen by at least 40° F since the engine was started.

Refer to the OBD II course for additional information.

EVAPORATIVE PURGE SOLENOID

The PCM controls Evaporative Purge Solenoid operation and provides a ground path that allows the solenoid to open. Refer to the Emission Control Systems section of this publication for more information.

LEAK–DETECTION PUMP SOLENOID (STARTING IN 1998)

The PCM energizes the Leak–Detection Pump Solenoid when specific operating conditions have been met. Refer to the Emission Control Systems section of this publication for more information.

NOTES:

EMISSIONS CONTROL SYSTEM

The emissions control system is comprised of evaporative emissions and exhaust emissions. Its function is to control the output of Hydrocarbons (HC), Carbon Monoxide (CO) and Oxides of Nitrogen (NOx). The PCM controls exhaust emissions by monitoring the inputs and controlling Fuel and ignition systems. A three–way catalyst is also used.

EVAPORATIVE EMISSION CONTROL

The evap control system consists of: fuel cap, rollover valves, vapor lines, filler neck, evap canister, Duty Cycle Purge (DCP) solenoid, and orifice. On some vehicles, there is also an Evaporative System Leak Detection pump (fig. 85). For the 2000 model year the canister and LDP move to the rear of the vehicle.

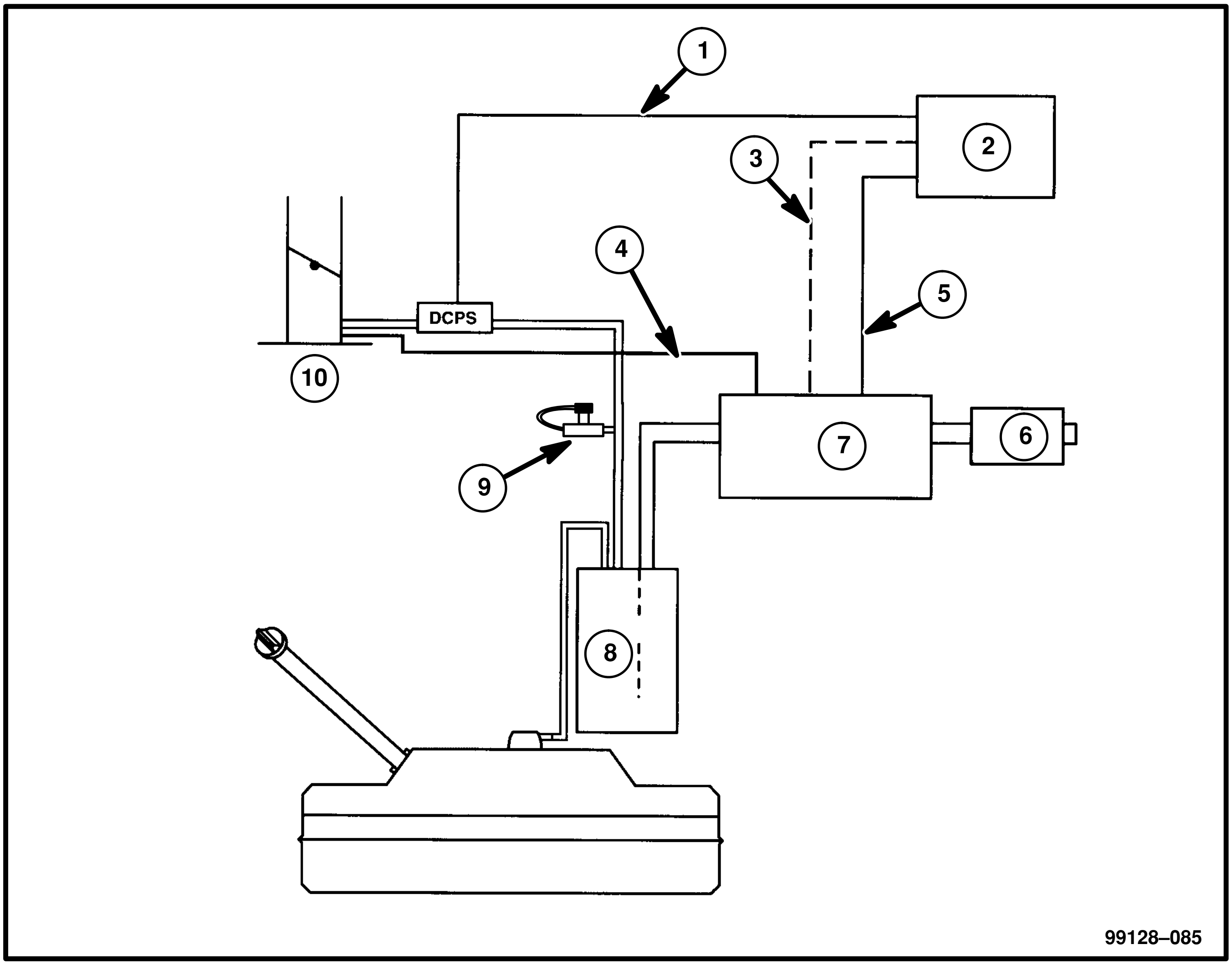


Figure 85 EVAP Leak Detection Pump System (1998,1999 & 2000)

1	Duty Cycle Purge Solenoid Driver	6	Remote Filter
2	PCM	7	Combined Canister Vent Valve and Leak Detection Pump
3	Switch Signal Input to the PCM	8	Canister
4	Vacuum Line	9	Service Port
5	3–Port Solenoid Driver	10	Throttle Body

Fuel Filler Cap

The fuel filler cap is a screw–on type, with a ratchet mechanism to keep the tightening force on the filler cap constant. Also, the cap is equipped with a valve to relieve both pressure and vacuum extremes in the fuel tank.

Rollover Valves

The rollover valve is designed to allow fuel tank vapors to be routed to the canister. If an accident causes the vehicle to overturn, a check valve prevents fuel from entering the vapor line.

Purge Solenoid (Bi–Level Purge) (1992–1995)

The purge solenoid is mounted on the charcoal canister (fig. 86). Its purpose is to prevent the release of unburned hydocarbons from gasoline vapor into the atmosphere. The solenoid controls the application of manifold vacuum to the canister purge valve on top of the canister. With the solenoid in its de–energized state, manifold vacuum is supplied to the purge control valve to open it, allowing vapor purge.

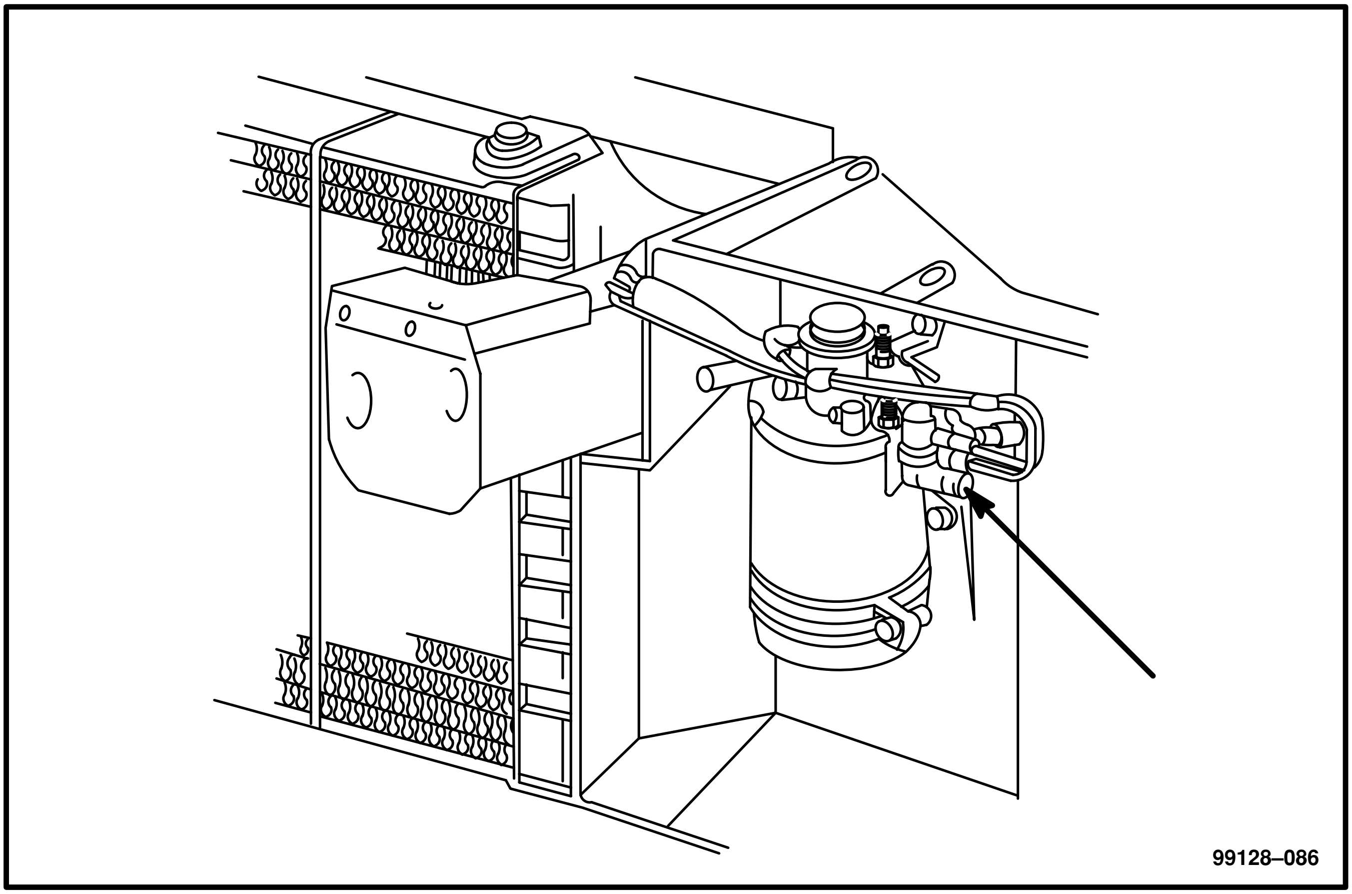


Figure 86 Purge Solenoid (1992–1995)

Duty–Cycle Purge Solenoid (1996–2000)

The duty–cycle EVAP purge solenoid regulates the rate of vapor flow from the EVAP canister to the throttle body. The PCM operates the solenoid.

During the cold–start warm up period and the hot start time delay, the PCM does not energize the solenoid. When de–energized, no vapors are purged.

When purging, the PCM energizes and de–energizes the solenoid approximately 5 or 10 times per second, depending upon operating conditions. The PCM varies the vapor flow rate by changing solenoid pulse width (fig. 87).

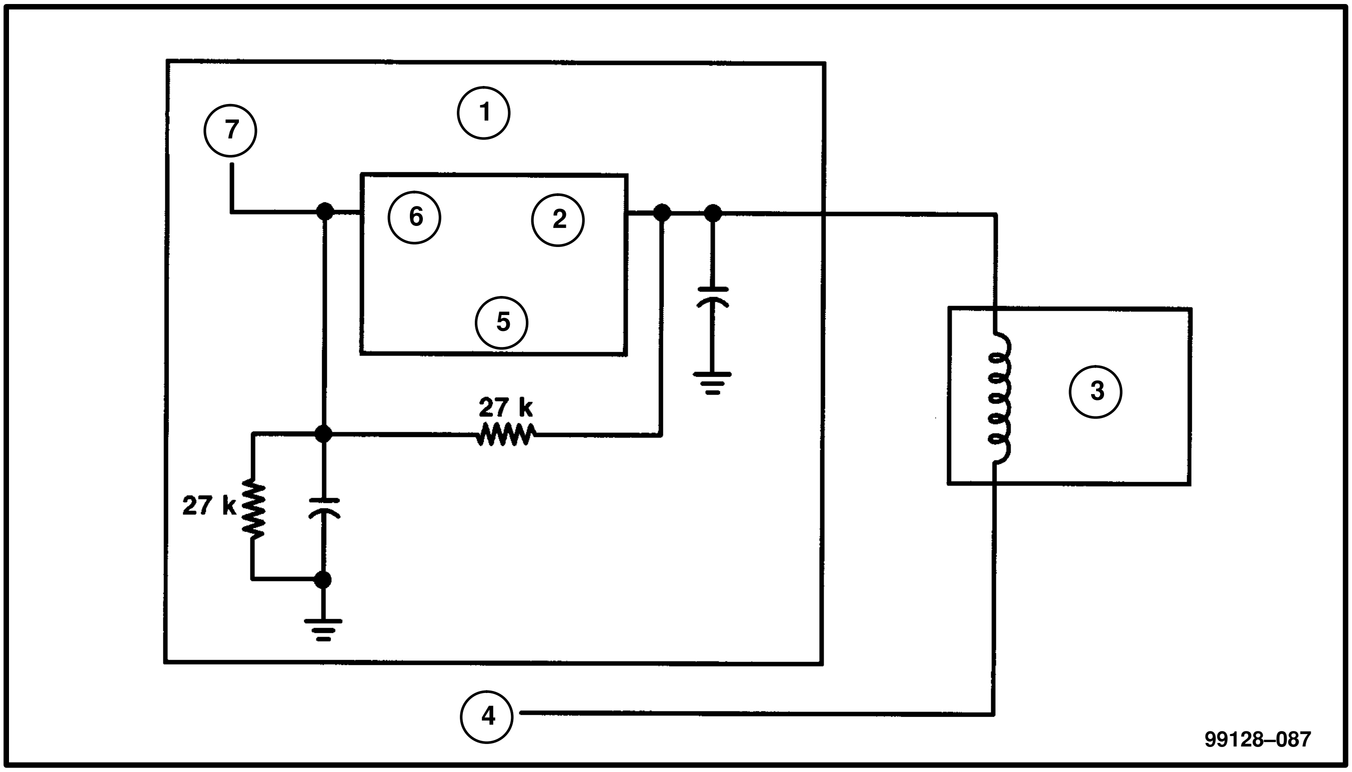


Figure 87 Duty Cycle Purge Solenoid Control Circuit (1996–2000)

1	JTEC PCM	5	Quad Driver
2	Output	6	Input
3	Purge Solenoid	7	From Micro
4	Ignition		

Fuel–Vapor Recovery System (Duty–Cycle Purge Control)

Duty–Cycle Purge is a system that feeds fuel gases from the purge canister and gasoline tank into the throttle body for mixing with incoming air. The system meters gases when the PCM duty–cycles the purge solenoid.

The system is disabled during Wide Open Throttle (WOT) conditions and while the engine is below a specified coolant temperature. When engine temperature exceeds a calibrated parameter, duty cycle purge is delayed for a calibrated time. Once purge delay is over, purge will be ramped in to soften the effect of dumping additional fuel into the engine.

The PCM provides a duty–cycle operating at 5 Hz (at closed throttle) or 10 Hz (at open throttle) to control this system. The duty–cycle is based upon a calculated airflow (based upon known fuel flow through the injector at a given pulse width and rpm) and is adjusted to compensate for changes in flow due to varying engine vacuum.

The duty–cycle represents the amount of On/Off time, while the Hz represents how often the duty–cycle is repeated.

On–Board Refueling Vapor Recovery (ORVR) System – 2000

ORVR is the recovery of the fuel vapors during the refueling event. This is done by venting the fuel vapors to the canister while refueling, and by reducing the diameter of the fill pipe. The small diameter fill pipe gives a solid column of fuel, which causes a venturi effect, drawing air and vapor into the fuel tank and canister. The canister is located in close proximity to the fuel tank, and has a large diameter supply line to reduce any restrictions while refueling.

Note: *On ORVR vehicles, when fueling, once the pump nozzle shuts off, the tank is full. Additional fuel should not be added after the pump shuts off.*

Leak Detection Pump (Beginning in 1998)

The leak detection pump is a device that pressurizes the evaporative system to determine if there are any leaks. When certain conditions are met, the PCM will activate the pump and start counting pump strokes (fig. 88). If the pump stops within a calibrated number of strokes, the system is determined to be leak free. If the pump does not stop, a DTC will be set. Refer to the OBD II course for more information.

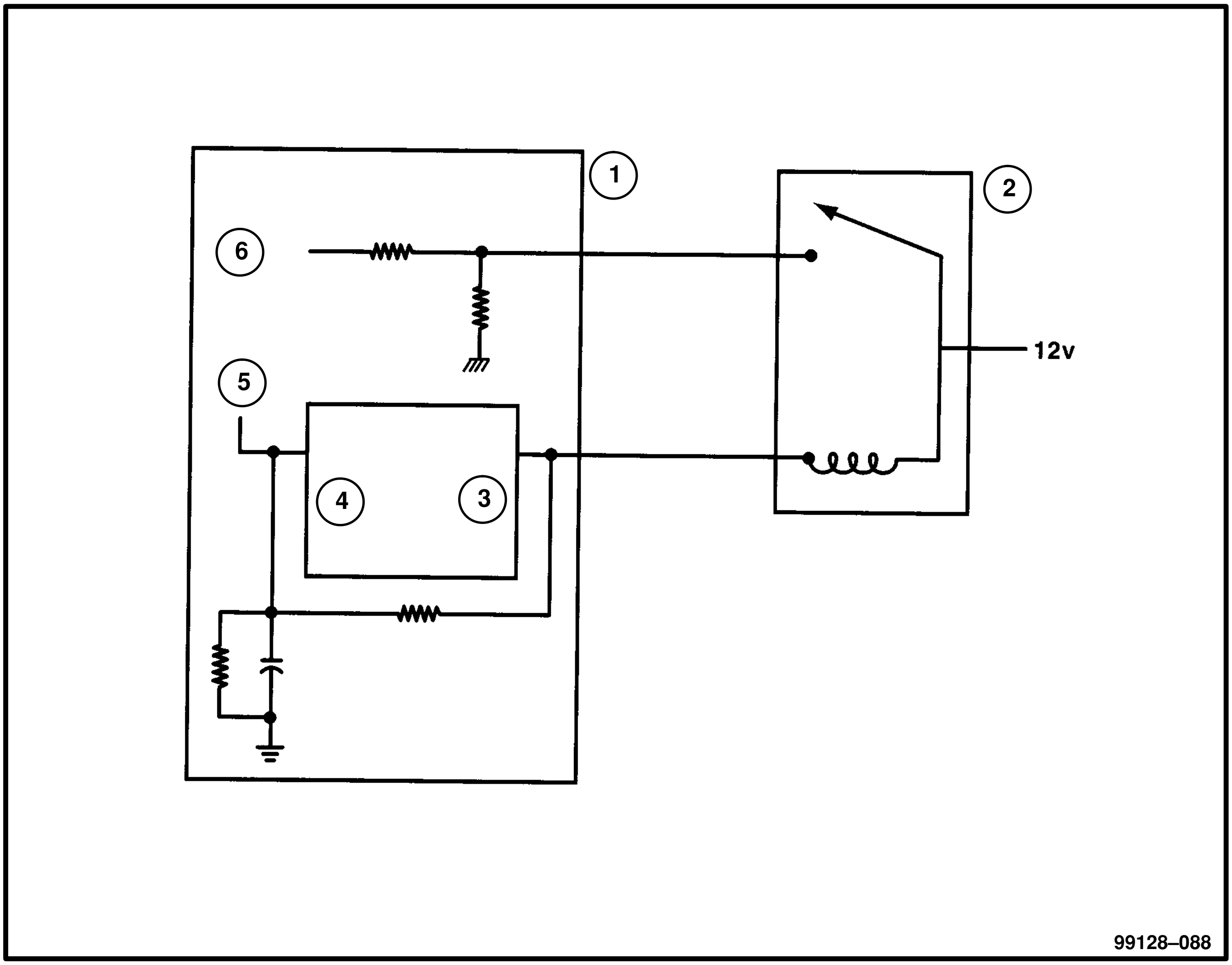


Figure 88 Leak Detection Pump Control Circuit (1998 & 2000)

1	JTEC PCM	4	Input
2	Leak Detection Pump	5	From Micro
3	Output	6	To Micro

POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM (1992–1997)

Viper engines are equipped with a Positive Crankcase Ventilation (PCV) System.

Crankcase vapors and piston ring blow–by are removed from the engine by manifold vacuum through the Positive Crankcase Ventilation (PCV) valve (figs. 89 & 90). The vapors pass through the PCV valve into the intake manifold where they become part of the calibrated air–fuel mixture and are burned and expelled with the exhaust gases.

The air cleaner supplies make–up air when the engine does not have enough vapor or blow–by gases. In this system, fresh air enters the crankcase through the left valve cover on heavyweight engines and both valve covers on lightweight engines.

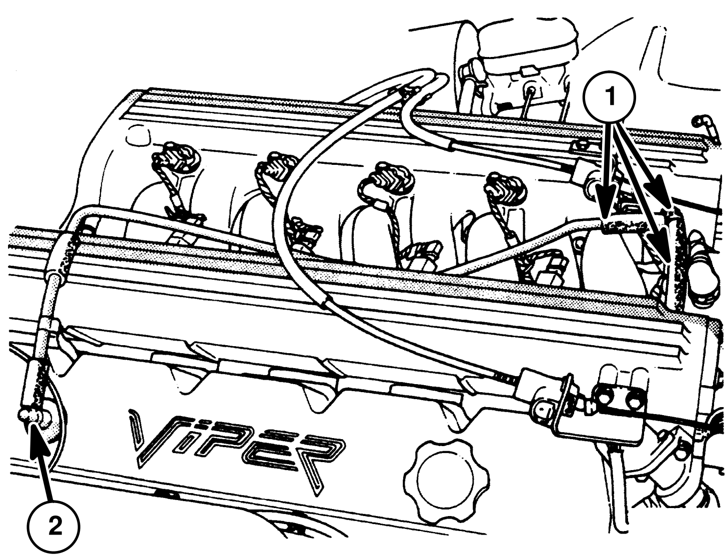


Figure 89 PCV Valve (1992–1995)

1	PCV Housing	2	PCV Valve

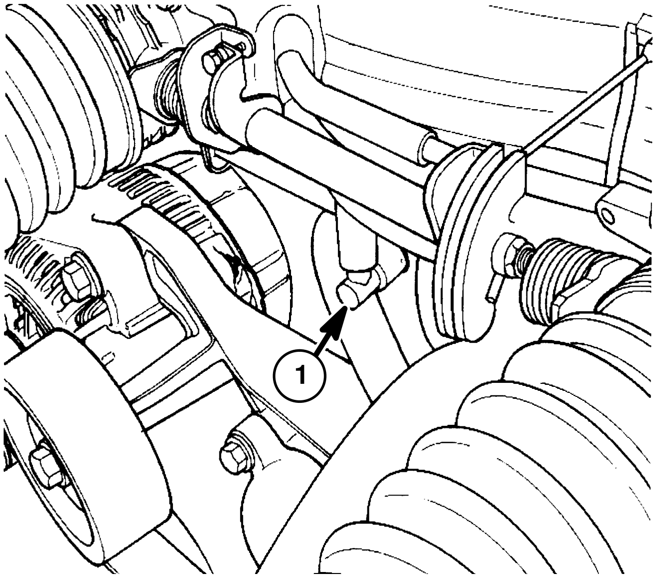


Figure 90 PCV Valve (1996 & 1997)

1	PCV Valve		

POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM (1998 & LATER)

1998 and later Vipers are equipped with a Fixed Orifice PCV System (fig. 91). The fixed orifice system performs the same function as a conventional PCV system, but does not have a PCV valve.

The fixed orifice system meters the amount of crankcase vapors drawn out of the engine. The fixed orifice fitting is grey in color. When the engine is operating, fresh air enters the engine and mixes with crankcase vapors. Manifold vacuum draws the vapor/air mixture through the fixed orifice and into the intake manifold. The vapors are then consumed during engine combustion.

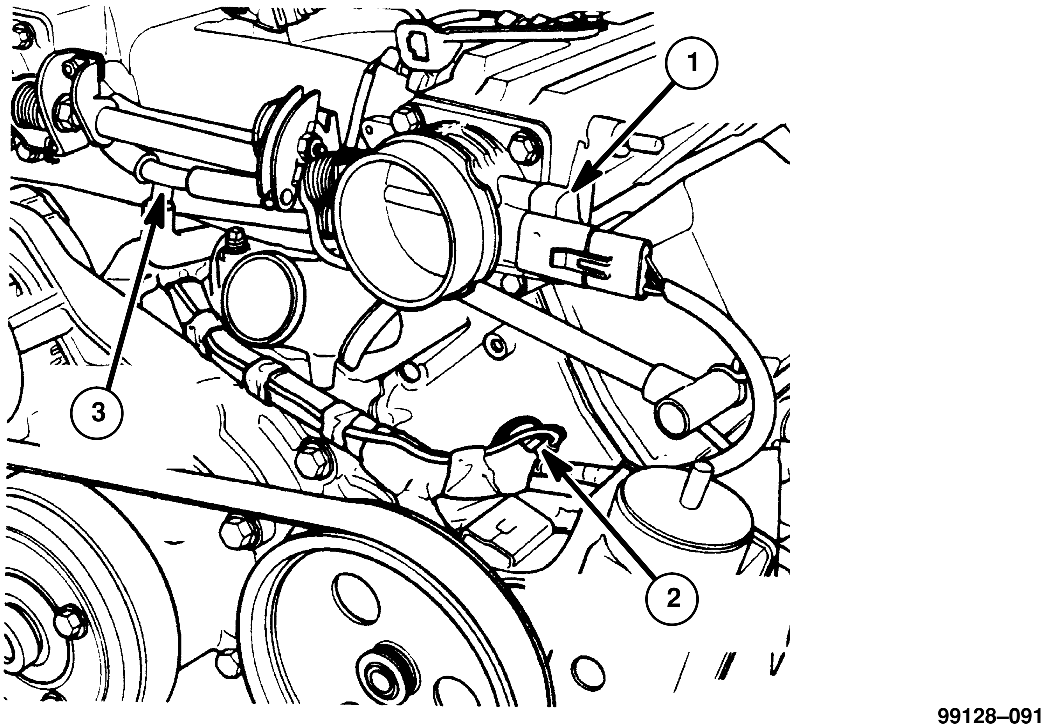


Figure 91 Fixed Orifice System (1998 & Later)

1	TPS	3	Fixed Orifice Fitting
2	ECT		

NOTES:

AIR CONDITIONING CONTROLS

INSTRUMENT PANEL A/C SELECT SWITCH

When the A/C–heater control switch is moved to an A/C position or the Defrost position, the switch provides a ground for a 12–volt pull–up circuit. This tells the PCM that air conditioning has been selected.

Note: *Vipers equipped with SBEC PCMs use one wire for the A/C Request input, while Vipers with a JTEC PCM use a separate wire for A/C Select and A/C Request.*

A/C REQUEST SIGNAL

After the driver has selected air conditioning, the PCM looks at the A/C request circuit to determine if system conditions are appropriate for compressor operation. The A/C request signal provides information to the engine controller for the air–conditioning high and low pressure switches. This signal indicates that system pressures are in an acceptable range for air–conditioning application. If the PCM request circuit is pulled low with switches closed, the PCM will provide a ground for the A/C Compressor Clutch Relay (figs. 92, 93 & 94). The PCM also looks at the thermostatic switch. If the switch is closed, the PCM considers conditions acceptable for A/C compressor operation.

A/C COMPRESSOR CLUTCH RELAY

The PCM energizes the A/C Compressor Clutch Relay by providing a ground for the relay coil. The PCM energizes the relay only after the following conditions have been met:

- Engine speed is greater than 500 rpm
- Approximately six seconds have elapsed since the start–to–run transfer occurred
- High–side pressure is > 28.4 – 36.0 psi
- Low–side pressure is < 369 – 455 psi
- Engine coolant temperature is below 257° F

Once all of the above conditions have been met and the A/C request signal indicates that A/C compressor operation is desired, the PCM energizes the A/C Compressor Clutch Relay.

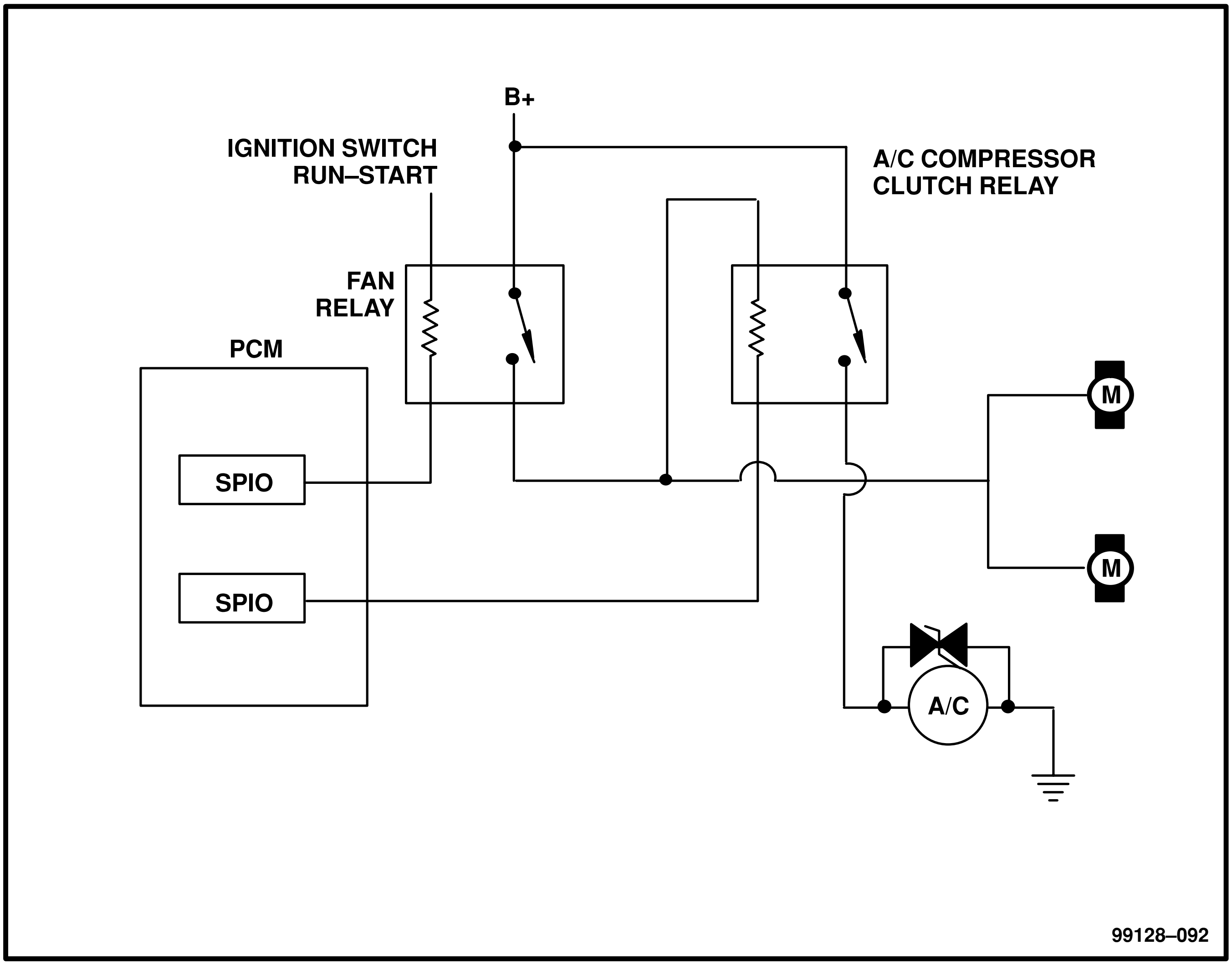


Figure 92 1992–1993 A/C Compressor Clutch Circuit

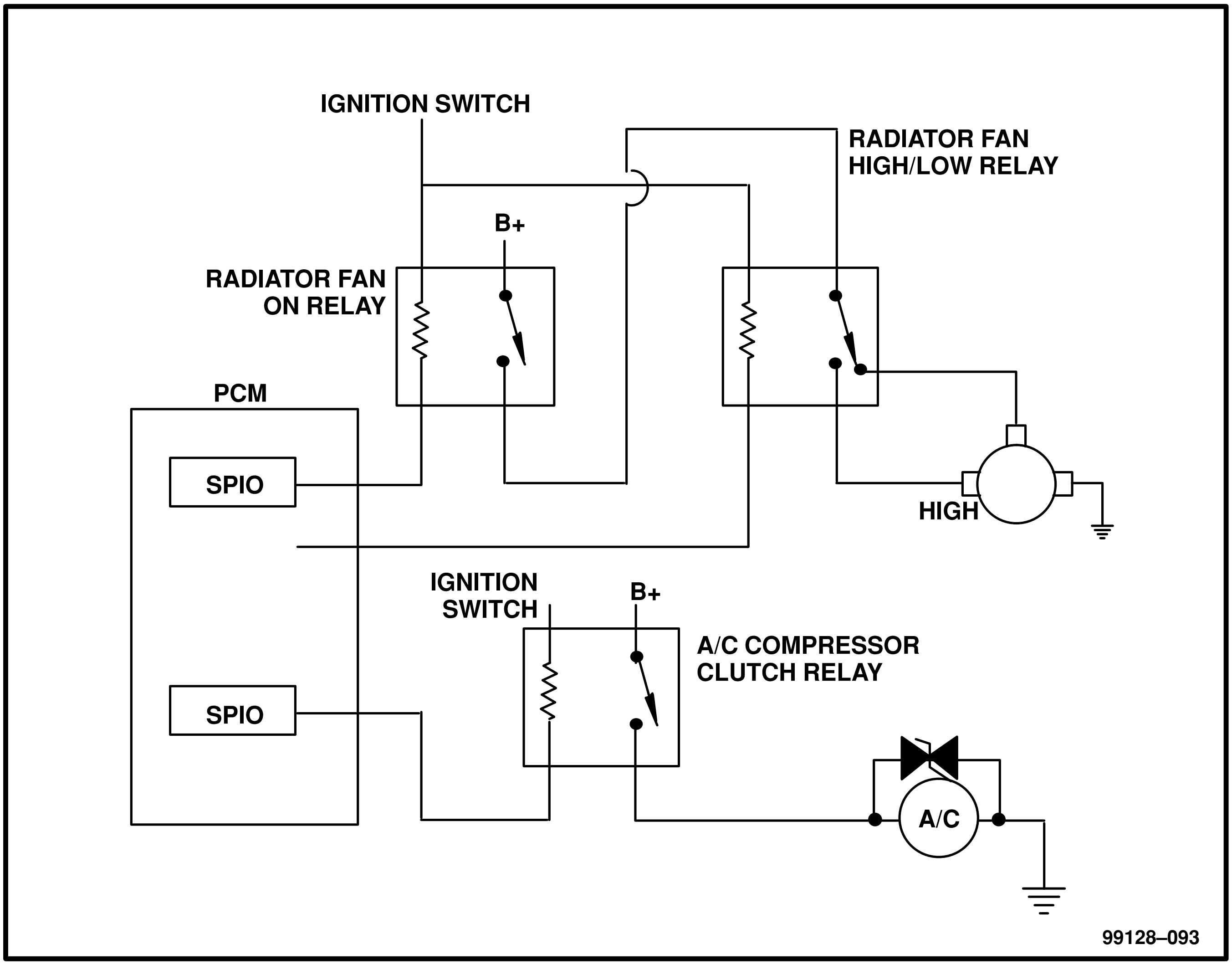


Figure 93 1994–1995 A/C Compressor Clutch Circuit

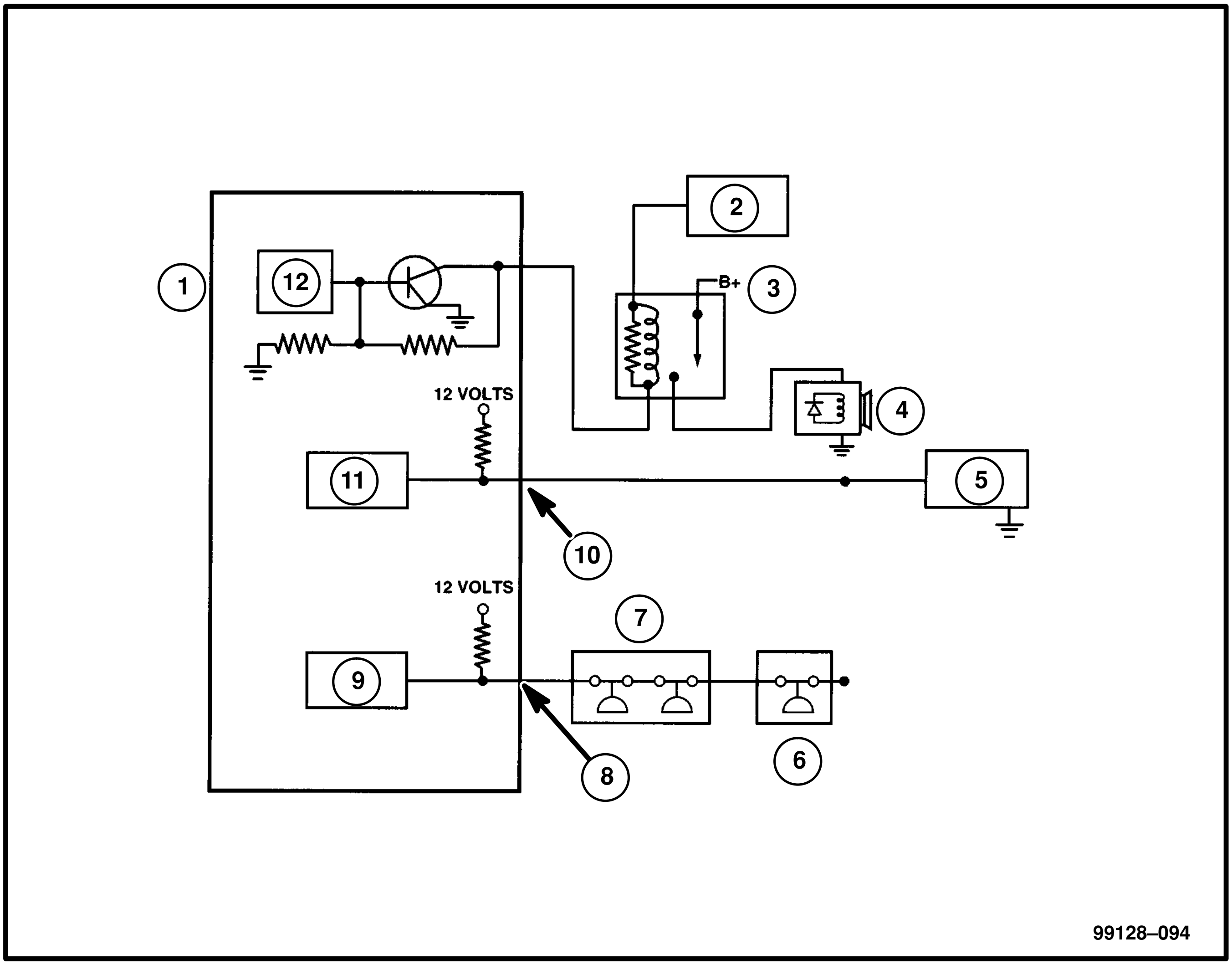


Figure 94 JTEC A/C Compressor Clutch Circuit

1	JTEC PCM	7	A/C High and Low Pressure Switches
2	Ignition Switch	8	A/C Request
3	A/C Compressor Clutch Relay	9	Voltage Level Detection
4	A/C Compressor Clutch	10	A/C Select
5	A/C Switch	11	Voltage Level Detection
6	Thermostatic Switch	12	Micro

NOTES: