SERVICE REPAIR

MANUAL

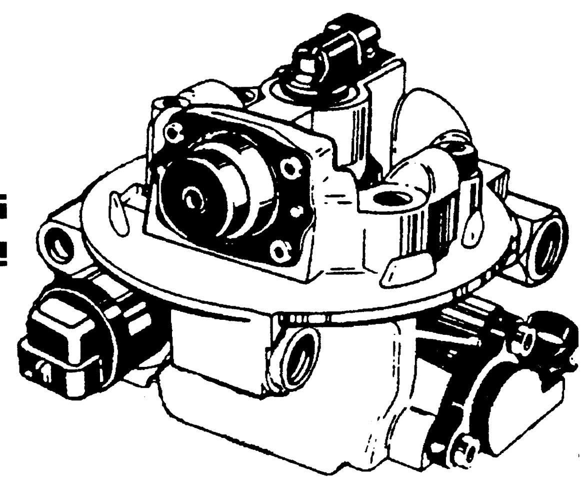
Hyster D177 (H45XM, H50XM, H55XM, H60XM, H65XM) Forklift

HYSTER

ELECTRONIC ENGINE CONTROL

GM 3.0L
DESCRIPTION AND OPERATION

S/H2.00–3.20XM (S/H40–65XM)



HYSTER

PART NO. 897856

2200 SRM 612

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- When lifting parts or assemblies, make sure that all slings, chains or cables are correctly fastened and that the load being lifted is balanced. Make sure that the crane, cables and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand. Use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See "How To Put The Lift Truck On Blocks" in the **OPERATING MANUAL** or the **PERIODIC MAINTENANCE** section.
- Keep the unit and working area clean and in order.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER** *APPROVED* parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure that all nuts, bolts, snap rings and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE sign to the controls of the unit when making repairs or if the unit needs repairs.
- Make sure you follow the **DANGER, WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), and Diesel are flammable fuels. Make sure that you follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area has ventilation.

CONTENTS

This section is for the following models:
S/H2.00–3.20XM (S/H40–65XM)

"THE QUALITY KEEPERS"

HYSTER APPROVED PARTS

INTRODUCTION

GENERAL

This section has a description of the electronic engine control system.

The troubleshooting and repair procedures for the parts of the electronic engine controls are in the section **ELECTRONIC ENGINE CONTROL – Troubleshooting and Repair, 2200 SRM 611.**

DESCRIPTION AND OPERATION

GENERAL

An Electronic Control Module (ECM) is the main component of this control system. The ECM is a small computer that controls the ignition timing and fuel supply in the gasoline engine. The ECM has the information for the best operation of the engine according to the fuel, temperature, load and other conditions. The ECM has sensors that give information about engine operation and the systems it controls. The ECM can do some diagnosis of itself and of other parts of the system. When a problem is found, the ECM turns on the "Malfunction Indicator" lamp on the instrument panel and a diagnostic trouble code will be stored in the ECM memory.

ELECTRONIC CONTROL MODULE (ECM) (See FIGURE 1.)

The Electronic Control Module (ECM) is the control center of the fuel injection system. It constantly monitors the information from the sensors, and controls the components and systems which affect engine operation. The ECM also performs the diagnostic function of the system. It can sense problems, activate the "Malfunction Indicator" lamp, and store a diagnostic trouble code or codes (DTC). The ECM controls the following systems and components for the best fuel use and engine performance:

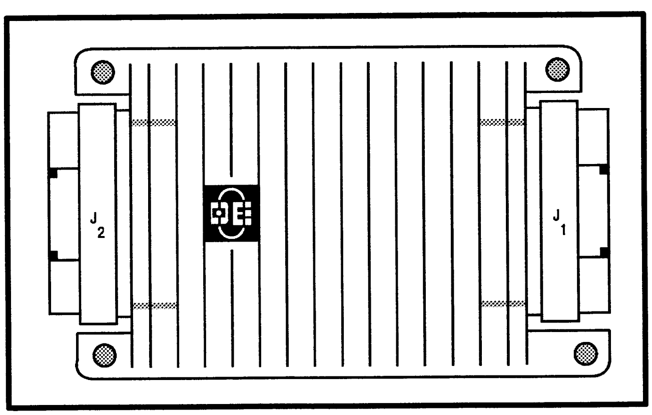
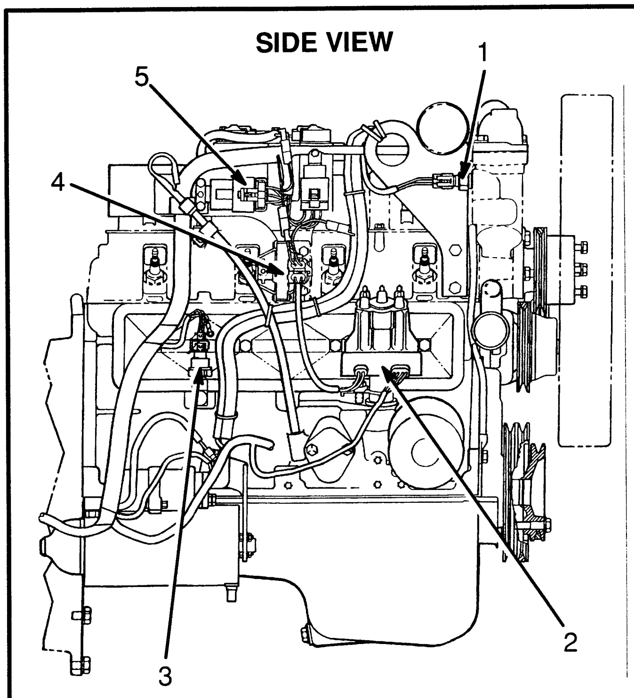


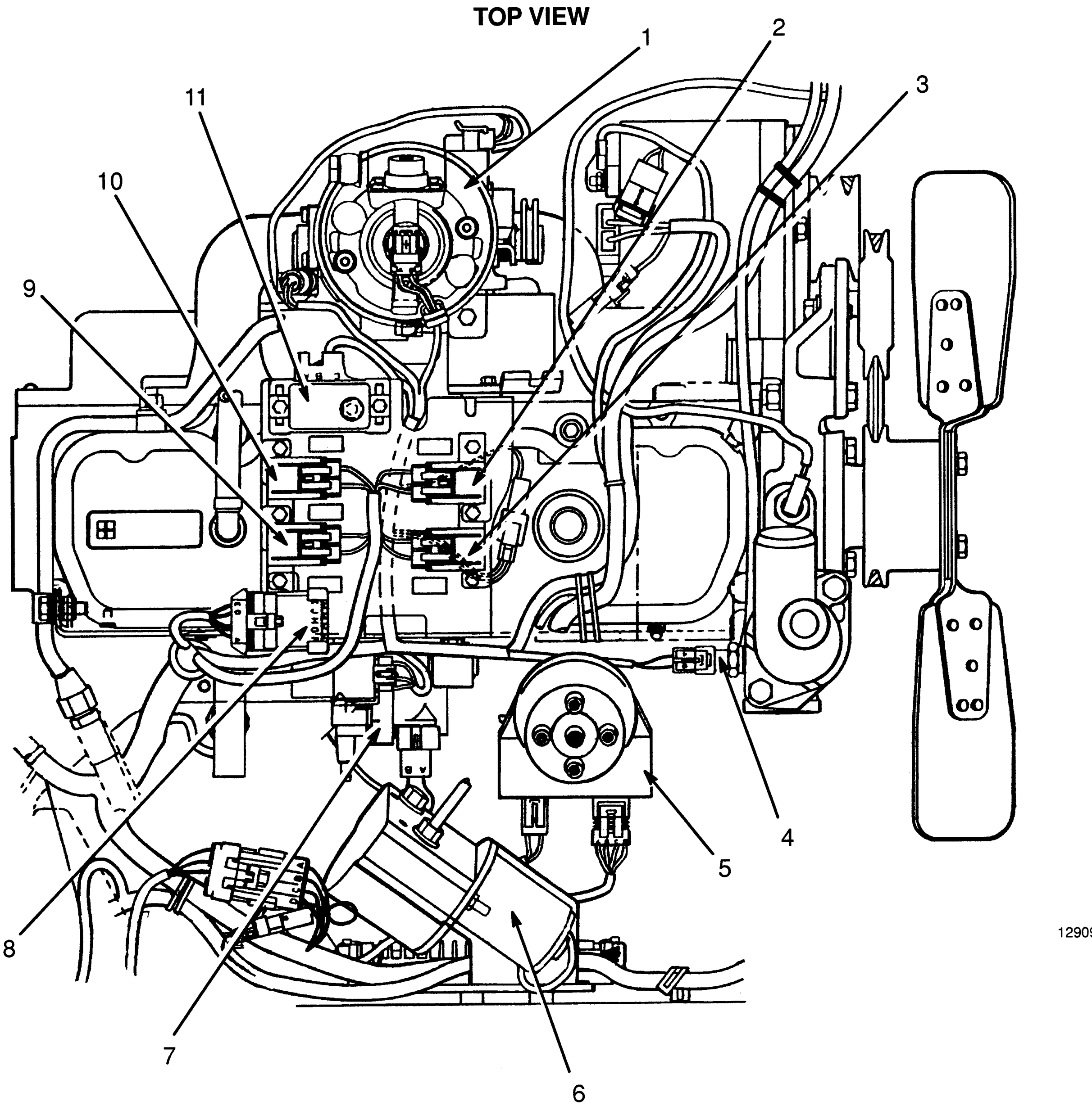
FIGURE 1. ECM

- Fuel Injection System
- Electric Spark Timing (EST)
- An electronic governor
- "Check Engine" light
- Idle air control (IAC)
- Fuel pump relay
- Diagnostic link connector (DLC) for troubleshooting



1. ENGINE COOLANT TEMPERATURE (ECT) SENSOR
2. DISTRIBUTOR
3. OIL PRESSURE/FUEL PUMP SWITCH
4. IGNITION COIL
5. FUEL PUMP RELAY

FIGURE 2. ARRANGEMENT OF COMPONENTS FOR ELECTRONIC ENGINE CONTROL (1 of 2)



1. THROTTLE BODY INJECTION (TBI) UNIT
2. FUEL INJECTOR FUSE
3. IGNITION FUSE
4. ENGINE COOLANT TEMPERATURE (ECT) SENSOR
5. DISTRIBUTOR
6. GOVERNOR MOTOR
7. IGNITION COIL
8. DIAGNOSTIC LINK CONNECTOR (DLC)
9. FUEL PUMP FUSE
10. ECM FUSE
11. MAP SENSOR

FIGURE 2. ARRANGEMENT OF COMPONENTS FOR ELECTRONIC ENGINE CONTROL (2 OF 2)

How The ECM Begins Operation

When the ignition switch is turned to **ON**, the ECM does the following functions:

- Measures the atmospheric pressure (BARO signal) from the MAP sensor.
- Checks the signal from the engine coolant temperature (ECT) sensor.
- Energizes the fuel pump relay for approximately two seconds.
- Checks that the throttle position sensor indicates that the throttle is less than 80% open. (If the throttle is more than 80% open, the ECM will determine that the engine is flooded with fuel and will deliver less fuel to the engine.)
- **EST Distributor System:** Checks the starting mode from the ignition module. [When the starter is engaged, the ignition module sends electronic pulses to the ECM. The frequency of the pulses indicates to the ECM that the engine is being started. The ignition module also electronically energizes (**ON**) and deenergizes (**OFF**) the primary circuit of the ignition coil to create a spark at the spark plugs.]

The ECM makes the checks in a few milliseconds and determines the correct air and fuel ratio for starting the engine. The range of this air and fuel ratio is 1.8:1 at –40°C (–40°F) to 17:1 at 150°C (302°F) as indicated by the signal from the engine coolant temperature sensor. The ECM controls the amount of fuel sent to the engine by changing the pulse times [how long the fuel injector is energized (**ON**) and deenergized (**OFF**)].

When the engine starts, the frequency of the pulses from the ignition module increases and indicates to the ECM that the engine is running. The ECM takes control of the ignition timing and fuel control for the best engine operation. When the engine is operating, the ECM continuously checks the signals from the MAP, ECT, TPS and engine speed sensors to make timing and fuel adjustments for the engine operating conditions.

ELECTRONIC ENGINE CONTROL

What The ECM Does

The ECM receives signals from the following components:

- **Manifold Absolute Pressure (MAP)** sensor. This sensor is a pressure transducer that measures the atmospheric pressure before the engine is started and the ECM uses this pressure as a reference. This sensor then measures changes in pressure in the intake manifold during engine operation.
- **Engine Coolant Temperature (ECT)** sensor. This sensor is a thermistor (resistor that is calibrated to change its value as its temperature changes) that monitors the engine coolant temperature.
- **Throttle Position Sensor (TPS)**. This sensor indicates the position of the throttle that is set by the operator and is used with the indications from the other sensors to determine the correct engine operation.

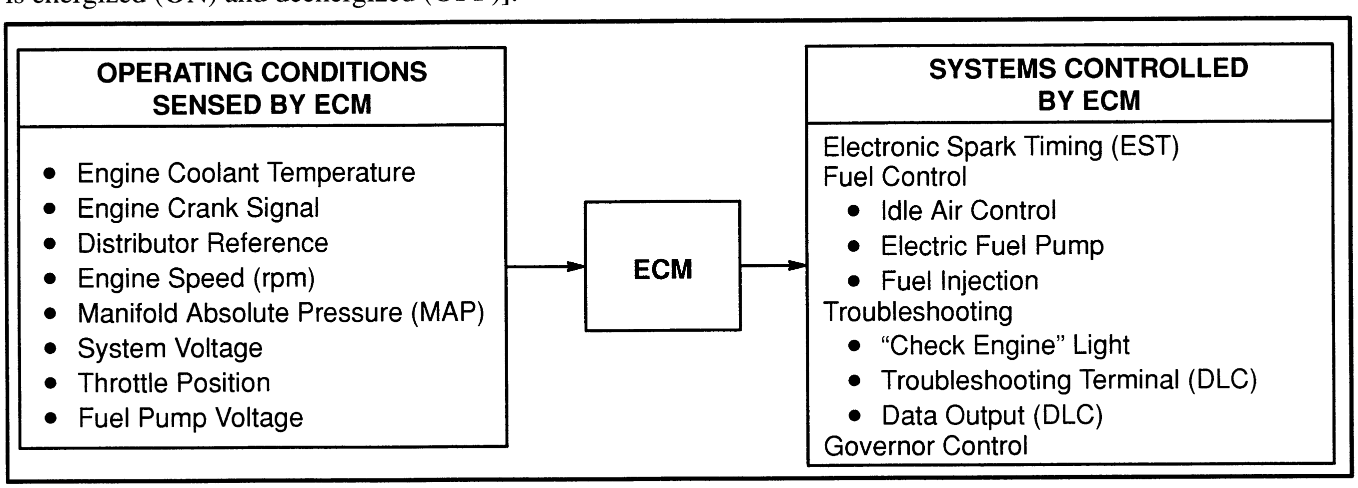


FIGURE 3. ELECTRONIC ENGINE CONTROL SYSTEM

- **Fuel Pump.** When the key switch is first turned to "ON", the ECM energizes the fuel pump relay for two seconds. This action quickly raises the fuel pressure to the fuel injectors. If the engine is not cranked or started within two seconds, the ECM deenergizes the fuel pump relay and the fuel pump goes to "OFF". When the engine is cranked by the starter, the ECM energizes the fuel pump relay again so that the fuel pump operates.
- **Ignition module.** This component is a small electronic module within the distributor. See FIGURE 4. This ignition module is a signal converter that senses the operation of the distributor. A sensor coil in the distributor senses the rotation of the timer core and the ignition module senses the speed of rotation. A square wave generator in the ignition module converts the pulses from the sensor coil to a square wave signal that is sent to the ECM. If the signals from the ignition module to the ECM indicate that the crankshaft is rotating at less than 400 rpm, the ECM determines that the engine is being cranked by the starter. The ignition module controls the ignition for an engine being started. The Electronic Spark Timing (EST) function from the ECM is deenergized. If the signals from the ignition module to the ECM indicate that the crankshaft is rotating at greater than 400 rpm, the ECM determines that the engine is running and the Electronic Spark Timing (EST) controls the ignition.
- **Electronic governor.** The ECM senses the engine speed from the ignition module and operates the governor motor on the throttle body to control the engine speed. The governor motor will override the throttle position that is set by the operator to control the engine speed within the limits set in the ECM.

Distributor (See FIGURE 4.)

A timer core (permanent magnet) on the shaft of the distributor has external teeth which align with an equal number of teeth on the pole piece. When the teeth of the timer core rotate past the teeth of the pole piece, there is a decrease in the air gap between the timer core and the pole piece. The magnetic field increases. When teeth are not aligned, the magnetic field decreases between the timer core and the pole piece. As the timer core rotates, the magnetic field increases and decreases in a cycle.

When a coil is near a changing magnetic field, a voltage is generated in the coil. This principle is called magnetic induction. A sensing coil is installed over the permanent magnet. As the magnetic field near the pole piece changes, a small voltage is generated in the sensing coil.

The principle of magnetic induction also controls the polarity of the voltage generated in the coil. An increasing magnetic field will generate a voltage in the coil that is the opposite polarity of a magnetic field that is decreasing. This signal pulse causes the integrated circuits in the ignition module to generate a square wave signal. The ignition module and a magnetic pulse generator control the primary circuit to the ignition coil when the engine is started. The ECM receives the square wave signal from the magnetic pulse generator and ignition module as one of the signals to control the ignition. The pole piece has the same number of teeth as the engine has cylinders so that a spark voltage is correctly sent to each spark plug as the shaft in the distributor rotates.

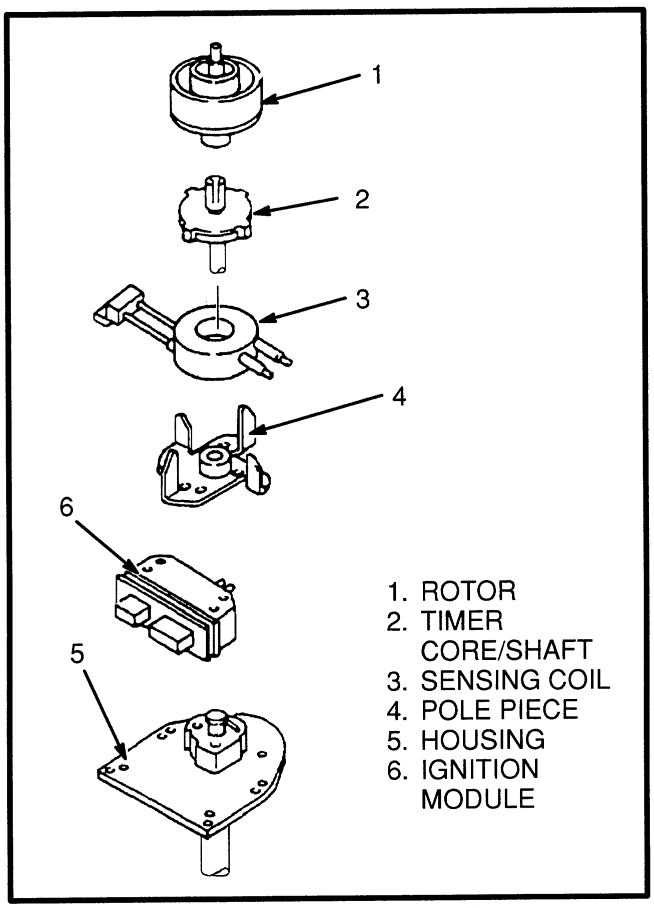


FIGURE 4. DISTRIBUTOR

Ignition Module

The ignition module is a solid–state electronic device that operates like a fast switch except that it does not have any moving or mechanical parts. See FIGURE 4. Small electrical pulses from the sensing coil of the pulse generator go to the ignition module.

The ECM must always know the speed at which the engine is operating. The engine speed signal is generated by the ignition module. The signal converter in the ignition module changes the signal voltage from the sensing coil to a square wave reference signal to the ECM. This square wave reference signal for engine speed is called "REF HI". The ECM must also have a reference to compare with "REF HI". An additional wire between the ECM and the EST module is called "REF LO" (GROUND). The "REF HI" and "REF LO" connections give the PROM in the ECM the necessary information about engine speed.

The other two wires between the ECM and the distributor control the Electronic Spark Timing and are called "EST" and "BY–PASS".

NOTE: The ignition module controls spark timing only when the the engine is being started or if the ECM fails. The ECM controls the spark timing during engine operation. The ignition module will also control the spark timing if there are some failures in the signals to the ECM. This "back–up" mode of operation will often permit operation of the engine so that the lift truck can be moved to an area for repair. The result of failures in signals to the ECM is described in the paragraphs under "Electronic Control Module (ECM) Corrections".

When The Engine Is Being Started

See FIGURE 5. When the engine is rotated by the starter, the electronic relay (2) is in the deenergized position. The sensing coil is connected through the square wave generator (3) to the base of the transistor (8).

When the sensing coil (4) applies a positive voltage (the square wave voltage is increasing) to the transistor (8), the transistor goes **ON**. When the voltage from the sensing coil changes to negative (the square wave voltage is decreasing), the transistor goes **OFF**. When the transistor is **ON**, current flows through the primary winding of the ignition coil. When the transistor goes **OFF**, the current flow through the primary winding stops. The changing magnetic field in the primary winding generates a high voltage in the secondary winding of the ignition coil This high voltage generates a spark at the spark plug.

When the Engine Is Running

See FIGURE 6. When the engine speed is approximately 400 rpm, the ECM determines that the engine is running and applies 5 volts on the "BY–PASS" wire to the ignition module. This voltage energizes the electronic relay (2) and makes the following changes: The "EST" wire is not grounded and is now connected to the base of the transistor (8). The sensing coil is disconnected from the base of the transistor (8).

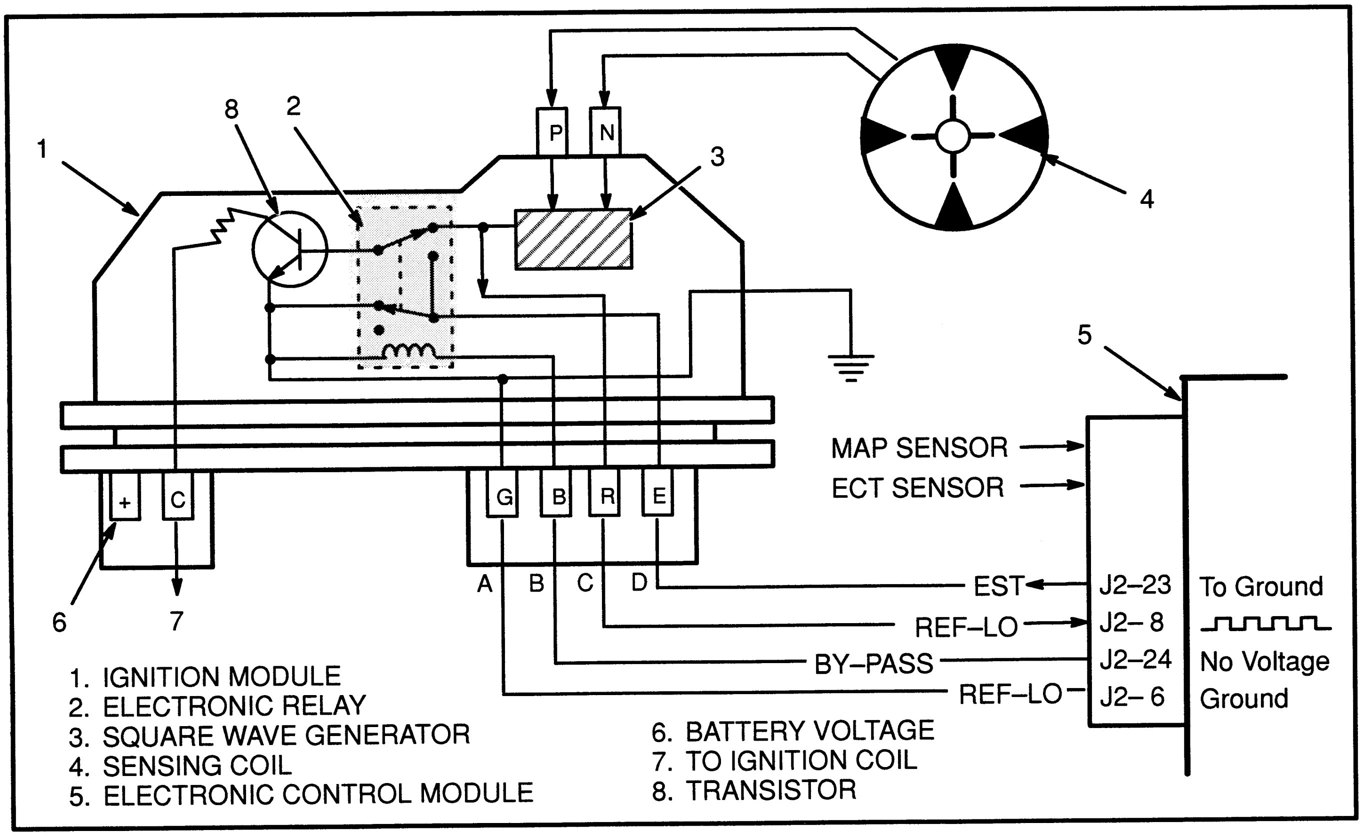


FIGURE 5. IGNITION MODULE WHEN ENGINE IS BEING STARTED

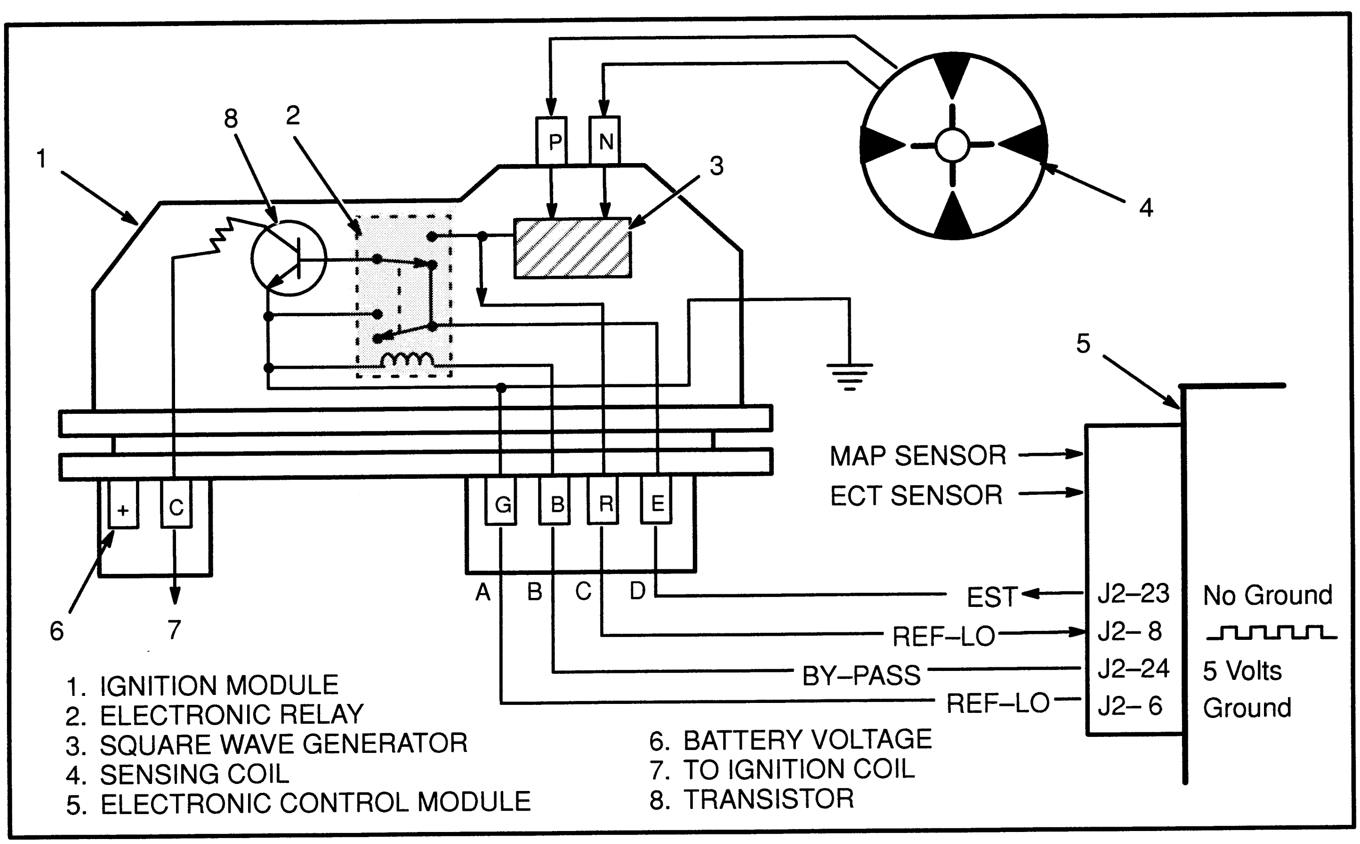


FIGURE 6. IGNITION MODULE WHEN ENGINE IS RUNNING

The ignition module and the ignition timing is now controlled by the "EST" signal from the ECM. This mode of operation is called the "EST mode".

Electronic Control Module (ECM) Corrections

The ECM does a check of the system components of the EST. A set of normal operating limits are part of the PROM program. If a sensor sends a signal that is outside of the limits of the PROM program, the ECM will not use the information. The ECM will use a standard value from its program and continue to operate the EST.

The following examples are the action of the ECM if it finds a problem:

MAP Sensor Signal Voltage Is Too High Or Too Low. The ECM will use a MAP value from its PROM program and use this value to calculate the ignition timing.

ECT Signal Voltage Is Too High Or Too Low. If the coolant sensor sends a signal voltage that is outside of the range programmed by the ECM, the ECM will determine that the engine is "cold". The ECM will use a value for a cold engine.

Open Circuit In EST Wire. Normally, the signal from the ECM to the ignition module rises and falls as the voltage from the sensing coil rises and falls. If the EST circuit is open, the electronic relay in the ignition module is not at ground potential.The engine will start but will not continue to run. If the EST circuit becomes open during engine operation, the engine will stop.

Short–Circuit (Grounded Circuit) In EST Wire. When the engine is being rotated by the starter, the ECM normally detects 0 volts in the EST circuit because the circuit is at ground potential in the ignition module. The ECM would not detect a problem until the engine began to run. The ECM could not operate in the EST mode and the engine will not operate. If the EST circuit has a short–circuit (grounded circuit) when the engine is running, it will stop.

Open Circuit Or Short–Circuit In The BY–PASS Circuit. The ECM would not detect a problem until the engine began to run. The ECM could not operate in the EST mode and the engine would operate with reduced power. If this problem occurs when the engine is running, the engine will only operate in the starting mode.

Open Circuit Or Short–Circuit In The REF HI Circuit. The ECM would not detect that the engine was operating. The ECM could not operate in the EST mode and the engine will not operate.

Open Circuit Or Short–Circuit In The REF LO Circuit. The ECM would not have a comparison for operation. The ECM could not operate in the EST mode and the engine will not operate correctly.

What The ECM Does

The ECM receives signals from the following components:

- **Manifold Absolute Pressure** (MAP) sensor. This sensor is a pressure transducer that measures the atmospheric pressure before the engine is started and the ECM uses this pressure as a reference. This sensor then measures changes in pressure in the intake manifold during engine operation.
- **Engine Coolant Temperature (ECT) Sensor**. This sensor is a thermistor (resistor that is calibrated to change its value as its temperature changes) that monitors the engine coolant temperature.
- **Throttle position sensor (TPS)**. This sensor indicates the position of the throttle that is set by the operator and is used with the indications from the other sensors to determine the correct engine operation.
- **Fuel Pump**. When the key switch is first turned to "ON", the ECM energizes the fuel pump relay for two seconds. This action quickly raises the fuel pressure to the fuel injectors. If the engine is not cranked or started within two seconds, the ECM deenergizes the fuel pump relay and the fuel pump goes to "OFF". When the engine is cranked by the starter, the ECM energizes the fuel pump relay again so that the fuel pump operates.
- **Engine speed sensor**. If the signals from the EST module to the ECM indicate that the crankshaft is rotating at less than 400 rpm, the ECM determines that the engine is being cranked by the

starter. The ignition module controls the ignition for an engine being started. The Electronic Spark Timing (EST) function from the ECM is deenergized. If the signals from the ignition module to the ECM indicate that the crankshaft is rotating at greater than 400 rpm, the ECM determines that the engine is running and the Electronic Spark Timing (EST) controls the ignition.

- **Governor**. The governor prevents engine speeds above the specification when operating with light loads, and permits the throttle to open for full power for heavy loads. The operation of the governor is described later in this section under **"Governor System."**

FUEL CONTROL OPERATION

The function of the fuel injection system is to deliver the correct amount of fuel to the engine under all operating conditions. Fuel is delivered by the Throttle Body Injection (TBI) unit, which is controlled by the Electronic Control Module (ECM), based on certain operating conditions. These conditions, which include engine speed, manifold pressure, engine coolant temperature, and throttle position, determine the "mode" of engine operation. These modes are: Starting, Clear Excess Fuel (Clear Flood), Run, Acceleration, Deceleration, and Fuel Cut–off.

Starting Mode. When the key is first turned **ON**, the ECM turns "ON" the fuel pump relay for two seconds, and the fuel pump builds up fuel pressure at the TBI unit. The ECM then monitors the coolant temperature, throttle position, manifold pressure, and ignition signal to determine the proper air/fuel ratio for starting. This ranges from 1.5:1 at –36°C (–33°F) to 14.7:1 at 94°C (201°F).

Clear Excess Fuel (clear flood) Mode. If the engine does not start from excess fuel, it can be cleared by pressing the accelerator pedal all the way to the floor. The ECM then pulses the injector for an air to fuel ratio of 20:1 or more. The ECM maintains this injector rate as long as the throttle stays wide open and the engine speed is below 600 rpm. If the throttle position becomes less than 80%, the ECM returns to the Starting Mode.

Run Mode. The Run Mode is the mode under which the engine operates most of the time. In this mode, the engine operates on normal amounts of fuel.

Acceleration Mode. When the ECM senses rapid increase in throttle position and manifold pressure, the system enters the Acceleration Mode. In this mode, the ECM gives the extra fuel needed for smooth acceleration.

Deceleration Mode. When deceleration occurs, the fuel remaining in the intake manifold can cause backfiring. When the ECM observes a fast reduction in throttle opening and a sharp decrease in manifold pressure, it causes the system to enter the Deceleration Mode. In this mode, the ECM reduces the amount of fuel delivered to the engine. When deceleration is very fast, the ECM cuts off fuel completely for short periods.

Fuel Cut–Off Mode. To prevent possible engine damage from over speed, the ECM will "cut–off" fuel from the injector at about 3600 rpm. Fuel "cut–off" remains in effect until engine speed drops below about 3600 rpm. (The governor would normally not allow the engine to reach this condition.)

FUEL SYSTEM COMPONENTS

The fuel supply is kept in the fuel tank. An electric fuel pump, located in the fuel tank, supplies fuel through a filter to the TBI unit. (See FIGURE 7.) The pump delivers fuel at a pressure greater than is needed by the injector. A pressure regulator, part of the TBI assembly, keeps fuel available to the injector. Fuel that is not used is returned to the fuel tank by a separate line.

Module Assembly. The Fuel Meter Body has the Fuel Injector and the Fuel Pressure Regulator

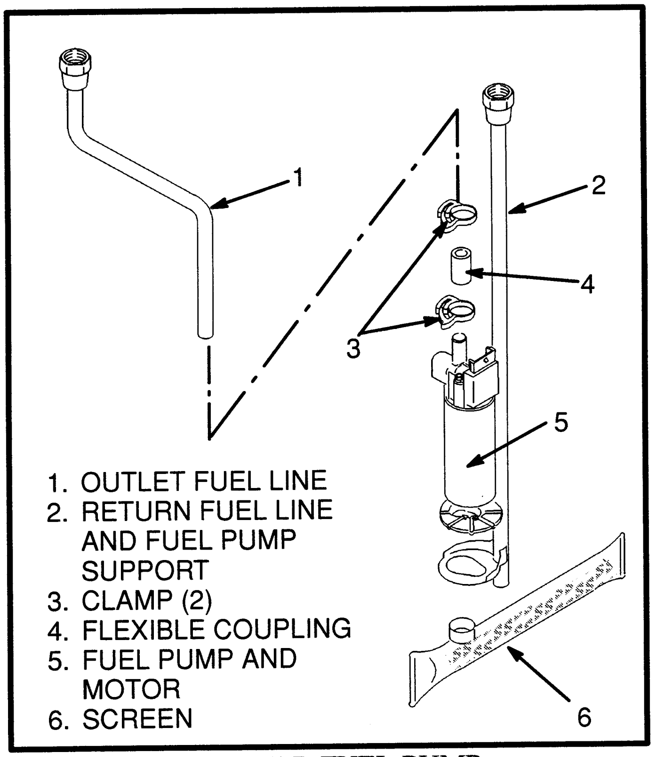


FIGURE 7. FUEL PUMP

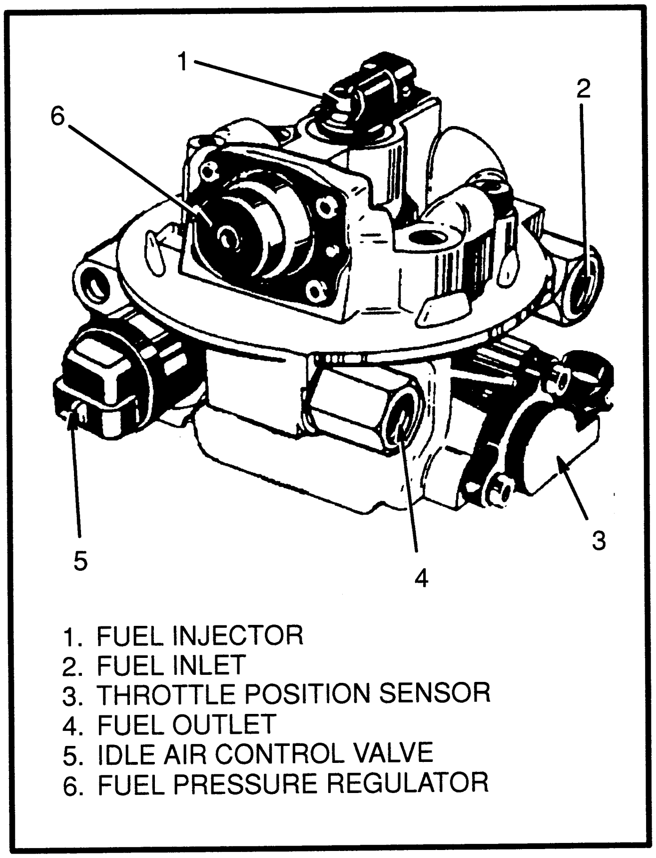


FIGURE 8. THROTTLE BODY INJECTION (TBI) UNIT

Fuel Pump Electrical Circuit

When the ignition switch is turned to the **ON** position (engine not running), the ECM turns the fuel pump relay "ON" for two seconds. This action quickly raises the fuel pressure to the fuel injector. If the engine is not started within two seconds, the ECM deenergizes the fuel pump relay and the fuel pump goes to OFF. When the engine is cranked by the starter, the ECM energizes the fuel pump relay again so that the fuel pump operates.

As a parallel system to the fuel pump relay, the fuel pump also can be turned "ON" by the oil pressure switch. The oil pressure sender has two internal circuits. One circuit operates the oil pressure indicator or gage in the instrument cluster, and the other is a normally open switch that closes when oil pressure reaches approximately 28 kPa (4 psi). If the fuel pump relay has a fault, the oil pressure switch runs the fuel pump.

Throttle Body Injection (See FIGURE 8.)

The TBI unit consists of two major assemblies; the Throttle Body and the Fuel Meter Body. The parts of the Throttle Body are the Throttle Position (TP) Sensor, Idle Air Control (IAC) Valve, Throttle Valve and the Tube

Throttle Position (TP) Sensor

The Throttle Position (TP) Sensor is a potentiometer that is connected to the throttle shaft on the throttle body. It senses the position of the throttle plate and sends that information to the ECM. This information permits the ECM to generate the correct pulses to the fuel injector for fuel control. If the throttle position sensor indicates a fully opened throttle to the ECM, the ECM then increases the pulse width to the fuel injector.

The TP Sensor electrical circuit has a 5 volt supply line and a ground path line, both from the ECM. A third wire is used as a signal line to the ECM. By monitoring the voltage on this signal line, the ECM calculates throttle position. As the throttle plate angle is changed (accelerator pedal moved), the signal voltage of the TP Sensor also changes. At a closed throttle position, the signal of the TP Sensor is below 1.25volts. As the throttle plate opens, the signal voltage increases, so that at wide open throttle, it is approximately 5 volts.

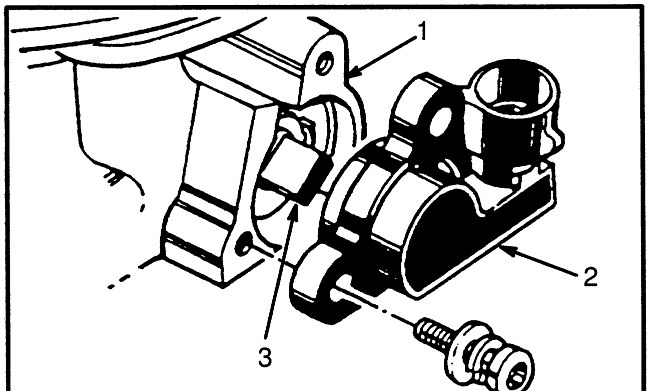


FIGURE 9. THROTTLE POSITION SENSOR

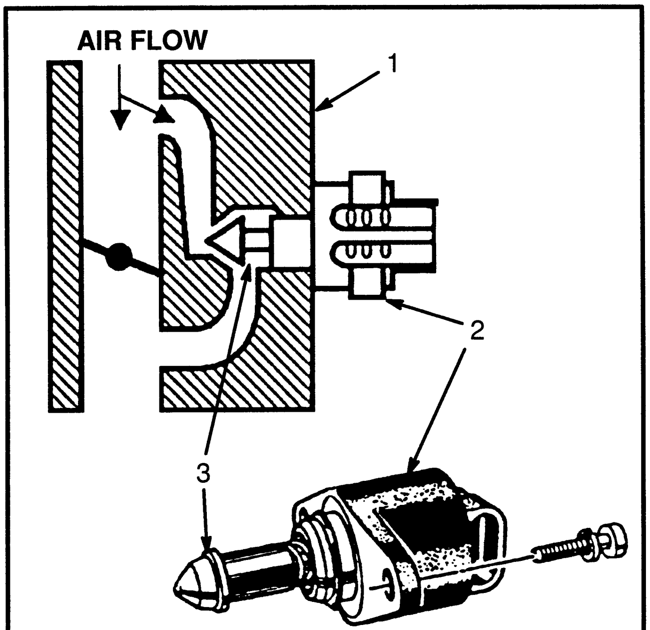


FIGURE 10. IDLE AIR CONTROL VALVE

Idle Air Control (IAC) Valve (See FIGURE 10.)

The idle speed of the engine is controlled by the ECM through the Idle Air Control (IAC) valve. The idle air control valve has a linear DC step motor that moves a pintle valve to control the idle air system. See FIGURE 10. The step motor moves the pintle one step for each "count" that it receives from the ECM. Each voltage pulse from the ECM to move the pintle valve is a count. This movement of the pintle valve controls the air flow around the throttle plate. (When the pintle valve is EXTENDED, it decreases air flow and when RETRACTED, it increases air flow.) This air flow controls the engine idle speed at all operating temperatures. A minimum setting is for engine idle at sea level and normal conditions. A heavier load from the alternator, hydraulic pump or other accessories will cause the ECM to set a higher number of counts on the pintle valve.

The number of counts that indicates the position of the pintle valve can be seen when the "scan" tool is connected for troubleshooting.

Pintle Extended = Decrease rpm = Lower Counts.
Pintle Retracted = Increase rpm = Higher Counts.

Fuel Injector

The fuel injector is a solenoid that is controlled by the ECM. When the ECM energizes the solenoid, a normally closed ball valve is lifted off its seat. The fuel is under constant pressure and is injected in a cone spray pattern into the bore of the throttle body, above the throttle plate. The fuel that is not used by the fuel injector flows through the pressure regulator and returns to the fuel tank.

Fuel Pressure Regulator

The fuel pressure regulator is part of the fuel metering assembly of the TBI. The function of the fuel pressure regulator is to maintain a constant fuel pressure at the injector during all operating modes. An air chamber and a fuel chamber are separated by a diaphragm–operated relief valve and a calibrated spring. Fuel pressure at the fuel injector is controlled by the difference in pressure on each side of the diaphragm. The fuel pressure from the fuel pump on one side of the diaphragm acts against the force of the calibrated spring on the other side of the diaphragm. The system operates in a pressure range of 62 to 90 kPa (9 to 13 psi).

The fuel meter assembly includes a vapor relief hole that relieves system pressure when the engine is turned **OFF**.

This hole also helps release vapors from the injector and regulator for starting a hot engine.

Idle Speed Control

The ECM uses two basic items to control idle rpm. The Idle Air Control (IAC) valve and spark timing are adjusted to give the correct idle rpm. During varying idle loads and engine temperature the ECM must be able to keep the engine running at the correct rpm.

Spark timing varies engine speed by varying the engine power output. IAC valve changes the air delivered to the engine which also changes the engine output.

Also remember that air can enter the engine in other areas. One is by the throttle plate and another is the PCV valve. Vacuum leaks can affect idle speed.

Maximum RPM Control

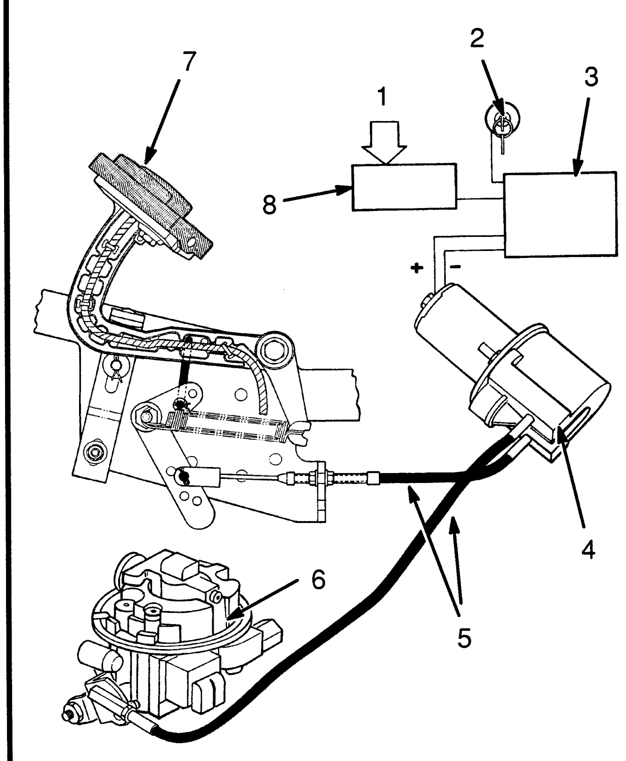
There are two items that control maximum engine rpm. One is the ECM fuel cut–off, and the other is a governor system. Fuel cut–off is used only if the governor system malfunctions.

Governor speed control is a lower rpm value. This system uses a cable drum that is driven by a motor. The motor is controlled by a governor module. When a calibrated rpm is reached, the ECM sends a signal to the module which in turn runs the motor. The throttle plate on the throttle body is driven toward the closed position to limit engine rpm.

GOVERNOR SYSTEM (See FIGURE 11.)

The governor motor is an electric DC motor that is actuated and controlled by the Electronic Control Module (ECM) through the governor control module (governor motor driver circuit). The governor prevents engine speeds above specifications when operating with light loads, and permits the throttle to open for full power for heavy loads.

The components of the governor system are the ECM, the governor control module and the governor motor assembly and cables. The cables and drum allow the throttle control to be split. This split arrangement allows the governor motor drum to close the throttle plate, yet open them indirectly. The first drum is turned by the accelerator pedal. A spring located inside the drum pushes on the second drum. This action allows the operator to open the throttle when under heavy load, but the motor will rotate the drum, against the spring, to close the throttle plate under light load–high rpm. Using engine speed and load, the governor controls the actual position of the throttle plate, within that range of possible opening.



1. SENSOR INPUTS
2. KEY SWITCH
3. GOVERNOR CONTROL MODULE
4. GOVERNOR
5. THROTTLE CABLES
6. TBI UNIT
7. THROTTLE (MONOTROL) PEDAL
8. ELECTRONIC CONTROL MODULE (ECM)

FIGURE 11. GOVERNOR SYSTEM

The engine sensors, such as the Throttle Position (TP) Sensor, Manifold Absolute Pressure (MAP) sensor, and crankshaft reference pulses (rpm) gives constant information on engine operating conditions to the Electronic Control Module (ECM). The ECM uses the information on throttle plate position and engine rpm to determine whether or not governed operation is needed.

At low engine speeds, below calibration rpm, the governor drive motor is not energized. At higher engine speeds, above calibration rpm, where the governor is needed, the ECM sends a signal to the governor control module to increase current flow to the governor motor. The governor motor rotates the drum and this causes the throttle plate to rotate toward the closed position. Control of the throttle plate is determined by the TP Sensor and engine speed signals to the ECM. When engine load increases and rpm decreases, the electrical current to the motor is reduced by the ECM through the governor control module, thus allowing the throttle plate to open farther.

ECM SENSORS AND CONTROLLERS

Manifold Absolute Pressure (MAP) Sensor (See FIGURE 12.)

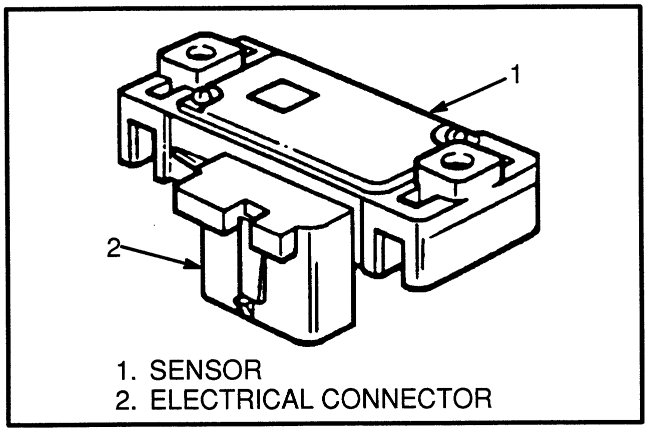


FIGURE 12. MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The Manifold Absolute Pressure (MAP) sensor is a pressure transducer that measures pressure changes in the intake manifold. Pressure changes are the result of engine load and speed changes. The MAP sensor converts these pressure changes to a signal voltage to the ECM.

A closed throttle causes a low pressure (high engine vacuum) in the intake manifold. This low pressure causes a low voltage signal from the MAP sensor to the ECM. A fully opened throttle causes a higher pressure (low engine vacuum) in the intake manifold. This higher pressure causes a higher voltage signal from the MAP sensor to the ECM. These pressure changes indicate the load on the engine and sends a signal to the ECM. The ECM then calculates the spark timing and fuel requirements for best engine performance.

The MAP sensor also measures barometric pressure when the key switch is turned to ON and before the engine is started. The ECM "remembers" the barometric pressure (BARO signal) after the engine is running. This method enables the ECM to automatically adjust for different altitudes and atmospheric conditions.

The ECM supplies 5 volts to the MAP sensor and monitors the voltage on a signal line. The sensor provides a path to ground through its variable resistance. The MAP sensor signal affects fuel delivery and ignition timing controls in the ECM.

Engine Coolant Temperature (ECT) Sensor (See FIGURE 13.)

The Engine Coolant Temperature (ECT) Sensor is a resistor that changes its resistance when the temperature changes (thermistor). It is installed in the engine coolant system. Low coolant temperature causes high resistance; 100,000 ohms at –40°C (–40°F). High temperature causes low resistance; 70 ohms at 130°C (266°F).

The ECM applies 5 volts to the coolant sensor and monitors the voltage on a signal line. The sensor provides a path to ground through its thermistor. The voltage will be high when the engine is cold, and low when the engine is hot. By monitoring the voltage, the ECM determines the engine coolant temperature. Engine coolant temperature affects most of the ECM functions.

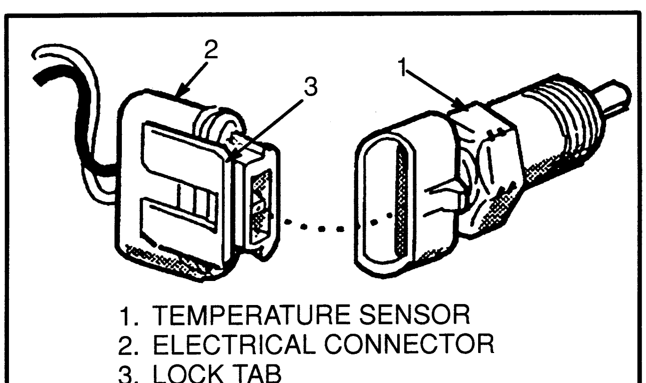


FIGURE 13. COOLANT TEMPERATURE SENSOR (CTS)

POSITIVE CRANKCASE VENTILATION (See FIGURE 14.)

The Positive Crankcase Ventilation (PCV) system is used as a vent for vapors from the crankcase. Clean air from the air cleaner is supplied to the crankcase, mixed with gases from the valve cover. This mixture then goes through the Positive Crankcase Ventilation (PCV) valve into the intake manifold. For correct engine idle, the PCV valve restricts the flow when there is high vacuum at the intake manifold.

The incorrect operation of the PCV system can be:

- Rough idle
- Stalling or slow idle speed
- High idle speed
- Oil leak
- Oil in the air filter

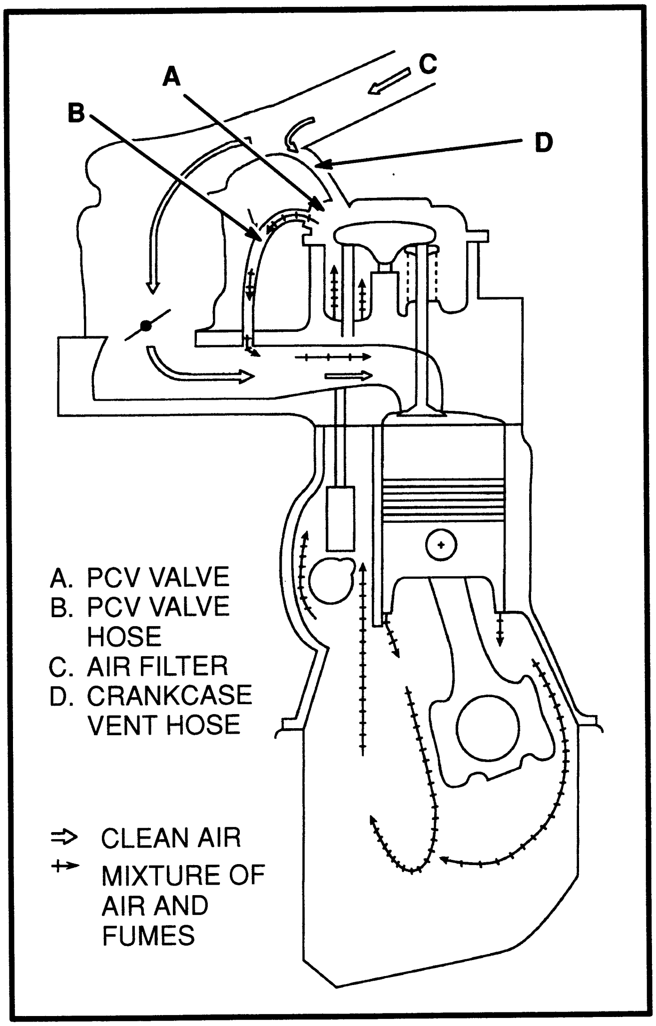


FIGURE 14. POSITIVE CRANKCASE VENTILATION SYSTEM