

E - THEORY/OPERATION**1991 ENGINE PERFORMANCE Jeep Theory & Operation****INTRODUCTION**

This article covers basic description and operation of engine performance-related systems and components. Read this article before diagnosing vehicles or systems with which you are not completely familiar.

SINGLE BOARD ENGINE CONTROLLER-II

The Single Board Engine Controller-II (SBEC-II) is a dual microprocessor that receives various signals from engine sensors and provides the necessary signals to control engine sub-systems. The SBEC-II has a voltage converter that converts battery voltage to regulated 5-volt or 8-volt outputs. The regulated 5-volt output is used to power Manifold Absolute Pressure (MAP) sensor, Throttle Position Sensor (TPS) and logic circuits. The regulated 8-volt output is used to power crankshaft position sensor and synchronization signal generator in distributor.

The ignition and fuel injection systems are controlled by the SBEC-II. Based on present engine operating conditions, the engine controller is programmed to provide a precise amount of fuel and the correct ignition timing to meet existing engine speed and load requirements.

The engine controller adjusts ignition timing based on inputs it receives from synchronization sensor generator, MAP sensor, coolant temperature sensor, throttle position sensor, vehicle speed sensor, transmission gear selection (automatic transmissions only), and brake switch.

The engine controller adjusts idle speed based on inputs it receives from throttle position sensor, vehicle speed sensor, transmission gear selection (automatic transmissions only), A/C clutch switch, and brake switch.

The engine controller also controls the speed (cruise) control system and alternator charge rate by controlling the alternator field.

NOTE: **Components are grouped into 2 categories. The first category covers INPUT DEVICES, which control or produce voltage signals that are monitored by the SBEC-II. The second category covers OUTPUT SIGNALS, which are components controlled by the SBEC-II.**

INPUT DEVICES

Vehicles are equipped with different combinations of input devices. Not all devices are used on all models. To determine the input device usage on a specific model, see appropriate wiring diagram in **WIRING DIAGRAMS** article. The available input signals include the following:

A/C Pressure Switch & Evaporator Switch

When A/C switch is in ON position and A/C low pressure switch and evaporator switch are closed, an A/C select signal is sent to engine controller. If A/C low pressure switch or evaporator switch opens, the engine

controller will not receive an A/C select signal.

When A/C function is selected (A/C switch on), the A/C request signal provides information to the engine controller from the A/C temperature control thermostat (evaporator switch). This signal indicates evaporator temperature is in the proper range for A/C operation.

The A/C request signal is used by engine controller to determine required Automatic Idle Speed (AIS) motor position and to activate or deactivate A/C compressor clutch. When engine controller receives an A/C request signal, it repositions the AIS motor to increase idle speed. The increased idle speed compensates for additional engine load caused by engagement of A/C compressor.

On 4.0L engine, whenever A/C compressor clutch is energized, engine controller also energizes the radiator (cooling) fan relay. This occurs regardless on engine coolant temperature.

Alternator Output

The engine controller keeps charging system voltage at 13.4-15.0 volts. Charging system voltage will be adjusted by engine controller based on battery temperature sensor, located within engine controller housing. The voltage determined by engine controller as final goal for charging system is called "control" voltage. The control voltage will be used to determine alternator field control and to detect if charging system is operating properly.

If sensed voltage is lower than "control" voltage, engine controller will alter duty cycle and ground alternator (rotor) field for a longer period of time and create a higher alternator output which should raise sensed voltage level. If sensed voltage is higher than "control" voltage, engine controller will alter duty cycle and lower alternator output which should lower sensed voltage level.

Battery Voltage Signal

The engine controller uses a battery voltage signal to determine vehicle's battery voltage level. The engine controller uses this information to determine injector pulse width and alternator field control.

The engine controller uses battery voltage level to regulate alternator field (rotor) duty cycle and alter fuel injector pulse width according to available voltage. If battery voltage drops, engine controller will increase injector on time to compensate for the reduced fuel flow of injector caused by the lower voltage. This will permit injector to deliver proper amount of fuel to the engine.

Brake Switch

The brake switch is mounted on steering column support bracket, under instrument panel. The engine controller uses the brake switch to determine when brakes are being applied or not. When brakes are applied (brake switch on) and if engine controller sees a TPS opening and a lower speed sensor rate, it recognizes a deceleration condition and opens up the Automatic Idle Speed (AIS) motor. The brake switch signal will also disengage speed (cruise) control operation, if it was engaged.

Coolant Temperature Sensor

The coolant temperature sensor is mounted on top of engine, next to thermostat housing. It provides an analog

signal to the engine controller that is used to calculate injector pulse width and ignition timing when engine is cold. Input from the coolant temperature sensor will also affect Automatic Idle Speed (AIS) motor position and spark advance operation.

Crankshaft Position Sensor

The Hall Effect type crankshaft position sensor is mounted on transaxle bellhousing. The sensor reads slots (4 per cylinder) on flywheel/flex plate. The signal generated provides engine speed and crankshaft position information to engine controller. The engine controller uses this information to determine proper fuel injection and ignition timing.

When a flywheel/flex plate slot passes the crankshaft position sensor magnet, output voltage of the Hall Effect sensor goes high (5 volts). When the metal between the slots is aligned with sensor, output voltage goes low (.3 volts).

This high/low voltage signal is generated and sent to engine controller each time one of the slots passes the crankshaft position sensor. The engine controller uses this information to determine when to energize the injectors for fuel delivery to the proper cylinders.

Ignition Circuit

When ignition key is turned to the ON position, the engine controller receives a signal that the ignition circuit has been activated. The engine controller will start looking at the input signals.

Manifold Absolute Pressure (MAP) Sensor

The MAP sensor is mounted on engine compartment firewall. The MAP sensor is used by engine controller to calibrate amount of air/fuel mixture supplied to the engine. This sensor measures manifold absolute pressure and ambient barometric pressure when ignition switch is first turned on, during engine cranking, and at wide open throttle.

The MAP sensor transmits a low voltage signal (1.5-2.1 volts) at idle when manifold vacuum is high, and a higher voltage signal (3.9-4.8 volts) during open throttle when manifold vacuum is low.

Input voltage (from the engine controller) to MAP sensor ranges from 4.8-5.1 volts. Adjustments made as a result of this input will usually affect injector pulse width, ignition timing, idle speed and upshift indicator light.

Manifold Air Temperature (MAT) Sensor

The MAP sensor is located on intake manifold, with sensor element extending into the air stream. The sensor measures the temperature of air entering the intake manifold. This sensor provides an analog voltage signal to engine controller. This signal is used to compensate for changes in air density due to temperature.

The MAT sensor is a Negative Temperature Coefficient (NTC) thermistor-type sensor. Its internal resistance varies opposite with temperature. At cold temperatures, the resistance is high. As temperature increases, its resistance decreases.

Oxygen (O2) Sensor

The heated oxygen sensor detects amount of oxygen content of the exhaust gases and produces a voltage signal. Engine controller uses this signal to monitor system output signals which control air/fuel mixture.

Variations in voltage signal from O₂ sensor serve as air/fuel ratio indicators. Changes occur because oxygen sensor voltage input to engine controller varies. When oxygen content is low (rich mixture), voltage signal will be approximately one volt. When oxygen content is high (lean mixture), voltage signal will be approximately 0.1 volt.

The O₂ sensor contains a ceramic heater in the sensor housing. The heater operates on 12 volts. The heater is used in cold starts to help O₂ sensor heat up quicker and to maintain the O₂ sensor's Zirconia semiconductor at its operational temperature of 932-1112°F (500-600°C).

In "closed loop" operation, engine controller monitors O₂ sensor input (along with other sensors) and adjusts the injector pulse width accordingly. During "open loop" operation, engine controller ignores O₂ sensor input and adjust injector pulse width to a pre-programmed value based on the other sensor inputs.

Park/Neutral Switch

On vehicles equipped with automatic transmission, a gear position indicator signal is sent to engine controller when gear selector lever has been moved to the Drive range. This signal comes from the Park/Neutral switch (Neutral safety switch on AW-4) and allows engine controller to adjust idle speed, fuel injector pulse width, and ignition timing advance.

Power Steering Switch

On 2.5L vehicles with power steering, a power steering switch is used. The switch is located on pressure line, next to power steering pump.

The power steering switch sends a signal to engine controller when pressures in system rise above 250-300 psi (17.6-21.1 kg/cm²) and engine RPM is low. The engine controller, through AIS motor, will raise the idle speed to prevent engine from stalling.

Serial Communications Interface Receive

The Serial Communications Interface (SCI) receive circuit is the serial data circuit that is used when diagnosing vehicle with Chrysler's Diagnostic Readout Box-II (DRB-II). The engine controller receives data from the DRB-II through this SCI receive circuit.

Speed (Cruise) Control Switches

The speed (cruise) control switches provide 3 separate inputs to the engine controller. The ON/OFF switch informs engine controller that speed control system has been activated. The SET switch informs engine controller that a set vehicle speed has been selected. The RESUME switch informs engine controller that the previously selected set speed has been selected.

Start (Cranking) Signal

The start (cranking) signal from starter relay signals engine controller when starter is engaged. When engine

controller determines that starter is engaged, it starts looking at inputs from crankshaft position sensor and synchronization signal generator.

The engine controller then uses these signals to determine spark timing and whether the first fuel injection should occur at cylinder No. 4 or 1 (4-cylinder) or cylinder No. 3 or 4 (6-cylinder). Once synchronization has been established, the engine controller energizes the proper injector and provides the ignition output needed to start the engine.

Synchronization Signal Generator

The synchronization signal generator is located in distributor. This Hall Effect type sensor works in conjunction with engine speed signal of crankshaft position sensor providing engine controller with inputs necessary to establish and maintain proper fuel injector firing order.

When leading edge of pulse ring enters the sync signal generator, change in the magnetic field causes a 5-volt reference signal to be induced. On 4-cylinder engines, this indicates to the engine controller that piston No. 4 will be the next piston at Top Dead Center (TDC). On 6-cylinder engine, it indicates that piston No. 3 will be at TDC.

When trailing edge of pulse ring leaves the sync signal generator, the collapse of the magnetic field causes reference signal to drop to zero volts. On 4-cylinder engines, this indicates that piston No. 1 will be the next piston at TDC. On 6-cylinder engine, it indicates that piston No. 4 will be at TDC.

Throttle Position Sensor (TPS)

The TPS is mounted on throttle body and monitors opening angle of throttle valve. It contains a potentiometer operated by the opening and closing of throttle plate. Engine controller uses TPS input signal to determine throttle position under all operating conditions and adjust fuel injector pulse width and ignition timing accordingly.

The engine controller supplies a 5-volt reference signal to TPS. The TPS output voltage (input signal to engine controller) represents throttle blade position. The TPS output voltage varies from one volt at minimum throttle opening (idle) to 4 volts at wide open throttle.

Vehicle Speed Sensor

The vehicle speed sensor is located on transaxle extension housing (2WD models) or on transfer case extension housing (4WD models). The engine controller uses vehicle speed (distance) sensor to detect if vehicle is moving and at what speed it is moving.

The sensor is an 8-pole switch which provides a pulse or switching rate, proportional to vehicle speed, to the engine controller. By comparing the number of pulses to time elapsed, the controller determines vehicle speed and distance traveled.

The vehicle speed sensor generates 8 pulses per sensor revolution. This signal, along with a closed throttle signal from the TPS sensor, indicates a closed throttle deceleration to the engine controller.

Under deceleration conditions, engine controller adjusts the Automatic Idle Speed (AIS) motor to maintain

desired MAP value. During idle (vehicle stopped), the engine controller adjusts the AIS motor to maintain a desired engine speed.

The vehicle speed (distance) sensor input is also used to maintain speed (cruise) control operation and as a reference for Emission Maintenance Reminder (EMR) light.

Vehicle Theft Alarm

Cherokee is equipped with vehicle theft alarm. The theft alarm module will provide a signal to engine controller to enable it to start the engine. With theft alarm module activated, no signal though the communication bus will be sensed by the engine controller and the engine will not start. The engine controller controls ignition and fuel delivery to the engine.

OUTPUT SIGNALS

NOTE: Vehicles are equipped with different combinations of computer-controlled components. Not all components listed below are used on every vehicle. For theory and operation on each output component, refer to the system indicated after component.

A/C Compressor Clutch Relay

See MISCELLANEOUS CONTROLS.

Alternator Light

See MISCELLANEOUS CONTROLS.

Automatic Shutdown Relay

See FUEL DELIVERY.

Automatic Idle Speed (AIS) Motor

See IDLE SPEED.

Ballast Resistor

See FUEL DELIVERY.

Ballast Resistor By-Pass Relay

See FUEL DELIVERY.

CHECK ENGINE Light

See SELF-DIAGNOSTIC SYSTEM.

Emission Maintenance Reminder (EMR) Light

See EMISSION SYSTEMS.

Fuel Injectors

See FUEL DELIVERY.

Fuel Pump Relay

See FUEL DELIVERY.

Ignition Coil

See IGNITION SYSTEM.

Injection Timing

See FUEL DELIVERY.

Radiator (Cooling) Fan Relay

See MISCELLANEOUS CONTROLS.

Serial Communication Interface Transmit

See MISCELLANEOUS CONTROLS.

Speed (Cruise) Control Solenoids

See MISCELLANEOUS CONTROLS.

Tachometer

See MISCELLANEOUS CONTROLS.

Upshift Light

See MISCELLANEOUS CONTROLS.

FUEL SYSTEM**FUEL DELIVERY****Automatic Shutdown Relay**

The Automatic Shutdown (ASD) relay is located in power distribution center near the battery or next to radiator coolant recovery bottle.

The ASD relay is used by the engine controller to supply voltage to fuel pump, fuel injectors and ignition coil. The relay contacts are normally open.

Power is supplied to relay coil when the ignition switch is turned on. The engine controller controls the ground circuit, which energizes the coil and closes the relay contacts.

The engine controller will only ground the relay when ignition switch is in the RUN or START positions and some activity is sensed through the crankshaft position sensor and the synchronization signal in the distributor. If the engine controller senses the RPM signal has stopped, it will remove the ground from relay coil, which will cause the contacts to open and remove power from the circuit.

Ballast Resistor

Cherokee and Comanche models have a ballast resistor located between fuel pump relay and the fuel pump. Its purpose is to reduce voltage to the fuel pump. This reduces fuel pump noise during operation. Ballast resistor is mounted on fender panel, next to washer fluid reservoir.

When fuel pump relay is energized, voltage is supplied to fuel pump through the ballast resistor. During start and wide open throttle conditions, ballast resistor is by-passed and fuel pump receives its voltage from ballast resistor by-pass relay.

NOTE: Wrangler models DO NOT use a ballast resistor or ballast resistor by-pass relay in the fuel pump circuit. The engine controller operates fuel pump through the fuel pump relay during all operating conditions.

Ballast Resistor By-Pass Relay

Cherokee and Comanche models have a ballast resistor by-pass relay located on a bracket next to power distribution center (next to coolant recovery bottle). By switching the ground circuit on or off, the engine controller can control fuel pump (power) feed. The ballast resistor by-pass relay receives its voltage from fuel pump relay.

Normally, voltage is supplied to fuel pump through a ballast resistor. At wide open throttle, fuel pump receives voltage through the ballast resistor by-pass relay, which speeds up fuel pump to compensate for higher fuel demand.

Fuel Pump (Electric)

Cherokee, Comanche and Wrangler models are equipped with a gear/rotor type electric pump. Pump is driven by a permanent magnet, 12-volt electric motor that is immersed in fuel tank. The pump is an integral part of the fuel gauge sending unit.

Fuel system pressure is maintained at about 31 psi (2.2 kg/cm²) when pump is operating and vacuum applied to fuel pressure regulator. With no vacuum applied to fuel pressure regulator, fuel pressure should be 39-41 psi (2.7-2.9 kg/cm²) or higher. When fuel pump is not operating, fuel pressure is maintained at 19-39 psi (1.3-2.7 kg/cm²) by fuel pump outlet check valve and the fuel pressure regulator.

Fuel Pump (Mechanical)

The Grand Wagoneer is equipped with a single action mechanical fuel pump. The fuel pump is comprised of an actuating lever, an inlet valve, an outlet valve and a diaphragm and spring assembly. An eccentric cam on the engine camshaft operates the fuel pump lever, which is linked to the pump diaphragm. The lever pulls the diaphragm to its extended position to draw fuel past the inlet valve.

When the carburetor float needle valve closes, fuel pump output is limited to the amount of fuel that returns back to the fuel tank through the fuel return tube. The fuel accumulated in the fuel pump chamber prevents the diaphragm from relaxing. The actuating lever continues to move up and down, but is prevented from operating the diaphragm which is held in the extended position by fuel pressure. Fuel flow from the pump remains halted until excess pressure is released through the fuel return tube or until the carburetor float needle moves off its seat.

Fuel Pump Relay

Cherokee and Comanche models have a fuel pump relay located in the power distribution center, next to coolant recovery bottle. On Wrangler, the fuel pump relay is located in power distribution center next to battery.

The feed side of the relay coil is powered by the ignition switch. The relay is energized by the engine controller by grounding the other side of the relay coil. The relay contacts are normally open and will close when the engine controller provides a ground path for the relay coil.

The fuel pump circuit is completed during cranking and whenever the engine is running. If the ignition key is turned to the RUN position, the fuel pump will operate for 1-3 seconds and then shut off. If the engine controller DOES NOT receive a crank or run signal, it deactivates the fuel pump by opening the relay coil ground circuit. The 1-3 second time limit is used to prevent unnecessary operation of the fuel pump once the system is pressurized. If the engine were running, the engine controller would maintain the fuel pump relay coil ground allowing continuous operation of the fuel pump.

Fuel Return System

The Grand Wagoneer employs a fuel return system to reduce the possibility of high temperature fuel vapors. The fuel return system consists of a fuel filter equipped with a return nipple and a return tube to the fuel tank. During normal operation a small amount of liquid fuel is returned to the fuel tank. During periods of high under hood temperatures, vaporized fuel is returned to the fuel tank instead of being delivered to the carburetor. The fuel filter must be installed with the return fitting positioned upward to ensure proper fuel return system operation.

FUEL CONTROL

NOTE: The Grand Wagoneer 5.9L engine is equipped with a Motorcraft 2150, 2-barrel carburetor. Carburetor includes float (fuel inlet) circuit, bowl vents, idle metering (low speed) circuit, main metering (high speed) circuit, pump and power enrichment circuit, thermostatically controlled choke, and an altitude compensator circuit. Only the thermostatically controlled choke and altitude compensator circuit will be covered here.

Altitude Compensator Circuit

The altitude compensator supplies extra air necessary to lean out the air/fuel mixture at high altitudes. The compensator circuit parallels the carburetor main metering (high speed) circuit. The altitude compensator circuit has a small separate, nonadjustable choke valve that is linked directly with the primary choke valve. This small choke valve controls the airflow when the main choke is closed. See **Fig. 1**.

Air flows down through a passage in carburetor main body and into a plenum chamber located adjacent to the 2 main venturi bores. A spring-loaded valve regulates the amount of air passed from plenum into the compensator body. Air flows from altitude compensator body through 2 air passages bored into the main venturi tubes.

The opening and closing of the valve in the compensator body is controlled by an aneroid bellows that reacts to atmospheric pressure. At lower atmospheric pressures (high altitude), the bellows pushes on the end of the compensator valve stem, opening the valve. At lower altitudes, the aneroid bellows relaxes, automatically closing the valve. The aneroid bellows is calibrated during factory assembly and is NOT adjustable.

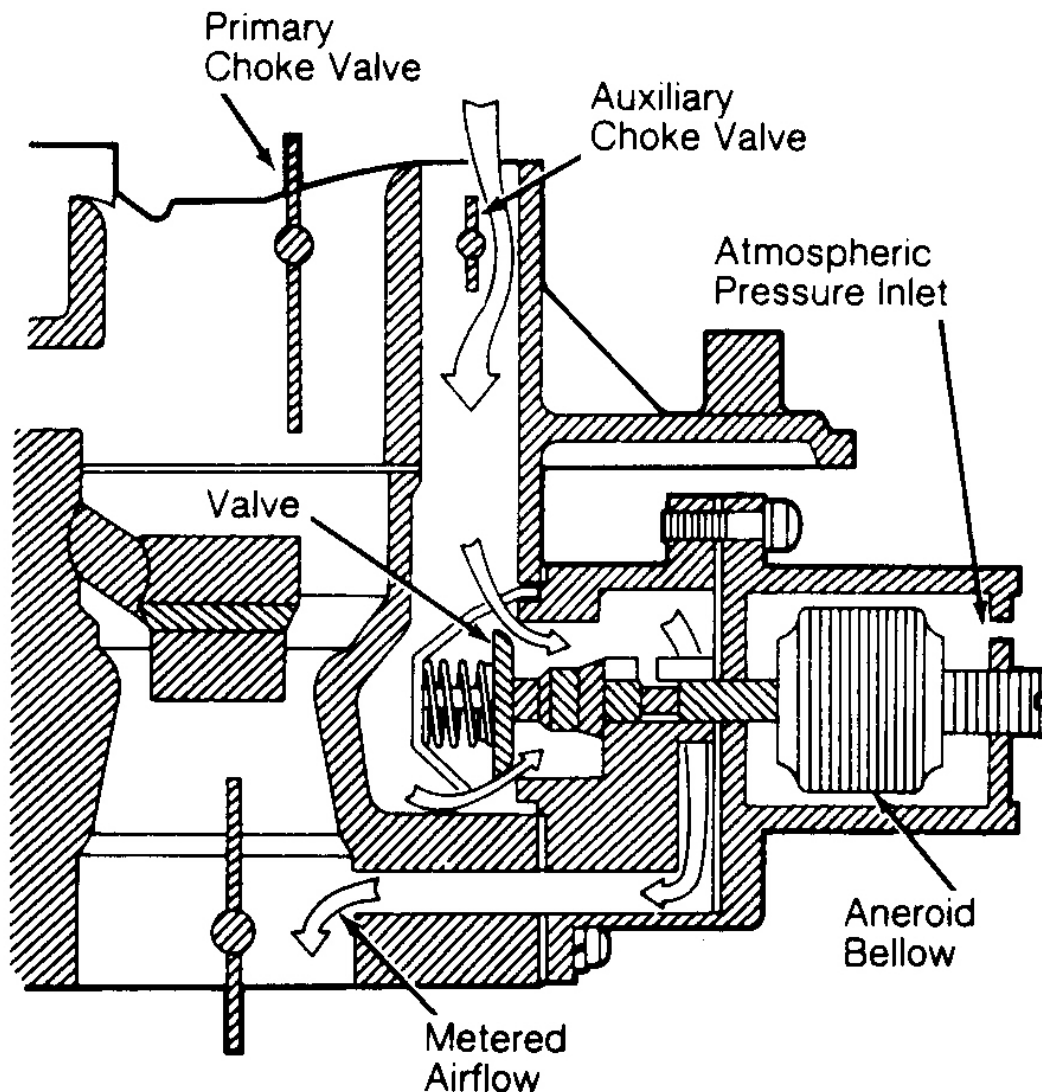


Fig. 1: Altitude Compensator Circuit (Grand Wagoneer)

Fuel Injectors

The fuel injectors are controlled electronically by the engine controller. Because each injector is connected to 12 volts, the injector is energized when connected to ground through the engine controller. The engine controller also controls the amount of time the injector is energized (pulse width). Pulse width is based on various inputs and is calculated by the engine controller. The fuel injectors are sequentially energized, by firing order, by the engine controller.

With injector connected to a pressurized fuel supply, a fine mist will spray from the injector nozzle into the intake manifold. The injector uses an electromagnet and spring pressure to open or close the fuel metering plunger. When connected to battery voltage, the coil of wire in the injector becomes an electromagnet. The

magnetic field generated will overcome spring pressure and raise the plunger off its seat. When the injector circuit is opened by the engine controller, the magnetic field collapses and spring pressure forces the plunger against its seat.

Whenever an injector is opened, it will always spray a consistent amount of fuel for a given amount of pressure. Because pressure drop across the injector is fixed and the fuel flow rate constant, the only control variable is the amount of time injector is open. By controlling the time the injector is open (pulse width), the engine controller can decrease pulse width for engine idle or it can increase pulse width at wide open throttle.

Injection Timing

The 2.5L and 4.0L engine use a sequential port fuel injection system. This means that the injectors have a specific firing order and fuel injection is timed to piston movement. The spark plugs and injectors are fired in the same order: 1-3-4-2 on 2.5L and 1-5-3-6-2-4 on 4.0L.

In order for the engine controller to fire the injectors in a specific order timed to crankshaft and piston movement, it has to establish a reference point. Establishing the reference point requires engine controller inputs from the crankshaft position sensor and synchronization signal generator.

The crankshaft position sensor is located on transmission bellhousing and provides the engine controller with crankshaft angle and speed. The engine controller converts crankshaft speed into engine RPM and crankshaft angle into piston position.

On 2.5L engine, the slotted flywheel/drive plate, rotating past the sensor, contains 2 groups of 4 slots located 180 degrees apart. Each group of slots represents the position of two of the pistons. Pistons No. 1 and 4 approach TDC at the same time and use the same flywheel slot, while piston No. 3 is matched with piston No. 2.

On 4.0L engine, the slotted flywheel/drive plate, rotating past the sensor, contains 3 groups of 4 slots located 120 degrees apart. Each group of slots represents the position of two of the pistons. Pistons No. 1 and 6 approach TDC at the same time and use the same flywheel slot. Pistons No. 2 and 5 are matched, while piston No. 3 is matched with piston No. 4.

The engine controller, through the crankshaft position sensor, knows that two pistons are approaching TDC and uses the sync signal generator to determine which injector/spark plug to fire. See **Fig. 2**.

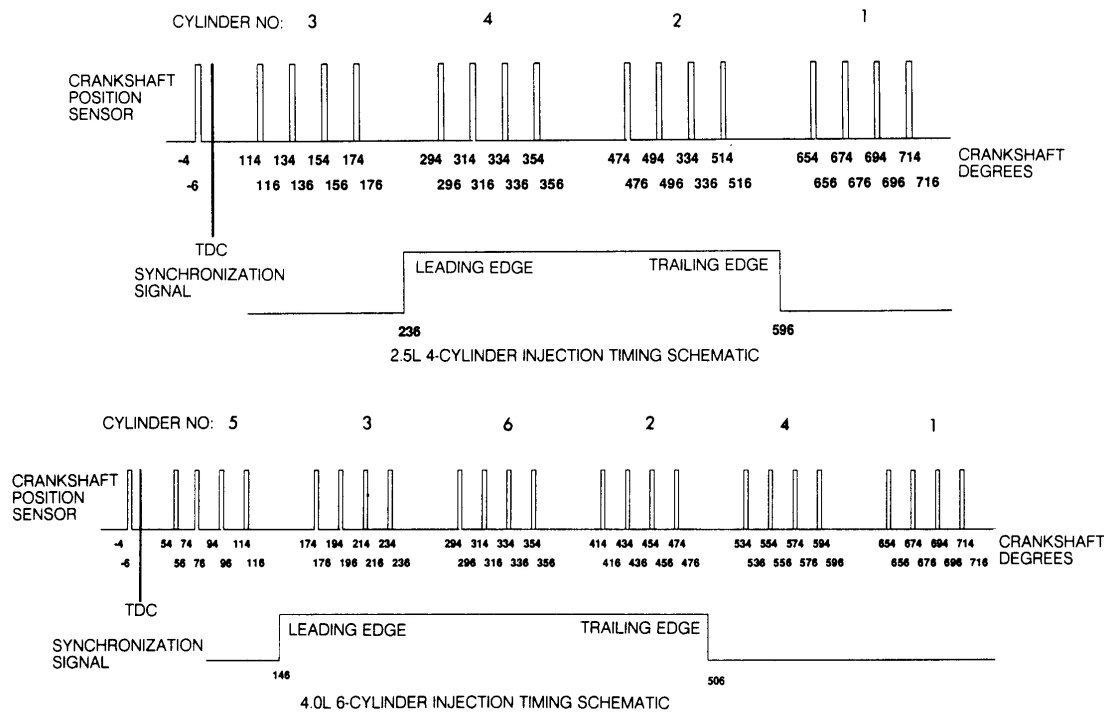


Fig. 2: Sequential Port Fuel Injection (SPFI) Timing

Thermostatically Controlled Choke

The choke valve is located in the air horn assembly and provides a richer air/fuel mixture required for cold engine starting and operation. The choke shaft is connected by linkage to a bimetallic coil that winds up when cold and unwinds when warm.

When engine is cold, tension of the bimetallic coil holds the choke valve closed. When the engine is started, manifold vacuum is channeled through an opening at the base of the carburetor through a passage on the bottom side of the modulator diaphragm assembly, to move the diaphragm downward against the set screw. At the same time, the modulator arm contacts a tang on the choke shaft. The downward movement of the diaphragm assembly compresses the piston spring and exerts a pulling force on the modulator arm, causing the choke valve to open slightly.

The bimetallic coil is warmed by an electric heater element and, as the engine warms, heated air is routed from the exhaust crossover through a heat tube to the choke housing. The heater element and heated air entering the choke housing cause the bimetallic coil to begin unwinding and decrease the closing tension exerted against the choke valve. The coil gradually loses its tension and allows the choke valve to open.

A thermostatically controlled by-pass valve, helps prevent premature choke valve opening during an early part of engine warm-up period. The valve regulates temperature of the hot air flow to the choke housing by allowing unheated air to enter the heat tube. A thermostatic disc which is incorporated into the valve, is calibrated to close the valve at 75°F (24°C) and open the valve at 55°F (13°C).

The fast idle cam, actuated by the choke rod, contacts the fast idle speed adjustment screw and increases engine

speed in proportion to choke valve opening. When the choke valve reaches the fully open position, the fast idle cam rotates free of the fast idle speed adjustment screw and allows the throttle lever to return to curb idle speed position.

IDLE SPEED

Automatic Idle Speed (AIS) Motor

The AIS motor is mounted on throttle body and is used by the engine controller to adjust engine idle speed. The throttle plate regulates off idle engine speed by controlling the amount of air allowed to enter the intake manifold and is mechanically operated by the accelerator cable.

The engine controller and idle stepper motor adjust engine idle by regulating the size of an air by-pass passage that routes air past the closed throttle plate. The amount of air flowing through the by-pass circuit depends on engine operating conditions at idle.

When the engine is cold, the engine controller increases engine speed by retracting the stepper motor pintle, thus allowing more air to enter the intake manifold. To maintain the proper air/fuel mixture, more fuel is also injected into the intake manifold. The increased air/fuel mixture, in turn, raises the engine idle speed. As the engine warms up, the engine controller will extend the stepper motor pintle into the air passage to reduce the amount of air by-passing the throttle plate.

IGNITION SYSTEM

SBEC-II CONTROLLED IGNITION SYSTEM

The Cherokee, Comanche, and Wrangler 2.5L or 4.0L engines use a Single Board Engine Controller-II (SBEC-II) based ignition system. Base ignition timing is NOT adjustable with this system. The SBEC-II controlled ignition system consists of coolant temperature sensor, crankshaft position sensor, distributor (includes rotor and synchronization sensor), ignition coil, manifold absolute pressure sensor, Single Board Engine Controller-II, and throttle position sensor.

Coolant Temperature Sensor

See INPUT DEVICES.

Crankshaft Position Sensor

See INPUT DEVICES.

Distributor

Distributor consists of cap, rotor, and synchronization signal generator. The distributor does not have built-in centrifugal or vacuum advance mechanisms to advance ignition timing. Ignition timing advance is electronically controlled by the engine controller. See SYNCHRONIZATION SIGNAL GENERATOR under INPUT DEVICES.

Ignition Coil

The ignition coil is constructed of epoxy-embedded windings and is not oil filled. Battery voltage is supplied to the ignition coil positive terminal. The engine controller receives inputs from the appropriate sensors. Based on these inputs, it then determines the proper ignition timing and interrupts the ignition coil ground signal to trigger secondary voltage of the ignition coil.

Manifold Absolute Pressure Sensor

See INPUT DEVICES.

Manifold Air Temperature Sensor

See INPUT DEVICES.

Single Board Engine Controller-II

The engine controller opens and closes the ignition coil ground circuit to adjust ignition timing according to engine operating conditions. The amount of electronic spark advance provided by the engine controller is determined by coolant temperature sensor, crankshaft position sensor (engine RPM), manifold absolute pressure sensor and throttle position sensor inputs. See COMPUTERIZED ENGINE CONTROLS for additional information.

Throttle Position Sensor

See INPUT DEVICES.

SOLID STATE IGNITION SYSTEM

The Grand Wagoneer 5.9L engine is equipped with a Solid State Ignition (SSI) system. The SSI system consists of ignition module, ignition coil, resistance wire, and distributor (pick-up coil and trigger wheel). Base ignition timing is adjustable with this system.

The ignition module is activated when ignition switch is in the START or ON position. The primary circuit is closed and current flows through the coil primary winding. When camshaft turns distributor, the trigger wheel teeth rotate past the pick-up coil assembly (in the distributor). As each tooth aligns with the pick-up coil, the resulting pulse triggers the ignition module which opens the coil primary circuit. A high voltage is then induced in the coil secondary winding and current flows to the distributor cap and rotor. As the rotor spins it distributes high voltage to the proper spark plug. Ignition timing is constantly changed by electronic, vacuum, and centrifugal advance mechanisms according to engine operating conditions.

Distributor

The distributor consist of cap, rotor, pick-up coil and trigger wheel, centrifugal and vacuum advance mechanisms. The distributor drive gear installed on the distributor shaft meshes with a spiral cut gear on the camshaft. The end of the distributor shaft is flattened and drives the oil pump. Flyweights connected to the distributor provide a means for centrifugal advance. Carburetor ported vacuum is used for vacuum advance.

Ignition Coil

The ignition coil is mounted on a bracket attached to intake manifold. Coil operation is controlled by the ignition module. Primary coil resistance is 1.11-1.25 ohms. Secondary coil resistance is 7650-9370 ohms.

Ignition Module

The electronic ignition module is located in engine compartment on left wheelwell. It is a permanently sealed, solid state module that is not repairable. The ignition module processes ignition signals it receives from the distributor and then interrupts the primary circuit to the ignition coil causing spark to occur.

Pick-Up Coil & Trigger Wheel

The ignition coil primary circuit is opened and closed electronically by the ignition module. The pick-up coil and trigger wheel provide the input signal for the ignition module. The trigger wheel is installed on the distributor shaft and has one tooth for each cylinder. The pick-up coil has a magnetic field that is intensified by the presence of ferrous metal and reacts to the trigger wheel teeth as they pass.

As a trigger wheel tooth approaches and passes the pole piece of the pick-up coil, it reduces the reluctance to the magnetic field and increases field strength. Field strength decreases as the tooth moves away from the pole piece. The increase and decrease of field strength induces an alternating current in the pick-up coil, which triggers the ignition module. The ignition module opens or closes the coil primary circuit according to the position of the trigger wheel teeth.

Resistance Wire

A 1.35-ohm resistance wire is installed in the ignition system wiring to supply less than full battery voltage to the ignition coil after the starter motor solenoid is de-energized. During engine cranking, the resistance wire is by-passed and full battery voltage is applied to the ignition coil. The by-pass is accomplished through the "I" terminals of the starter motor solenoid.

EMISSION SYSTEMS

CRANKCASE VENTILATION (CCV) SYSTEM

Cherokee, Comanche, and Wrangler engines use a crankcase ventilation system. The CCV system performs the same function as a conventional PCV system, but does not use a vacuum controlled valve. On 2.5L engine, a fitting on the driver's side of the cylinder head cover contains a metered orifice that is connected to manifold vacuum. On 4.0L engine, a molded vacuum tube connects manifold vacuum to the top of the cylinder head cover. The molded vacuum tube contains a fixed, calibrated orifice that meters the amount of crankcase vapors drawn out of the engine.

On both engines, a fresh air supply hose from the air cleaner is connected to the cylinder head cover. When the engine is operating, fresh air enters the engine and mixes with crankcase vapors. Manifold vacuum then draws the crankcase vapors/air mixture through the fixed orifice and into the engine by intake manifold vacuum.

EMISSION MAINTENANCE REMINDER LIGHT

The Emission Maintenance Reminder (EMR) light on instrument cluster indicates to vehicle owner components of the vehicle's emission system are scheduled for service or replacement.

The emission maintenance reminder function is built into the engine controller. The engine controller reads vehicle speed (distance) sensor and stores mileage information in a non-volatile, resettable memory. When the engine controller sees the appropriate mileage has accumulated, about 82,500 miles (133,000 kilometers), it turns on the EMR light.

The EMR light must be turned off and the engine controller reset by using Chrysler's Diagnostic Readout Box-II (DRB-II). If the engine controller has been replaced, the current EMR mileage must be installed into the replacement engine controller to maintain correct EMR light function. This procedure can only be accomplished by using the DRB-II diagnostic tester.

EVAPORATIVE EMISSION SYSTEM

This system stores fuel vapors from fuel tank, preventing vapors from reaching the atmosphere. As fuel evaporates inside fuel tank, vapors are routed inside vent hoses to evaporative canister, where they are stored until engine is started.

On Cherokee, Comanche and Wrangler, evaporative canister is equipped with a purge shutoff switch that controls canister purge operation. The switch is open when manifold vacuum is applied to it. The air cleaner contains a venturi as a purge line vacuum source. The effect of the venturi increases the speed of the intake air flowing by the slots in the venturi wall, creating a low pressure area around the slots. When the purge shutoff switch is open, vapors from the canister are drawn through slots and into the airstream flowing through the venturi. The vapors then pass through the intake manifold and into the engine combustion chambers.

On Grand Wagoneer, vacuum supply for the canister purge signal is controlled by coolant temperature. A Coolant Temperature Operated (CTO) valve restricts the purge signal vacuum flow to the canister until engine coolant temperature reaches 123-127°F (51-53°C). Once the CTO valve has opened, purge signal vacuum flows through the purge signal line to the canister. Vacuum from the purge signal line opens a one-way valve in the canister. When valve is open, fuel vapors stored in the canister are drawn into the engine by intake manifold vacuum.

Evaporative Canister

The evaporative canister used in Jeep vehicles is filled with granules of an activated carbon mixture. Fuel vapors entering the canister are absorbed by the granules. The evaporative canister has one inlet connected to the pressure relief/rollover valves of the fuel tank through hoses and tubes. On Grand Wagoneer, the evaporative canister has two inlet ports. One port connects to the fuel tank pressure relief/rollover valves and the other connect to the carburetor bowl vent valve.

Pressure Relief/Rollover Valves

All Jeep vehicle fuel tanks are equipped with two pressure relief/rollover valves. The dual function valves relieve fuel tank pressure and prevent fuel flow through fuel tank vent hoses in the event of a vehicle rollover. The valve consists of a plunger, spring, orifice and guide plate. The valve is normally open, allowing fuel vapors to vent to the canister where they are stored.

If bottom of plunger is contacted by sloshing fuel in fuel tank, the plunger seats in the guide plate, preventing liquid fuel from reaching the evaporative canister. In a vehicle rollover, the valve is inverted. This forces the plunger against the guide plate and fuel is prevented from flowing through the valve orifice and into fuel tank

vent tube.

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

The Grand Wagoneer 5.9L engine is equipped with an EGR system. System consists of EGR valve, EGR valve transducer, coolant temperature override valve, thermal vacuum switch, and connecting hoses.

Thermal Vacuum Switch (TVS)

The TVS is located in center of air cleaner. The TVS functions as an on/off switch and is controlled by air cleaner intake air temperature. At air temperatures below 40-50°F (4-10°C), the TVS prevents vacuum from opening the EGR valve thus improving cold engine driveability. If intake air temperature in air cleaner has reached 55°F (13°C), the thermal vacuum switch will open permitting vacuum to reach EGR valve transducer.

Coolant Temperature Override (CTO) Valve

The CTO valve is located at front of intake manifold, between oil filler tube and thermostat. When coolant temperature is lower than 155°F (68°C), no vacuum is applied to EGR valve. The CTO valve restricts vacuum flow to the thermal vacuum switch until coolant reaches 155°F (68°C). Once CTO valve opens, vacuum flows to thermal vacuum switch.

EGR Valve Transducer

The EGR valve transducer is connected to EGR valve by a vacuum hose and a backpressure hose. The transducer is controlled by exhaust system backpressure and is ported to exhaust manifold through a hose connecting it to the bottom of the EGR valve. When exhaust system backpressure is high enough, a bleed valve in the transducer will close, allowing vacuum to actuate the EGR valve. If backpressure does not close the bleed valve in the transducer, vacuum will be bled off.

When vacuum is applied to EGR valve, a metered amount of exhaust gas will be drawn into the intake manifold and mixed with air/fuel mixture.

POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM

The Grand Wagoneer 5.9L engine is equipped with a PCV system. The PCV system prevents crankcase vapors from entering the atmosphere. Filtered air from the crankcase is routed through the PCV inlet hose and into the crankcase, forcing crankcase vapors through the PCV outlet hose into the engine by intake manifold vacuum.

Crankcase Vent Filter

The crankcase vent filter is used to filter fresh air before it enters crankcase through the PCV system. The filter is located on oil filler cap.

PCV Valve

The PCV valve contains a spring-loaded plunger that meters the amount of crankcase vapors routed into the engine combustion chambers based on intake manifold vacuum. When the engine is not running or during an engine backfire, the spring forces the plunger back against the seat preventing vapors from flowing through the

PCV valve.

During periods of high manifold vacuum, such as idle or cruising speeds, manifold vacuum is high enough to completely compress the spring and pull the plunger to the top of the valve. In this position, there is minimal vapor flow through the PCV valve. During periods of moderate intake manifold vacuum, the plunger is pulled partially away from seat, resulting in maximum vapor flow through the PCV valve.

THERMOSTATIC AIR CLEANER (TAC)

The Grand Wagoneer 5.9L engine is equipped with a TAC system. The TAC system provides heated air for the carburetor during engine warm-up. The TAC system consists of heat stove, heated air tube, thermal switch, reverse delay valve, check valve, vacuum motor and air valve assembly.

SELF-DIAGNOSTIC SYSTEM

CHECK ENGINE LIGHT

The CHECK ENGINE light lets the driver know if the engine controller has recorded a system or sensor malfunctions. CHECK ENGINE light will come on if vehicle goes into a "limp-in" mode. The CHECK ENGINE can also be used to display fault codes. By cycling the ignition on, off, on, off and on within 5 seconds, the engine controller will display the fault codes in a series of flashes representing numbers. For additional information, see G - TESTS W/ CODES article in the ENGINE PERFORMANCE Section.

MISCELLANEOUS CONTROLS

NOTE: **Although not considered true engine performance-related systems, some controlled devices may affect driveability if they malfunction.**

A/C COMPRESSOR CLUTCH RELAY

The engine controller controls the A/C compressor clutch through a relay. This allows the engine controller to receive an A/C select signal when driver moves mode lever into A/C position. The engine controller also receives a request signal from the A/C temperature control thermostat (evaporator switch).

The engine controller then adjusts idle speed using the AIS motor. Only then can the engine controller activate the A/C compressor clutch through the A/C compressor clutch relay. The increased idle speed will compensate for the additional load caused by the A/C compressor.

On 4.0L engine, whenever the A/C compressor clutch is energized, the engine controller also energizes the radiator (cooling) fan relay. This occurs regardless on engine coolant temperature.

ALTERNATOR LIGHT

The alternator (charging indicator) light on the standard (base) instrument cluster will come on if the engine controller senses a low charging condition or an overcharging condition. Once engine controller compensates for the accessory electrical load, alternator light should go out.

RADIATOR COOLING FAN RELAY

An electric radiator cooling fan is used on Cherokee and Comanche models with the 4.0L engine and A/C or heavy duty cooling. Normal operation of the radiator cooling fan is controlled by the engine controller through the coolant sensor input. Cooling fan will also operate whenever A/C compressor clutch is activated, regardless of temperature.

When engine coolant temperature reaches 217°F (103°C), engine controller supplies radiator cooling fan relay with a ground path which closes the radiator cooling fan relay contacts and allows battery voltage from the ignition switch to reach radiator cooling fan motor.

SPEED (CRUISE) CONTROL SOLENOIDS

The engine controller controls the vacuum vent, and dump solenoids when operating the cruise control system. When the SET button is pushed, the engine controller sees voltage on terminal No. 48. When button is released, the voltage signal is removed and the engine controller locks in a set speed for the system. The set speed becomes the target for the cruise control system to maintain. The cruise control system will not permit speeds higher than 85 MPH to be set.

The engine controller energizes the vacuum solenoids located in the cruise control servo assembly to open the throttle to maintain the set speed. To increase set speed, the engine controller grounds the vacuum solenoid through terminal No. 33 of the engine controller. The solenoid receives battery voltage with ignition on and as long as the brakes are off. The vacuum solenoid is spring loaded to block vacuum from getting into the servo diaphragm. When energized, vacuum solenoid is pulled open, allowing vacuum to enter servo diaphragm and open throttle.

At the same time vacuum solenoid is being commanded to open the throttle, the engine controller must supply a ground to the vent solenoid. The vent solenoid is spring loaded so that when it is not energized, it bleeds vacuum from the servo chamber. The vent solenoid receives battery voltage with ignition switch on and as long as the brakes are off. When the engine controller supplies the vent solenoid with a ground, the solenoid blocks the leakage of vacuum from the servo chamber. To increase throttle opening, the engine controller grounds the vacuum solenoid. To reduce throttle opening, the engine controller grounds the vent solenoid.

Anytime the brakes are applied, the brake switch will interrupt power supply to the dump solenoid which causes it to vent vacuum as the vent and vacuum solenoids return to their relaxed (non-energized) positions by opening their ground circuits. The dump solenoid is reset when the brakes are released but the engine controller will only reactivate the vacuum and vent solenoids when the RESUME switch is pushed.

UPSHIFT INDICATOR LIGHT

Vehicles equipped with a manual transmission have an upshift light located in the instrument cluster. The upshift light is controlled by the engine controller and will illuminate the light to inform the driver when to shift to the next higher gear for best fuel economy. The engine controller determines which gear should be used by observing and remembering RPM and manifold absolute pressure values. A high gear switch is NOT used in the transmission.