PORSCHE 944 DME DIGITAL ENGINE CONTROL

DESCRIPTION

The Porsche 944 is equipped with the Bosch DME digital electronic engine control system. The DME system uses various data sensors that monitor intake air volume, speed, crankshaft position, coolant temperature, intake air temperature, and throttle position.

Signals from these sensors, as well as a start signal and oxygen sensor signal, are sent to the electronic control unit.

The electronic control unit (ECU) is a microcomputer, and is the "brain" of the DME system. Using information obtained from data sensors, the ECU determines the correct amount of fuel and optimum ignition timing.

The DME control unit switches from open loop to closed loop operation when the coolant temperature is above 113°F (45°C), and when the oxygen sensor temperature is above 480°F (250°C).

OPERATION

The DME system consists of 4 sub-systems: Fuel Control, Data Sensors, Electronic Control Unit (ECU), and Spark Timing.

FUEL CONTROL

The Porsche 944 is equipped with the Bosch Air Flow Controlled (AFC) fuel injection system. The AFC system is electronically controlled by the ECU, which is programed to regulate fuel injection based upon information received from various data sensors. It also considers the specific data for the 944 engine (stored in computer memory).

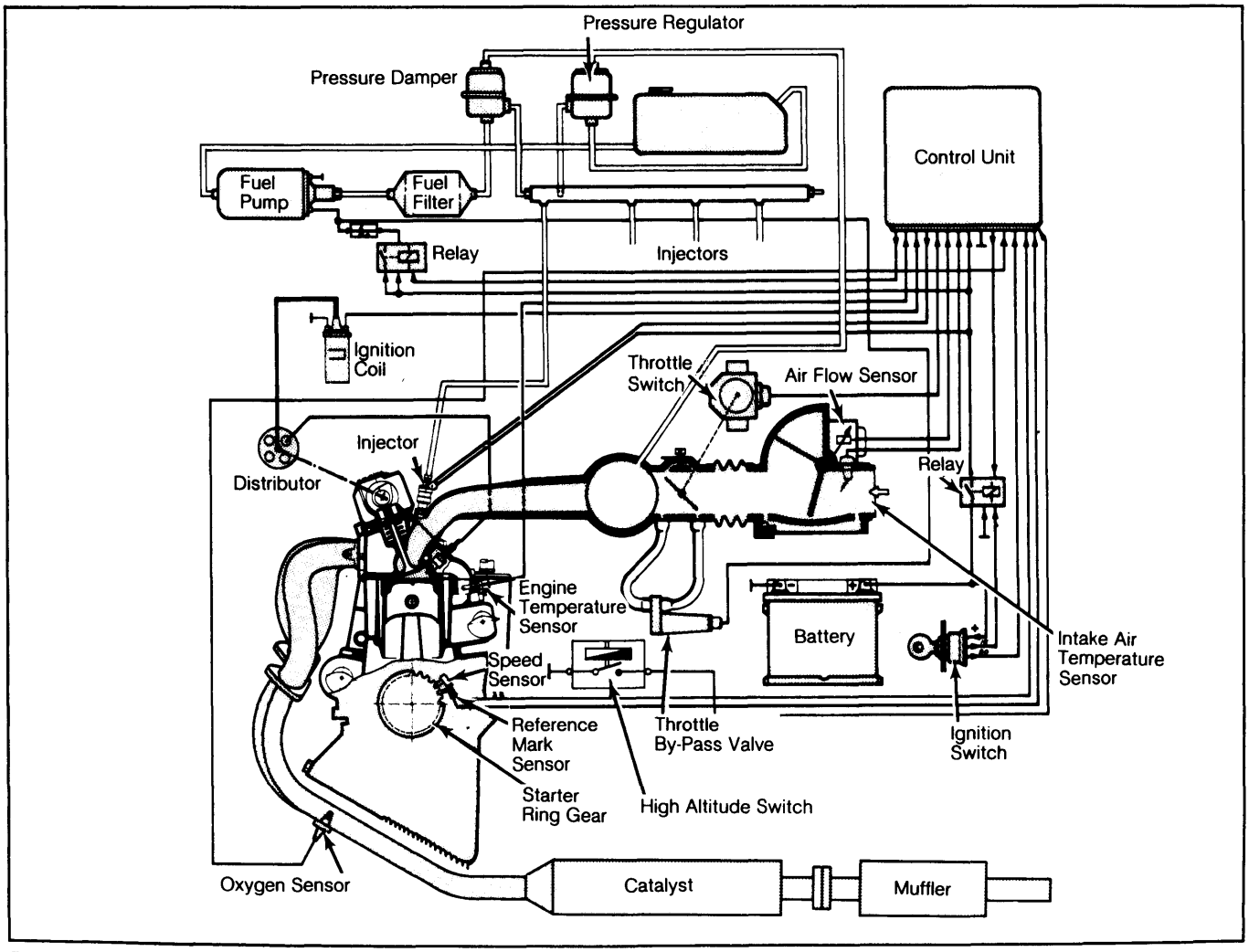
The ECU generates control signals for the fuel pump relay, auxiliary air valve, cold start injector coil, and the cylinder port injector coils. These devices control cold idle, curb idle speed and mixture, air/fuel ratio and fuel supply.

SPARK CONTROL

Spark control allows the electronic control unit (ECU) to determine the exact instant that ignition is required, based upon information received from data sensors.

At the optimum time, the ECU breaks the primary circuit of the ignition coil, producing a high voltage at coil center tower. This voltage surge fires the spark plug at the proper time for most efficient combustion, eliminating the need for vacuum and/or centrifugal advance.

Fig. 1: Schematic of DME Engine Control System



The DME system consists of 4 sub-systems.

Computerized Engine Controls

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DATA SENSORS

Each sensor furnishes electronic impulses to the ECU. Using this information, the ECU computes spark timing, and correct amount of fuel necessary to maintain proper engine operation.

The function of each sensor is closely related in maintaining proper engine operation. Operation of each sensor is as follows:

Oxygen Sensor

This sensor is mounted in engine exhaust stream, in front of catalytic converter. It supplies a low voltage (under 1/2 volt) when fuel mixture is lean (too much oxygen) and a higher voltage (up to 1 volt) when fuel mixture is rich (not enough oxygen).

Oxygen sensor must be hot (over 480°F/250°C) to function properly and to allow ECU to accept its electrical signals. The oxygen sensor measures quantity of oxygen only.

California vehicles are equipped with a special electrically heated oxygen sensor. This oxygen sensor reaches operating temperature sooner and also begins to function earlier. The heated oxygen sensor has 3 wires, 2 for the heater element (power & ground), and a single wire for the oxygen sensor signal.

The heating begins with ignition on (via fuel pump & DME relay terminal 87). The plugs from the sensor to the wiring harness are located near the flywheel sensor plugs (speed, reference mark).

NOTE: No attempt should be made to measure oxygen sensor voltage output. Current drain of conventional voltmeter could permanently damage sensor, shift sensor calibration range and/or render sensor unusable. Do not connect jumper wire, test leads or other electrical connectors to sensor. Use these devices only on ECU side of harness after disconnecting sensor.

Reference Mark Sensor

The reference mark sensor is located on crankcase flange. This sensor detects crankshaft position in relation to top dead center, and sends this signal to the control unit. It is triggered by a bolt cemented into the flywheel.

Speed Sensor

The speed sensor is mounted on an adjustable bracket with the reference mark sensor. The speed sensor measures engine speed by counting the teeth on the starter ring gear. The speed sensor sends 2 voltage pulses to the control unit for each tooth that passes.

Coolant Temperature Sensor

This sensor is located in the coolant stream of the intake manifold, and supplies coolant temperature information to the ECU. This information affects the following engine systems: Air/fuel ratio (as engine coolant temperature varies with time during a cold start), spark timing, and engine temperature lamp operation.

Intake Air Temperature Sensor

This sensor is located in the air stream of the air flow meter, and supplies incoming air temperature information to the ECU. The ECU uses this along with other information in regulating the fuel injection rate.

Air Flow Sensor

This sensor is located in the air stream of the air flow meter, and supplies air volume information to the ECU. The ECU uses this and other information in regulating the fuel injection rate.

The air flow meter incorporates a measuring flap, that opens against pressure of a spiral spring, and is connected to a potentiometer. The potentiometer transmits an electrical signal determined by position of the measuring flap, to inform the ECU of engine load.

Throttle Switch

A contact-type throttle switch is located on the throttle body. It converts throttle position into electrical signals to inform ECU of throttle position.

The potentiometer within the air flow meter prevents loss of engine power during sudden acceleration/deceleration by signaling the ECU of necessary fuel enrichment requirements.

High Altitude Switch

Switch is mounted under the dashboard, on driver's side of vehicle. In altitudes higher than 3300 ft. (1000 m) The high altitude switch closes, signaling the ECU to lean the fuel mixture.

Auxilary Air Valve

Auxilary air valve provides additional air during cold engine starts and warm-up. It is located next to throttle body. The valve consists of an electrically heated bi-metel strip, movable disc and air by-pass channel. The heater coil on the bi-metel strip is energized by the fuel pump relay.

Control of the valve is based upon engine temperature. The air by-pass channel is open when engine is cold and gradually closes as temperature rises. At predetermined temperatures, air by-pass channel is blocked and additional air flow stops.

Fuel Pressure Regulator

The pressure regulator is located at the end of the injection collection line. Pressure regulator maintains constant fuel pressure to the fuel injectors.

Pressure Damper

The pressure damper is located at inlet of injection collector tube. The damper absorbs the pressure oscillation caused by the injection cycle.

ELECTRONIC CONTROL UNIT (ECU)

The ECU monitors and controls all DME system functions. The ECU consists of input/output devices, Central Processing Unit (CPU), power supply and memories. A brief description and operation of each component is as follows:

Input/Output Devices

These integral devices of ECU convert electrical signals received by data sensors and switches to digital signals for use by CPU.

Central Processing Unit (CPU)

Digital signals received by CPU are used to perform all mathematical computations and logic functions necessary to deliver proper air/fuel mixture. The CPU also calculates spark timing information.

Power Supply

Main source of power for the ECU is from the battery, through ignition circuit.

Memories

The memory bank of the ECU is programed with specific information, that is used by the ECU during open loop (spark timing and fuel injection rate). This information is also used when a sensor or other componant fails in the system, allowing the vehicle to be driven in for repairs.

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ADJUSTMENTS

SPEED SENSOR CLEARANCE

NOTE: Adjusting speed sensor automatically adjusts reference mark sensor. They cannot be adjusted separately.

1) The speed sensor bracket is mounted on the crankcase flange with 2 bolts. To adjust clearance, loosen bolts and turn sensor holder. Clearance should be .030-034" (.75-.85 mm).

2) To adjust clearance with engine installed in vehicle, remove speed sensor. Usng a depth gauge, measure distance from sensor holder's upper surface to tooth head on starter ring gear.

3) Measure length of speed sensor. Subtract speed sensor length from holder-to-flywheel tooth distance. Difference should be .030-.034" (.75-.85 mm).

4) If not to specification, loosen screws and turn holder until holder-to-flywheel tooth distance is equal to the length of the sensor plus the specified clearance. Tighten screws, and install speed sensor in holder.

IDLE SPEED

Idle speed is adjusted by turning adjusting screw, located at by-pass port of throttle housing.

DIAGNOSIS & TESTING

CAUTION: DME ignition system voltage is extremely high. Contact with current-carrying parts while engine is running could prove fatal. Always turn ignition switch "OFF" or remove battery ground cable when connecting testers or replacing system components. High voltage is particularly present at spark plug, distributor, and ignition coil connections and at terminal 1 of the control unit. Do not attempt to check ignition system by a sparking test of spark plugs. This may destroy ignition coil or control unit.

NOTE: Complete testing of the DME system requires an oscilloscope, voltmeter, ohmmeter and special test leads to insert in multiple pin control unit connector. Therefore, system testing is limited.

ELECTRICAL CONNECTIONS

1) Check that all electrical connections are free of corrosion and securely attached. Check DME ground wire on engine flange and on clutch housing near speed and reference mark sensors. Be sure connections have good contact and are tight.

2) Particularly check 9-pin connector above brake booster, 4-pin connector on air flow sensor, 3-pin connector on throttle switch, 35-pin connector on control unit, 2-pin connector at temperature sensor, 1-pin connector for oxygen sensor (on firewall above flywheel sensors), and two 3-pin connectors for flywheel sensors (attached to No. 4 cylinder intake manifold).

NOTE: Control unit connector is held in place by a catch. Push catch to the right and pull off plug with a downward motion.

3) In addition, on California vehicles, check 2-pin connector for oxygen sensor heating element.

IGNITION CIRCUIT POWER CHECK

With ignition turned "ON", but with engine not running, connect positive voltmeter lead to terminal 1 of control unit harness connector. Connect negative lead to ground. Voltmeter should register battery voltage. If not, check wiring back to battery.

SPEED SENSOR CHECK

NOTE: This is an alternate test when an oscilloscope is not available.

1) Secure a Fresnel lens front LED from an electronics store or use Part No. 171 919 061B. Connect a 220-ohm-1/4 watt resistor in series with one of the LED terminals.

2) Connect positive LED test lead to terminal 8 of control unit harness connector. Connect negative LED test lead to terminal 27 of same connector. Do not start engine, but operate starter. L.E.D. will flicker dimly if speed sensor is sending a signal.

REFERENCE MARK SENSOR CHECK

NOTE: This is an alternate test when an oscilloscope is not available.

1) Using same LED tester as used for speed sensor, connect positive lead to control unit harness connector terminal 25 and negative lead to terminal 26.

2) Do not start engine, but operate starter. If sensor is sending a signal, LED should flicker dimly.

IGNITION COIL RESISTANCE CHECK

Primary Resistance

1) With ignition switch "OFF", disconnect wires from primary terminals of ignition coil to isolate it from the system. Set ohmmeter for x1 scale. Connect ohmmeter leads to 2 primary terminals.

2) Reading should be .4-.6 ohm. If not, replace ignition coil.

Secondary Resistance

1) With ignition switch still "OFF", remove wire from coil tower. Set ohmmeter at x1000 scale. Connect ohmmeter leads to ignition coil positive terminal and coil tower.

2) Reading should be 5,000-7,200 ohms. If not within specifications, replace ignition coil.

IGNITION RESISTANCE CHECKS

Shielded resistance of spark plug connectors should be 3,000 ohms. Shielded resistance of distributor rotor, and of all distributor cap connections should be 1000 ohms.

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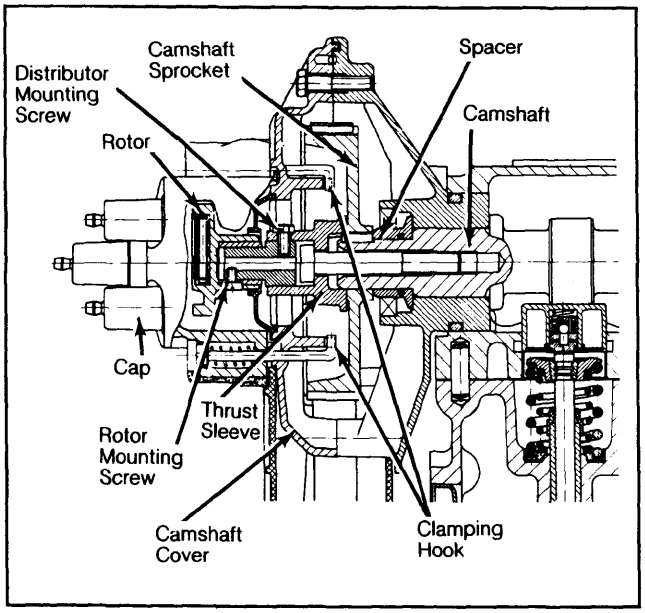
Fig. 2: Cutaway View of DME System Distributor



Align distributor cap with its locking boss facing up.

REMOVAL & INSTALLATION

Removal

1) Make a tool from a 4 1/2 - 6" long screwdriver, having a tip approximately 5/16" wide. Heat screwdriver and bend to a 90° angle about 3 1/2" from end of tip.

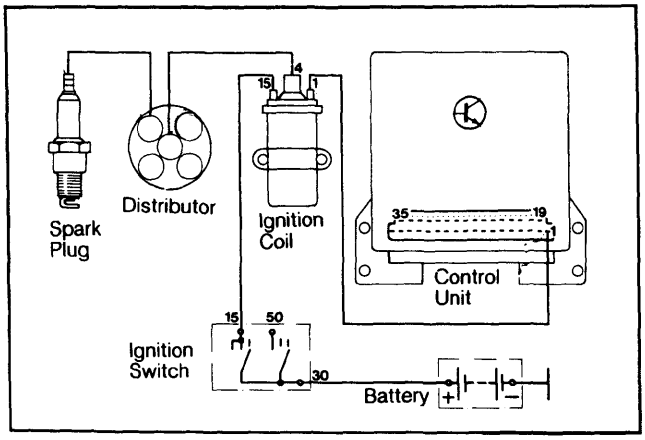
2) Push in lower clamping hook with a screwdriver, and turn to the right (clockwise). Push in on upper clamping hook and turn it to the right, and remove cap.

Installation

1) Before installing cap, remove cable for No. 3 cylinder to provide access to clamping hook. Align distributor cap with its locking boss facing up.

2) Align clamping hooks in distributor cap so they are positioned horizontally and facing toward left side when viewed from front. Guide hooks into both slots, and engage distributor cap by turning back and forth slightly. Watch position of dust cap.

Fig. 3: Wiring Diagram for Porsche DME System



3) Turn both clamping hooks against left stop. Press in on hooks far enough so that they can be turned counterclockwise approximately 1/4 turn and engage when released.

4) Check that distributor cap fits tightly. Be sure hooks are firmly engaged. Reinstall cable for No. 3 cylinder on distributor cap.