Computerized Engine Control

AUDI QUATTRO DIGITAL TIMING CONTROL

DESCRIPTION

A Bosch-Hitachi digital timing control system, called Hartig Electronic Ignition, provides timing functions. There is neither a centrifugal advance nor a vacuum advance/retard mechanism.

Instead, the system uses a Bosch Hall Effect distributor and ignition coil and a Hitachi fuel/timing control unit. Engine operating conditions are monitored by various sensors.

A single control unit is used to control the operation of both the ignition system and the oxygen sensor system. However, a second control unit is used to turn the ignition coil on and off.

OPERATION

When the engine is running, various sensors send their signals to the fuel/timing control unit. The Hall sending unit, the engine speed sensor, intake air pressure sensor, intake air temperature sensor, coolant temperature sensor, and an idle switch all provide input on engine operating conditions. A description of sensors and control units follows.

DATA SENSORS

Engine Speed Sensor

The engine speed sensor is actuated by the teeth of the flywheel. It produces 135 impulses for each crankshaft revolution (1 for each flywheel tooth). Signals are used to determine engine speed and ignition timing.

The fuel/timing control unit calculates engine speed by counting the number of flywheel teeth passing the sensor in a given unit of time. By counting the number of teeth passing the sensor after the reference mark pin, it determines crankshaft position.

Reference Mark Sensor

The reference mark sensor, located on the left rear side of the engine block, is actuated by a flywheel pin (60° BTDC on No. 1 cylinder). It produces 1 impulse per crankshaft revolution. It works with the Hall sending unit to identify ignition TDC for the No. 1 cylinder.

Hall Sending Unit

The distributor with its Hall sending unit is located at the left rear of the engine. It sends just 1 broad signal per distributor shaft rotation, just before ignition TDC on No. 1 cylinder.

This signal only permits the signal of 60° BTDC on No. 1 cylinder to be accepted as the reference mark signal in the control unit.

Intake Air Sensor

Intake air flows through the sensor in the front of the intake manifold. The signal changes as air temperature varies. The sensor signal is processed by the fuel/timing control unit only when boost pressure is above 14.5 psi (1.02 kg/cm²).

The intake air temperature sensor causes ignition timing to retard as air temperature increases. This helps to prevent engine knock or pinging.

Intake Manifold Pressure Sensor

The intake manifold pressure sensor is located in the fuel/timing control unit. It is subjected to intake manifold pressure.

Coolant Temperature Sensor

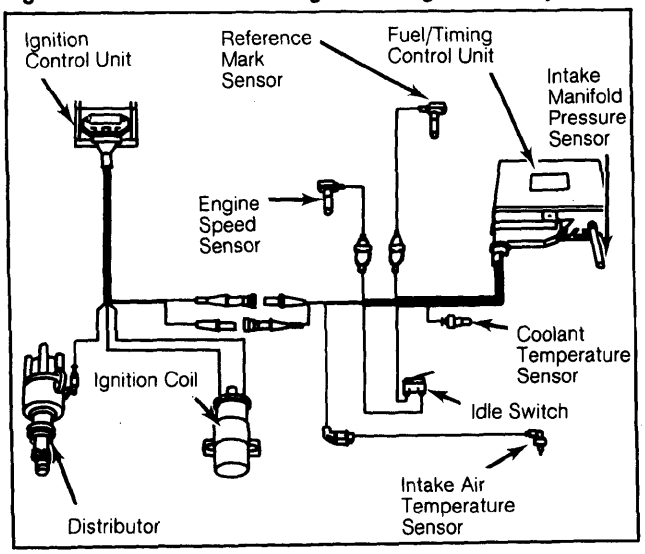
The coolant temperature sensor is a variable resistor. It is located on engine block just below the No. 1 spark plug. It provides the fuel/timing control unit with information on engine temperature. When engine is below 27°F (-3°C), the sensor causes ignition timing to be advanced.

This is to ensure complete combustion of air/fuel mixture, providing good cold engine performance. Sensor also influences duty cycle during engine cranking. When temperature is less than 140°F (60°C) duty cycle (dwell) will be about 80%. At temperatures above 140°F (60°C), duty cycle will be about 50%.

Oxygen Sensor

When the oxygen sensor reaches operating temperature of about 572°F (300°C), it begins sending a voltage signal to the fuel/timing control unit. The strength of this signal depends on the amount of oxygen in the exhaust. The control unit uses this information to determine whether to enrichen or lean the quantity of fuel.

Fig. 1: Schematic of Audi Digital Timing Control System



IDLE SWITCH

The idle switch, located on the throttle valve housing, is operated by a lever on the throttle valve shaft. It performs 3 functions:

- When the throttle is closed, if idle speed drops below 820 RPM, the idle stabilizer function in the control unit is switched on.
- When engine speed is above 1000 RPM, the idle switch activates the deceleration control function in the control unit upon deceleration.
- When the throttle valve is opened, the control system for determining ignition timing is switched on.

FUEL/TIMING CONTROL UNIT

The fuel/timing control unit is located under the instrument panel on right side of passenger compartment. It receives the information pulses from the various sensors. It then determines the optimum ignition timing and fuel mixture for all engine operating conditions, actuating the ignition control unit and frequency valve.

When the throttle valve is closed, ignition timing is determined by the idle stabilizer function in the control unit. This function switches on when engine speed is below 820 RPM. Between 720 and 820 RPM, ignition timing is advanced from 6° to 26° BTDC. The idle stabilizer advances timing to 26° BTDC when engine speed is between 600 and 720 RPM.

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Below 600 RPM, the idle stabilizer does not function. Timing is retarded to ensure easy starting. During deceleration, basic timing is advanced depending upon engine RPM, to ensure low exhaust emissions and to prevent backfiring.

When the throttle valve is opened, ignition timing is determined by engine speed, intake manifold pressure, and coolant temperature.

Above 14.5 psi (1.02 kg/cm²), ignition timing is also influenced by intake air temperature. On deceleration, ignition timing is determined by engine speed characteristic line, programmed into the control unit memory. Closed loop control is not possible until coolant temperature is above 90°F (32°C).

Until coolant temperature rises above 90°F (32°C), and oxygen sensor warms up, duty cycle is regulated between 42-65%. The fuel/timing control unit works in conjunction with a frequency valve to vary the amount of fuel delivered to the engine.

IGNITION CONTROL UNIT

The ignition control unit, located in the glove compartment, switches the ignition coil primary circuit on and off. Each time this occurs, a voltage surge occurs in the secondary circuit, firing a spark plug. The control unit limits the coil to a prescribed value, and switches the coil off when the engine is not running.

FREQUENCY VALVE

The frequency valve is an electromagnetic valve attached to the lower chamber of the fuel distributor. By opening and closing many times per second, frequency valve varies the pressure inside the fuel distributor, controlling the amount of fuel delivered to the engine.

FULL THROTTLE SWITCH

When the throttle valve is just a little more than 3/4 open, the full throttle switch closes and completes an electrical circuit. As soon as the throttle switch closes, the control unit will cause the quantity of fuel delivered to the engine to increase. Duty cycle during enrichment will be increased to 70-77% depending on engine RPM.

DIAGNOSIS & TESTING

Diagnostic and testing information was not available from manufacturer.

MAINTENANCE

Oxygen sensor should be replaced and mileage counter reset every 30,000 miles. Procedures were not available from manufacturer.

REMOVAL & INSTALLATION

Removal and installation information for system components was not available from manufacturer.

Fig. 2: Wiring Diagram for the Bosch-Hitachi Digital Timing Control System