

E - THEORY/OPERATION - GASOLINE

Article Text

1996 Volkswagen Golf

For Volkswagen Technical Site

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Thursday, August 19, 1999 11:37PM

ARTICLE BEGINNING

1996 ENGINE PERFORMANCE

Volkswagen Theory & Operation - Gasoline

Cabrio, Golf III, GTI, Jetta III, Passat

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.

COMPUTERIZED ENGINE CONTROLS

ELECTRONIC CONTROL MODULE

The Motronic engine management system uses a single Electronic Control Module (ECM) for fuel injection, idle speed control, ignition, and emission controls. See Fig. 1.

The ECM continually corrects air/fuel mixture based on signals from various input devices. The ECM is located underneath center of windshield cowl, behind engine compartment firewall.

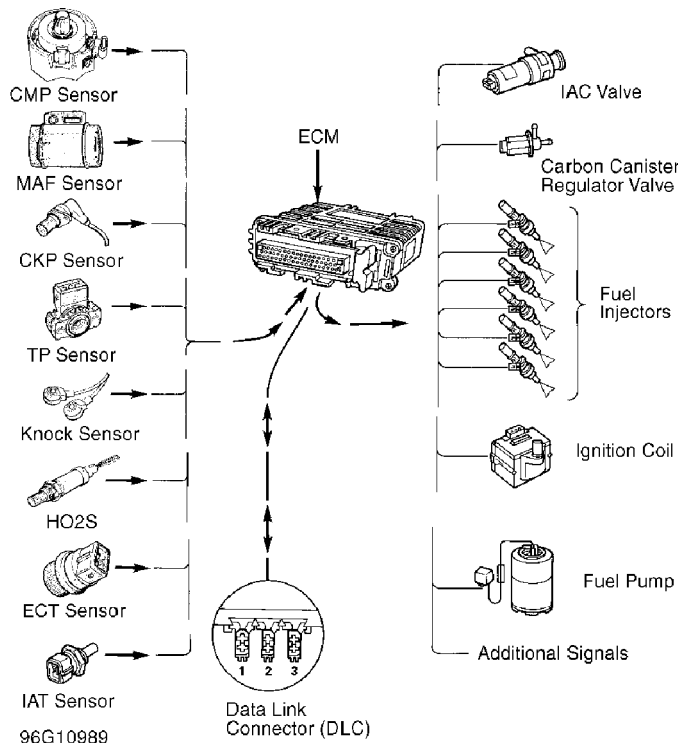


Fig. 1: Identifying Motronic System Components (VR6 Is Shown; 4-Cylinder Is Similar)

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

INPUT DEVICES

NOTE: Vehicles are equipped with different combinations of input devices. Not all devices listed below are used on every vehicle.

Engine Coolant Temperature (ECT) Sensor

ECT sensor is located on thermostat housing. As engine coolant temperature increases, resistance of sensor decreases. ECT sensor signals are used for control of ignition timing, injector pulse width, and idle speed stabilization. In addition, knock sensors, idle air control, heated oxygen sensor and fuel tank venting are activated based on coolant temperature.

Camshaft Position (CMP) Sensor

See ELECTRONIC IGNITION SYSTEM under IGNITION SYSTEM

Crankshaft Position (CKP) Sensor

Crankshaft position is registered by CKP sensor located on side of engine block. CKP sensor reads toothed wheel mounted on crankshaft. Wheel has a 2-tooth gap which is used as reference point for crankshaft position. Engine speed/reference signal is used to monitor engine RPM and identify TDC position of cylinder No. 1.

NOTE: For illustration of component locations, see appropriate I - SYSTEM/COMPONENT TESTS article.

Heated Oxygen Sensor (H02S)

H02S is made from zirconium dioxide, while inner and outer surfaces are coated with platinum. If fuel mixture is lean (excess oxygen), H02S will send a low voltage signal (about 100 millivolts) to ECM. If fuel mixture is rich (lack of oxygen), H02S will send a high voltage signal (about 900 millivolts) to ECM.

Intake Air Temperature (IAT) Sensor

IAT sensor is located on side of intake manifold. Signal from IAT sensor is used for idle stabilization and correction factor for ignition timing. If IAT sensor fails, ECM uses substitute temperature value of 68°F (20°C). If this happens, cold start problems could occur at temperatures less than 32°F (0°C).

Knock Sensor(s)

See IGNITION TIMING CONTROL under IGNITION SYSTEM

Mass Airflow (MAF) Sensor

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A hot-wire air mass sensor is used to measure airflow into engine. MAF sensor is attached to air filter housing. The hot wire in MAF sensor is kept at 356°F (180°C) above air temperature.

As airflow increases, wire is cooled and resistance of MAF sensor changes. Resulting current change is converted to a voltage signal, and is used by ECM to calculate the volume of air intake.

If a fault develops with MAF sensor signal, signal from throttle position sensor will be substituted for driveability.

Throttle Position (TP) Sensor

TP sensor is connected to throttle valve shaft. It informs ECM of power requested by driver (throttle opening). Idle and full throttle switches are not used in potentiometer. Idle speed and full throttle applications are recognized by ECM from voltage output of potentiometer.

TP sensor signals are used for idle speed stabilization, idle air volume control, fuel after-run shutoff, and full throttle enrichment. ECM uses mass airflow sensor signal and engine RPM signals as substitute values if TP sensor fails.

OUTPUT SIGNALS

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

EGR Regulator Valve

See EXHAUST GAS RECIRCULATION (EGR) SYSTEM under EMISSION SYSTEMS.

Fuel Evaporative (Regulator) Valve

See FUEL EVAPORATIVE EMISSIONS SYSTEM under EMISSION SYSTEMS.

Fuel Injectors

See FUEL CONTROL under FUEL SYSTEM

Fuel Pump

See FUEL DELIVERY under FUEL SYSTEM

Idle Air Control/Stabilizer Valve

See IDLE SPEED under FUEL SYSTEM

Malfunction Indicator Light (MIL)

See MALFUNCTION INDICATOR LIGHT (MIL) under SELF-DIAGNOSTIC SYSTEM

FUEL SYSTEM

FUEL DELIVERY

Fuel Pump

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A 2-stage fuel pump, located in fuel tank, is used (one motor drives 2 separate pumps). Stage one vane-type pump draws fuel, through a screen, from bottom of fuel tank and into an accumulator. Vane-type pump acts as a transfer pump. Stage two gear-type pump draws fuel from bottom of accumulator and out fuel lines.

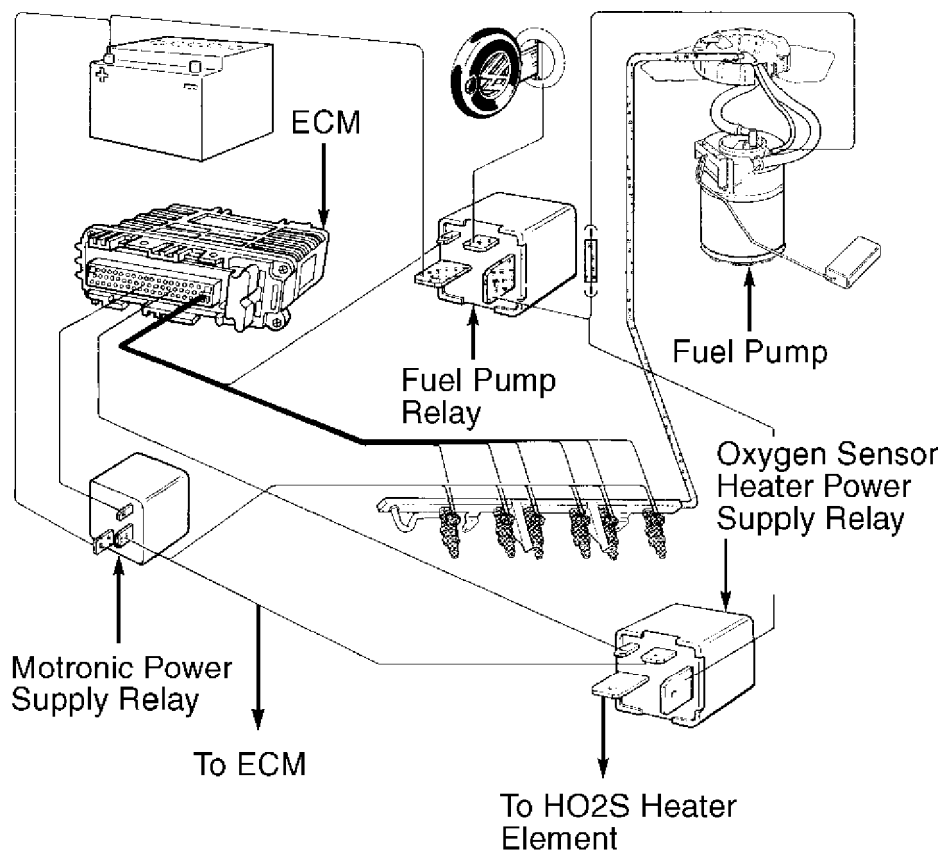
Fuel Pressure Regulator

A diaphragm-type fuel pressure regulator is attached to fuel return side of fuel rail. Fuel pressure is regulated depending on intake manifold pressure. As intake manifold pressure changes, pressure regulator will increase or decrease fuel system pressure.

FUEL CONTROL

Fuel Injectors

Fuel injectors are supplied with battery (system) voltage through power supply relay, and are controlled (grounded) by the ECM. See Fig. 2. Injectors are opened sequentially in cylinder firing order. Fuel quantity is determined by injector on time (duty cycle).



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Fig. 2: Identifying Fuel Control System Components (VR6 Is Shown; 4-Cylinder Is Similar)

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IDLE SPEED

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Idle Air Control (IAC) Valve

IAC valve is actuated by ECM through IAC valve ground control circuit. When a defect in circuit is recognized, both output stages are shut off and valve rotates to a fixed position. This permits engine to idle at a warm engine idle speed.

IGNITION SYSTEM

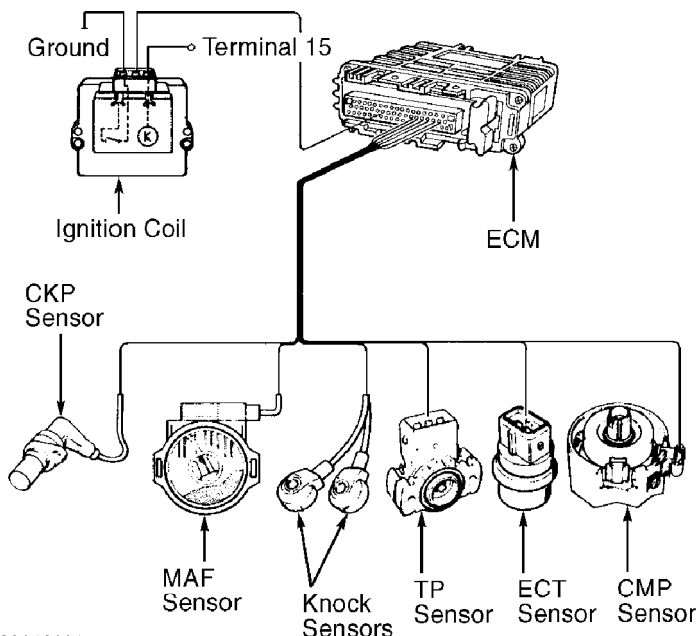
ELECTRONIC IGNITION SYSTEM

The electronic ignition system consists of ECM, CMP sensor, CKP sensor, ECT sensor, ignition coil, distributor, MAF sensor and TP sensor. See Fig. 3.

Ignition system uses engine speed, engine load and throttle valve position signals to calculate ignition timing. ECT sensor signal is used to correct ignition timing when engine is cold and to activate knock sensor circuit. See KNOCK SENSOR(S) under IGNITION TIMING CONTROL.

Camshaft Position (CMP) Sensor

CMP sensor is an integral part of distributor. CMP sensor consists of a magnetic enclosure and integrated semi-conductor circuit. A voltage signal is generated when trigger wheel, turning at camshaft speed, interrupts magnetic field created by semi-conductor. CMP sensor and engine speed/reference signals are used to identify TDC position of cylinder No. 1 for sequential fuel injection and spark knock regulation.



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Fig. 3: Identifying Ignition & Related System Components (VR6 Is Shown; 4-Cylinder Is Similar)

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IGNITION TIMING CONTROL

Knock Sensor(s)

Knock sensor (KS) works like a microphone to "listen" for spark knock (detonation). When detonation occurs, ignition timing is retarded until knock is eliminated.

One sensor is used on 2.0L engine. On 2.8L engine, 2 knock sensors are mounted on sides of engine block. Knock sensor I monitors cylinders No. 1, 3 and 5. Knock sensor II monitors cylinders No. 2, 4 and 6.

EMISSION SYSTEMS

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

EGR system consists of EGR valve, EGR regulator valve, and EGR temperature sensor. See Fig. 4. EGR system is activated when engine coolant temperature reaches 122°F (50°C). System recirculates a small portion of exhaust gas into intake air/fuel mixture to reduce oxides of nitrogen (NOx) emissions.

EGR Regulator Valve

EGR regulator valve is mounted on back of intake manifold. Regulator valve controls amount of vacuum supplied to EGR valve. ECM controls ground circuit of regulator valve based on engine speed and load. In doing so, ECM controls amount of recirculated exhaust gas entering engine.

EGR Temperature Sensor (EGR-TS)

EGR-TS is located in EGR valve exhaust gas recirculation channel. EGR-TS measures exhaust gas temperature. Electrical resistance of EGR-TS decreases as temperature of exhaust gas increases. Signal generated by EGR-TS is used for diagnosis of EGR system only.

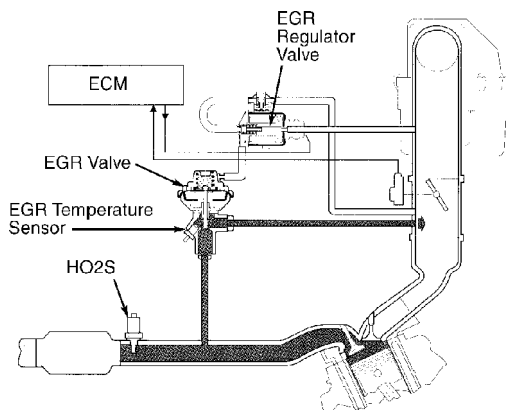


Fig. 4: Identifying EGR System Components (VR6 Is Shown; 4-Cylinder Is Similar)

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FUEL EVAPORATIVE EMISSIONS SYSTEM

Fuel Evaporative (Regulator) Valve

ECM determines duty cycle of regulator valve to regulate flow of fuel vapors from fuel evaporative (carbon) canister into engine. When no current is supplied to valve, it remains in open position. Valve is closed (100 percent duty cycle) when engine is started cold. A spring-operated check valve inside regulator valve closes when engine is off. This prevents fuel vapors from entering intake manifold, causing a rich mixture during engine restart.

Fuel Tank Venting

Engine speed, engine load, engine coolant temperature, and throttle valve potentiometer input signals are used by ECM to control fuel tank venting. Fuel vapors from fuel tank are vented to fuel evaporative (carbon) canister. When engine is warm and above idle speed, vapors will be drawn into intake manifold. Depending on engine load and heated oxygen sensor signal, fuel evaporative (regulator) valve will regulate amount of vapors entering intake manifold.

SELF-DIAGNOSTIC SYSTEM

Electronic Control Module (ECM) recognizes faults (open circuits, short circuits, missing signals, or a continuously applied signal voltage) in the following circuits/components.

- * Camshaft Position (CMP) Sensor
- * Crankshaft Position (CKP) Sensor
- * EGR Regulator Valve
- * EGR Temperature Sensor
- * Engine Coolant Temperature (ECT) Sensor
- * Fuel Evaporative (Regulator) Valve
- * Heated Oxygen Sensor (HO2S)
- * Idle Air Control (IAC) Valve
- * Intake Air Temperature (IAT) Sensor
- * Knock Sensor(s)
- * Throttle Position (TP) Sensor

MALFUNCTION INDICATOR LIGHT (MIL)

All models are equipped with a MIL. If MIL comes on and remains on during vehicle operation, cause of malfunction must be determined. See G - TESTS W/CODES article.

END OF ARTICLE