

## **E - THEORY/OPERATION**

### **Article Text**

1989 Volkswagen Golf

For Volkswagen Technical Site

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Monday, August 23, 1999 11:48PM

## **ARTICLE BEGINNING**

### **1989 ENGINE PERFORMANCE**

#### **Volkswagen Theory & Operation - CIS-E**

Fox, Golf, Golf GT, Jetta

## **INTRODUCTION**

This article covers the basic description and operation of engine performance related systems and components. Prior to diagnosing vehicles or systems with which you are not completely familiar, read through this article.

Bosch CIS-E fuel injection system uses Continuous Injection System (CIS) for fuel delivery and electronic controls for mixture adjustment. Mechanical portion of CIS-E system consists of Mixture Control Unit (MCU) which is also known as the fuel distributor, airflow sensor plate, diaphragm pressure regulator, fuel injectors, fuel pumps and filter.

Electronic controls consist of airflow sensor position indicator (potentiometer), Differential Pressure Regulator (DPR), thermo time switch, coolant temperature sensor, Electronic Control Unit (ECU), oxygen sensor, auxiliary air regulator, idle speed stabilizer control unit, cold start valve, idle speed boost valve.

## **COMPUTERIZED ENGINE CONTROLS**

### **CONTROL UNIT**

**NOTE:** For ease of understanding, components are grouped into 2 categories. The first category, INPUT DEVICES, is components which control or produce voltage signals that are monitored by the ECU. The second category, OUTPUT SIGNALS, are components that are controlled by the ECU (this is usually accomplished by the ECU grounding individual circuits).

#### **Electronic Control Unit (ECU)**

ECU is found behind plenum panel on driver's side of vehicle. ECU must not be exposed to temperatures above 180°F (85°C). ECU unit utilizes various input signals to control fuel delivery.

#### **Idle Speed Stabilizer Control Unit**

This unit is located near the fuse relay panel. Idle speed stabilizer control unit receives signals from ignition coil tach signal. When engine speed drops below 750 RPM, idle speed stabilizer control unit energizes the auxiliary air regulator to raise engine speed.

## **INPUT DEVICES**

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All vehicles are equipped with different combinations of input devices. Not all devices are used on all models. To determine the input usage on a specific model, see L - WIRING DIAGRAMS article. The available input signals include the following:

#### Airflow Sensor Potentiometer

Airflow sensor potentiometer is connected to the air sensor plate actuating lever. It returns a voltage signal to the ECU based on position of the throttle valve. The ECU uses this signal to fine tune mixture adjustment.

#### Coolant Temperature Sensor

Feeds a return signal to ECU for fuel control.

#### Exhaust Gas Oxygen Sensor

Oxygen sensor is located in exhaust manifold and measures amount of unburned oxygen in exhaust gas. If oxygen is low (rich mixture), higher voltage will be generated by sensor. If oxygen is high (lean mixture), lower voltage will be generated. Voltage signal from oxygen sensor is sent to ECU which controls fuel mixture through the differential pressure regulator.

#### Hall Effect Sensor

See IGNITION SYSTEM in this article.

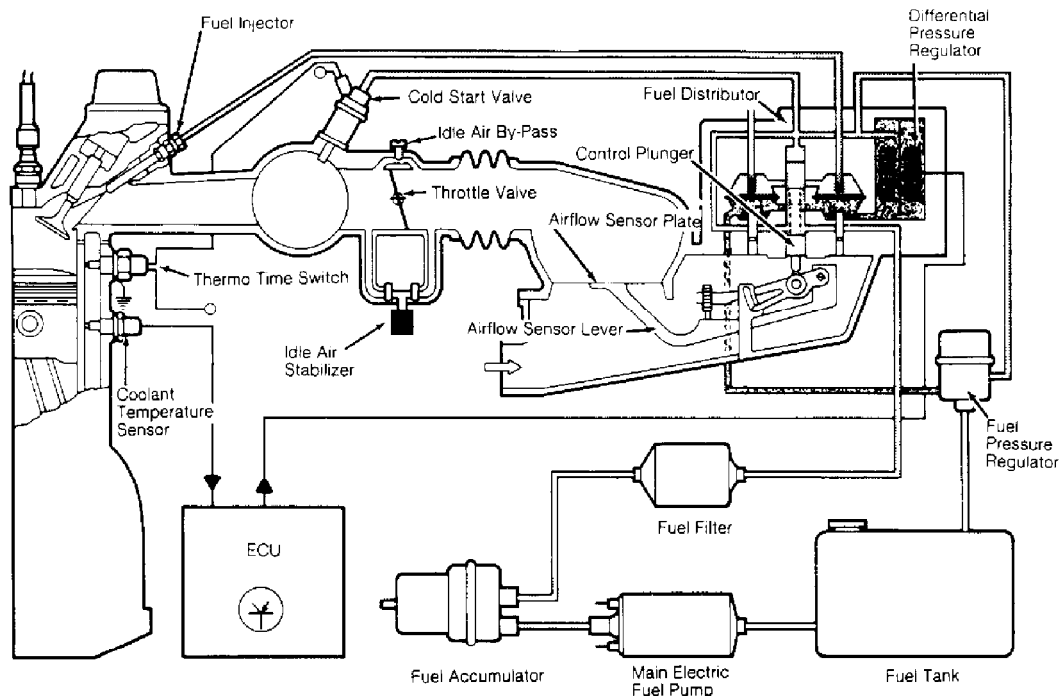


Fig. 1: Bosch CIS-E Component Diagram  
Courtesy of Volkswagen United States, Inc.

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#### **OUTPUT SIGNALS**

**NOTE:** For theory and operation on each output component, refer to the system indicated in brackets, to the right of each component.

- \* Auxiliary Air Regulator (Idle Speed)
- \* Fuel Injectors (Fuel Control)
- \* Differential Pressure Regulator (DPR) (Fuel Control)

#### **FUEL SYSTEM**

##### **FUEL DELIVERY**

###### **Fuel Pump(s)**

Main pump is located to rear of vehicle on frame crossmember. Some models use a pre-pump located inside fuel tank. Main fuel pump assembly, is equipped with a pressure damper at the suction end. Fuel pump(s) is/are activated during start-up and when engine is running.

###### **Fuel Pressure Regulator**

The fuel pressure regulator modulates system fuel pressure before it goes to top of plunger in fuel distributor.

###### **Fuel Pump Relay**

Fuel pump relay switches off fuel pump(s) in absence of signal from ignition control unit.

##### **FUEL CONTROL**

###### **Cold Start Valve**

Cold start valve is mounted on intake manifold and sprays fuel during starting. It provides additional enrichment so engine will start easily. Valve is powered through starter circuit and grounded through thermo time switch. It operates only while cold engine is being cranked.

###### **Differential Pressure Regulator (DPR)**

The DPR is mounted on side of fuel distributor. An electrically operated plate valve combined with fixed outlet orifice, governs pressure in lower chamber. See Fig. 2. Pressure change in lower chamber causes movement of diaphragm and fine tunes fuel volume flow to injectors. Actuating signal comes from ECU and can range from -60 to +120 mA, depending upon engine operating conditions.

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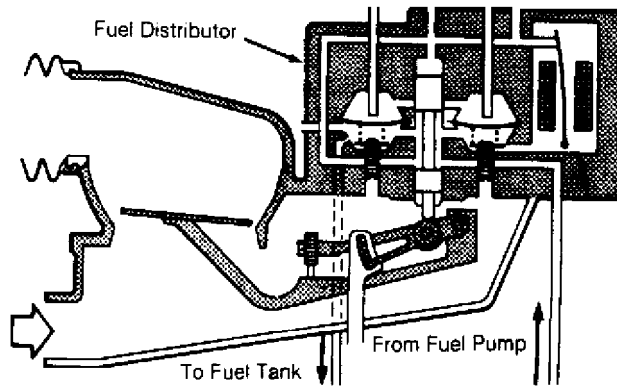


Fig. 2: Differential Pressure Regulator  
Courtesy of Volkswagen United States, Inc.

#### Fuel Distributor

The fuel distributor mechanically controls the rough control of fuel to the injectors. A control plunger, operated by the airflow sensor regulates the control pressure differential between the injector supply (upper chamber) and the lower chamber (fuel return). This differential in pressure controls the amount of fuel flow to the injectors.

#### Fuel Injectors

Fuel injectors in CIS-E system open at a pre-set pressure. Fuel is always present in lines between fuel distributor and injectors to ensure good starting. As pressure from fuel distributor increases (when engine is started), valves open and spray constantly. Amount of fuel injected will be determined by position of control plunger in fuel distributor and amount of voltage to differential pressure regulator.

#### Thermo Time Switch

This component energizes the cold start valve to provide cold start enrichment.

### IDLE SPEED

#### Electronic Idle Speed Control

If engine speed drops below 750 RPM, the auxiliary air regulator is energized until engine speed reaches 1050 RPM. The idle speed stabilizer control unit uses input from ignition coil tach signal to determine engine speed and control auxiliary air regulator. Vehicles with A/C also use a second valve, called idle speed boost valve. The operation of A/C compressor energizes the idle speed boost valve.

#### Auxiliary Air Regulator

Component is located in throttle valve by-pass hose. Receives voltage from idle speed stabilizer control unit. When energized it will route air around throttle valve to increase idle speed.

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#### **Idle Speed Boost Valve (A/C Models)**

Component is located in throttle valve by-pass hose. Idle speed boost valve will be energized when A/C compressor clutch is activated. When idle speed boost valve is energized, air will be routed around throttle valve to increase idle speed.

## **IGNITION SYSTEM**

### **ELECTRONIC IGNITION SYSTEM**

The Hall Effect sending unit in the distributor uses a shutter window wheel mounted on the distributor shaft. The shutter blades pass in and out of the air gap of the hall effect sender resulting in signal pulses. There is one shutter window for each engine cylinder. Signals from distributor hall sender are sent to the ignition control unit. The ignition control unit sends a switching voltage signal to the ignition coil primary circuit to discharge secondary spark voltage.

### **IGNITION TIMING CONTROL SYSTEM**

#### **Ignition Timing Advance Control**

Conventional vacuum and centrifugal advance is used.

## **EMISSION SYSTEMS**

#### **Evaporative Emissions Systems**

As fuel expands in fuel tank, vapor is forced out of the fuel tank through an upper vent port. Vapor flows up through a gravity valve and into an expansion tank where liquid fuel condenses and returns to fuel tank as temperature drops. Fuel vapor then flows from an upper vent port of expansion tank, through a control valve, and into the charcoal canister. When the engine is running at speeds faster than idle. A vacuum signal opens control valve. Canister vapor is drawn from canister through control valve and into intake manifold for burning.

## **MISCELLANEOUS CONTROLS**

**NOTE:** Although not considered true "Engine Performance" related systems, some controlled devices may affect driveability if they malfunction.

### **COOLING FAN**

**NOTE:** If detonation is a problem with a vehicle, it is possible the cooling fan is not coming on at proper temperature and should be considered as a possible cause.

#### **Cooling Fan Motor**

There are 2 different cooling fans used. On 2-pole thermo

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switches (single speed motor), cooling fan should come on at a temperature of 203°F (94°C) and go off at a temperature of 189°F (86°C).

On 3-pole thermo switches (double speed fan), first stage of cooling fan should come on at a temperature of 198-208°F (92-98°C) and go off at a temperature of 183-196°F (84-91°C). Second stage comes on at 210-221°F (99-105°C) and go off at 196-219°F (91-104°C).

**END OF ARTICLE**