

## **E - THEORY/OPERATION**

### **Article Text**

1993 Volkswagen Corrado

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## **ARTICLE BEGINNING**

1993 ENGINE PERFORMANCE

Volkswagen Theory & Operation - Motronic

Corrado SLC

## **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 UNIT**

The Motronic engine management system uses a single Electronic Control Module (ECM) for fuel injection, idle speed control, ignition, and emission controls. The Electronic Control Module (ECM) continually corrects air/fuel mixture based on signals from various signals. The ECM is located underneath center of windshield cowl, directly behind engine compartment firewall.

**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**

Engine Coolant Temperature (ECT) Sensor

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

Engine Speed (RPM)/Reference Sensor

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

Hall Effect Sensor

See ELECTRONIC IGNITION SYSTEM under IGNITION SYSTEM in this

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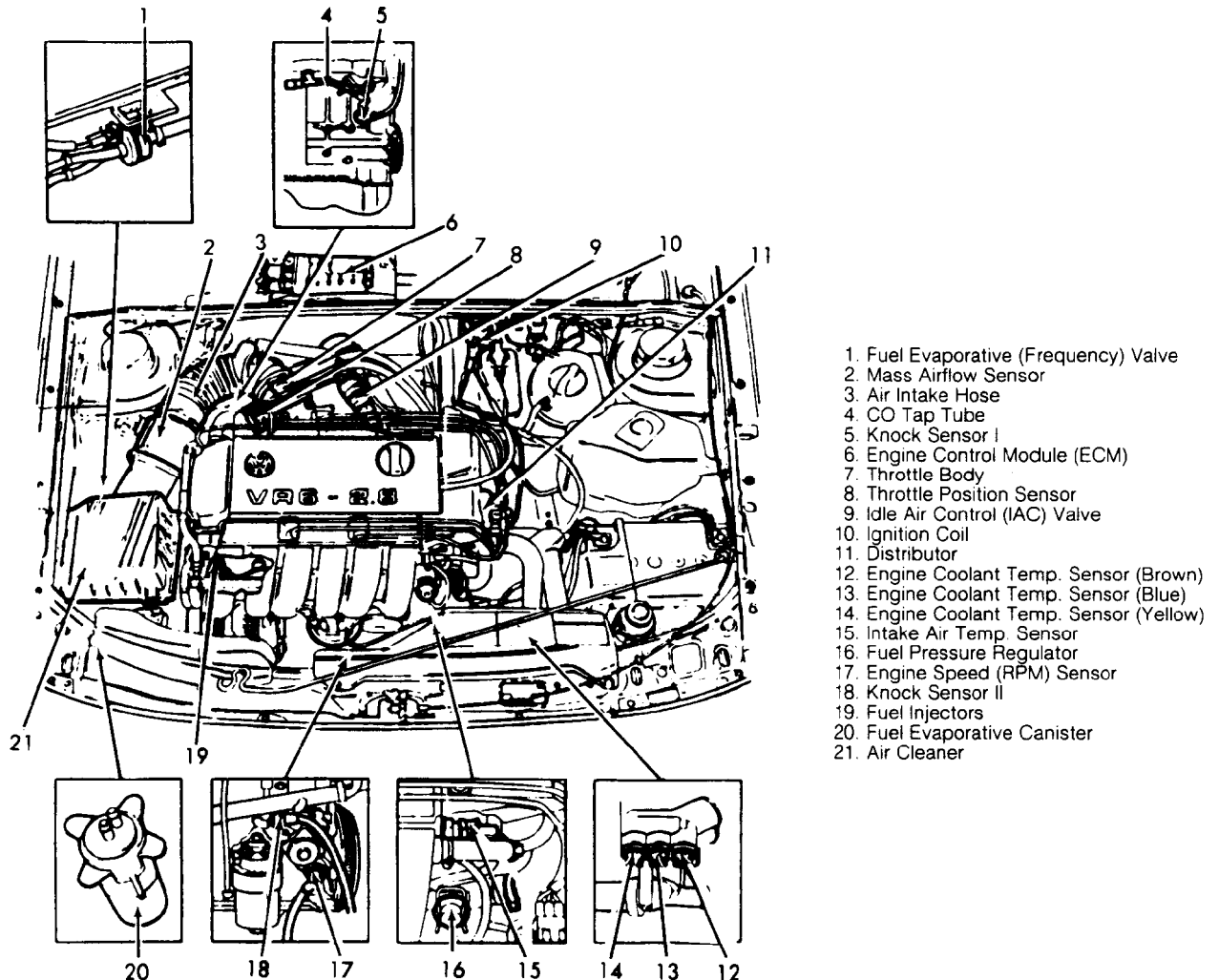
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article.

NOTE: For component locations, see Fig. 1.



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Fig. 1: Motronic Component Locations (Corrado SLC)  
Courtesy of Volkswagen United States, Inc.

#### Intake Air Temperature Sensor

Intake air temperature sensor is located on side of intake manifold. The signal from this sensor is used for idle stabilization and as a correction factor for ignition timing. If intake air temperature sensor fails, the ECM uses a temperature of 68°F (20°C) as a substitute value. 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 in this article.

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#### Mass Airflow Sensor

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

As airflow increases, the wire is cooled and the resistance of the sensor changes. The resulting current change is converted to a voltage signal and is used by the ECM to calculate the volume of air taken in.

If a fault develops with mass airflow sensor signal, the signal from throttle valve potentiometer is used as a substitute in order for the car to be driveable.

#### Throttle Valve Potentiometer

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

Throttle valve potentiometer signals are used for idle speed stabilization, idle air volume control, fuel after-run shut-off, and full throttle enrichment. The ECM uses mass airflow sensor signal and engine RPM signals as substitute values if the potentiometer fails.

NOTE: On automatic transmission equipped vehicles, the throttle valve potentiometer is combined in the housing with the potentiometer for transmission control.

#### Oxygen (O2) Sensor

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

### 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.

#### EGR Frequency Valve

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

#### Fuel Evaporative (Frequency) Valve

See FUEL EVAPORATIVE EMISSIONS SYSTEM under EMISSION SYSTEMS in this article.

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Fuel Injectors

See FUEL CONTROL under FUEL SYSTEM in this article.

Fuel Pump

See FUEL DELIVERY under FUEL SYSTEM in this article.

Idle Air Control/Stabilizer Valve

See IDLE SPEED under FUEL SYSTEM in this article.

Ignition Coil & Output Stage

See DISTRIBUTORLESS IGNITION SYSTEM (DIS) under IGNITION SYSTEM in this article.

Malfunction Indicator (CHECK ENGINE) Light

See MALFUNCTION INDICATOR (CHECK ENGINE) LIGHT under SELF-DIAGNOSTIC SYSTEM in this article.

## **FUEL SYSTEM**

### **FUEL DELIVERY**

Fuel Pump

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

Fuel Pressure Regulator

The 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, the 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. Injectors are opened sequentially in cylinder firing order. Fuel quantity is determined by injector on time (duty cycle).

### **IDLE SPEED**

Idle Air Control/Stabilizer Valve

The idle air control/stabilizer valve is actuated by the ECM thorough the valve's ground control circuit. When a defect in circuit is recognized, both output stages are shut-off and the valve rotates to a fixed position. This permits engine to idle at a warm engine idle speed.

## **IGNITION SYSTEM**

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NOTE: Corrado SLC models are equipped with a Distributorless Ignition System (DIS).

### **ELECTRONIC IGNITION SYSTEM**

The electronic ignition system consists of ECM, power output stage, ignition coil, distributor, mass airflow sensor, throttle valve potentiometer, engine coolant temperature sensor, and Hall Effect sensor.

Ignition system uses engine speed, engine load, and throttle valve potentiometer signals to calculate ignition timing. Engine coolant temperature 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 in this article.

#### **Hall Effect Sensor**

On Corrado SLC, this sensor is mounted on end of camshaft (near ignition coil). 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 the semi-conductor. Hall Effect sensor and engine speed/reference signals are used to identify TDC position of cylinder No. 1 for sequential fuel injection and spark knock regulation.

### **DISTRIBUTORLESS IGNITION SYSTEM (DIS)**

#### **Hall Effect Sensor**

See HALL EFFECT SENSOR under ELECTRONIC IGNITION SYSTEM in this article.

#### **Ignition Coil & Output Stage**

The distributorless (direct) ignition system consists of ECM, power output stage, 3 double-ended ignition coils and secondary ignition wires. The ECM operates each ignition coil through the power output stage. The power output stage and heat sink are located behind ignition coils. The ignition coils are located on left side of cylinder head. When the power output stage fires an ignition coil, a spark is supplied to 2 spark plugs at one time. One spark plug fires during the compression stroke, and the other spark plug fires during the exhaust stroke (waste spark).

### **IGNITION TIMING CONTROL**

#### **Knock Sensor(s)**

The knock sensor(s) work(s) like a microphone to "listen" for spark knock (detonation). When detonation occurs, ignition timing is retarded until the knock is eliminated.

On Corrado SLC, 2 knock sensors are mounted on side of engine block. Knock sensor I monitors cylinders No. 1, 3 and 5. Knock sensor II monitors cylinders No. 2, 4 and 6.

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## **EMISSION SYSTEMS**

### **AIR INJECTION SYSTEM**

The air injection system consists of electrically operated air pump, inlet valve, shut-off valve (mounted between intake ports for cylinders No. 2 and 4), and air pump control relay.

The Electronic Control Module (ECM) control operation of air injection system air pump by completing the ground circuit of the air pump control relay (located above brake master cylinder). In addition, the relay operates the secondary air injection inlet valve.

### **EXHAUST GAS RECIRCULATION (EGR) SYSTEM**

The EGR system consist of EGR valve, EGR frequency valve, and EGR temperature sensor. All Corrado SLC models are equipped with the EGR system. The EGR system is switched on when engine coolant temperature reaches 122°F (50°C). The system recirculates a small portion of exhaust gas into the intake air/fuel mixture to reduce nitrous oxide emissions (NOx).

#### **EGR Frequency Valve**

The EGR frequency valve is mounted on back of intake manifold. The frequency valve controls the amount of vacuum supplied to the EGR valve. The ECM, depending on engine speed and load, controls the frequency valve's ground circuit. In doing so, the ECM controls the amount of recirculated exhaust gas entering the engine.

#### **EGR Temperature Sensor**

Sensor is located in EGR valve exhaust gas recirculation channel. The EGR temperature sensor measures exhaust gas temperature. The electrical resistance of the sensor decreases as the temperature of the exhaust gas increases. The signal generated by the EGR temperature sensor is ONLY used for diagnosis of the EGR system.

### **FUEL EVAPORATIVE EMISSIONS SYSTEM**

#### **Fuel Evaporative (Frequency) Valve**

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

#### **Fuel Tank Venting**

The engine speed, engine load, engine coolant temperature, and throttle valve potentiometer input signals are used by the 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

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speed, the vapors will be drawn into intake manifold. Depending on engine load and oxygen sensor signal, the fuel evaporative (frequency) valve will regulate the amount of vapors entering the intake manifold.

### **SELF-DIAGNOSTIC SYSTEM**

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

- \* EGR Frequency Valve
- \* EGR Temperature Sensor
- \* Engine Coolant Temperature Sensor
- \* Engine Speed (RPM)/Reference Sensor
- \* Fuel Evaporative (Frequency) Valve
- \* Hall Effect Sensor
- \* Idle Air Control/Stabilizer Valve
- \* Intake Air Temperature Sensor
- \* Knock Sensor(s)
- \* Throttle Valve Potentiometer
- \* Oxygen Sensor

### **MALFUNCTION INDICATOR (CHECK ENGINE) LIGHT**

All California models are equipped with a malfunction indicator (CHECK ENGINE) light. If CHECK ENGINE light comes on and remains on during vehicle operation, cause of malfunction must be determined. See the G - TESTS W/CODES article.

### **END OF ARTICLE**