E - THEORY/OPERATION
Article Text
1993 Volkswagen EuroVan
For Volkswagen Technical Site

Saturday, March 18, 2000 10:31PM

ARTICLE BEGINNING

1993 ENGINE PERFORMANCE
Volkswagen Theory & Operation - Digifant

EuroVan

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

The Bosch AFC Digifant system is a computer-controlled fuel injection system. The system does not use cold start injector or thermo time switch for cold start enrichment. Different sensors and switches, along with Electronic Control Unit (ECU) or Engine Control Module (ECM), regulate fuel injection and ignition timing. See Fig. 1.

ELECTRONIC CONTROL UNIT

The ECU/ECM controls all engine operations and limits maximum engine speed. It receives information from various input devices and cannot be repaired.

ECU/ECM LOCATION

Application	Location
EuroVan	In Left Side Of Engine Compartment, Behind Headlight

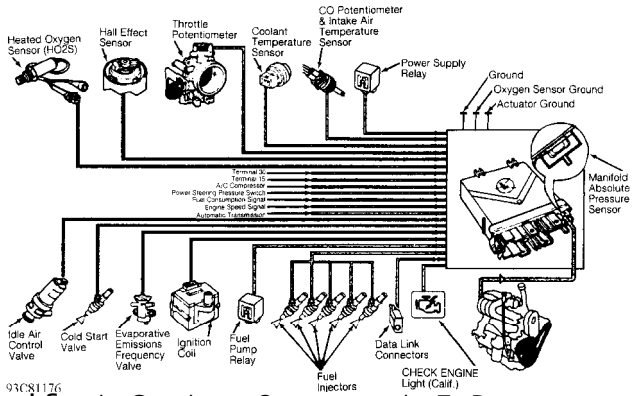

Fig. 1: Digifant System Component I.D.
Courtesy of Volkswagen United States, Inc.

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

INPUT DEVICES

Coolant Temperature Sensor

Sensor is a temperature sensitive variable resistor (less resistance as temperature increases). This sensor returns signals to the ECM to determine amount of cold start enrichment, acceleration enrichment, after-start enrichment, deceleration fuel cut-off and idle air control during cold start.

Hall Effect Sensor

See ELECTRONIC IGNITION SYSTEM under IGNITION SYSTEM.

Intake Air Temperature Sensor

Intake air temperature sensor is a thermistor-type variable resistor (resistance decreases with increase of temperature). This sensor voltage signal varies to ECU/ECM in relation to engine air temperature. The ECU/ECM uses this signal to control fuel injection duration.

Manifold Absolute Pressure (MAP) Sensor

MAP sensor is located inside the ECM. The MAP sensor signal is used by ECM to determine engine load. This signal along with RPM is used to calculate ignition timing and fuel injection quantity.

Oxygen (O2) Sensor

The O2 sensor detects oxygen content in the exhaust gas and sends this information to the ECU/ECM. In operation, the ECU/ECM receives signals from the O2 sensor and varies the duration during which fuel is injected. A high voltage signal indicates a rich mixture. A low voltage signal indicates a lean mixture.

The O2 sensor is heated electrically for rapid warm-up and constant operating temperature. Power to the heating element is supplied whenever ignition switch is turned to ON position.

Throttle Potentiometer

Throttle potentiometer is used by ECM to sense throttle position. This signal is also used for activation of idle air control, deceleration fuel shut-off and full throttle enrichment. On vehicles equipped with a manual transmission, a dashpot delays throttle valve closing just before idle.

OUTPUT SIGNALS

NOTE: Each vehicle may be equipped with different combinations of computer controlled components. The following listed components may NOT be used on all models. For theory and

operation on each output component, refer to the system indicated to right of each component.

Auxiliary Air Regulator
See IDLE SPEED.

Cold Start Valve
See FUEL CONTROL.

Fuel Injectors
See FUEL CONTROL.

Fuel Pump Relay
See FUEL DELIVERY.

Idle Air Control Valve
See IDLE SPEED.

Ignition Coil Control
See IGNITION SYSTEM.

FUEL SYSTEM

FUEL DELIVERY

Electric Fuel Pump
The fuel pump provides fuel under pressure to the fuel pressure regulator. Power for operation during cranking mode is provided from starter relay via fuel pump relay. After engine has started, control of fuel pump is through the ignition signal. The fuel pump is sealed unit.

Fuel Pump Relay
When energized by ignition switch and grounded by ECU/ECM, fuel pump relay provides battery voltage to the fuel pumps, injectors, idle stabilization control unit, oxygen sensor heating element and the power steering pressure switch.

Fuel Pressure Regulator
The fuel pressure regulator is a sealed, spring loaded diaphragm with connection for intake manifold vacuum. Fuel pressure is maintained at about 36 psi (2.5 kg/cmý) pressure.
A connection for intake manifold vacuum provides a constant pressure differential which ensures that the amount of fuel injected is solely dependent upon injector open ON time. Excess fuel is returned to fuel tank. No service of pressure regulator is required. The pressure regulator is located on or near fuel rail.

FUEL CONTROL

Data on engine temperature, engine speed, intake air volume, throttle position, exhaust oxygen content and intake air temperature

are used by ECU/ECM to determine injection pulse width.

Cold Start Valve

Cold start valve, mounted on intake manifold, sprays fuel to enrich mixture during starting so engine will start easily. The cold start valve is electronically controlled. The engine coolant temperature sensor with a signal supplied to ECM determines the opening time of the valve.

Fuel Injectors

A fuel rail links the fuel pressure regulator with the fuel injectors. Each cylinder is provided with a solenoid-operated injector which sprays fuel toward backside of each inlet valve. Each injector is energized through the ignition coil and grounded through the ECU/ECM to complete the circuit.

Each injector is linked to a resistor (resistor may be external or integral with injector or ECU/ECM) to reduce operating voltage to 3 volts and to protect injectors from power surges. The ECU/ECM controls length of time each injector is open. The ON time of the injector governs the amount of fuel delivered. The injector delivers 1/2 the amount of fuel required for an operating cycle each time they open (twice per cycle).

IDLE SPEED

Idle Air Control Valve

The idle air control valve is attached to intake manifold and adjusts the amount of air to engine to control engine idle speed when throttle valve is closed. The control valve receives signals from ECM. The control valve supplies additional air to engine when A/C is on.

IGNITION SYSTEM

ELECTRONIC IGNITION SYSTEM

The Hall Effect sensor 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 sensor, resulting in signal pulses. There is one shutter window for each engine cylinder.

Signals from distributor Hall Effect sensor are sent to the ECU/ECM. The ECU/ECM sends a switching voltage signal to the ignition coil primary circuit to discharge secondary spark voltage.

IGNITION TIMING CONTROL SYSTEM

Ignition Timing Control

Signals from distributor Hall Effect sensor are sent to the ECU/ECM, which produces a pulsating signal to the ignition coil. This computed signal from ECU/ECM to ignition coil controls ignition timing according to engine load (airflow sensor signal), engine speed (Hall Effect signal) and engine coolant temperature.

EMISSION SYSTEMS

Evaporative Emissions System

Fuel vapors are collected in the expansion tank. Liquid gasoline collects in expansion tank and flows back to the fuel tank through vent lines. See Fig. 2. When engine is not running, fuel vapors are drawn from tops of the expansion tanks, and flow into carbon canister, where vapors are stored.

After engine is started, the control valve is opened by throttle vacuum. Fresh air is drawn into bottom of the canister. Fuel vapors from the canister are drawn into the intake manifold. On EuroVan, fuel vapor flow is further regulated by an ECM-controlled evaporative emissions frequency valve.

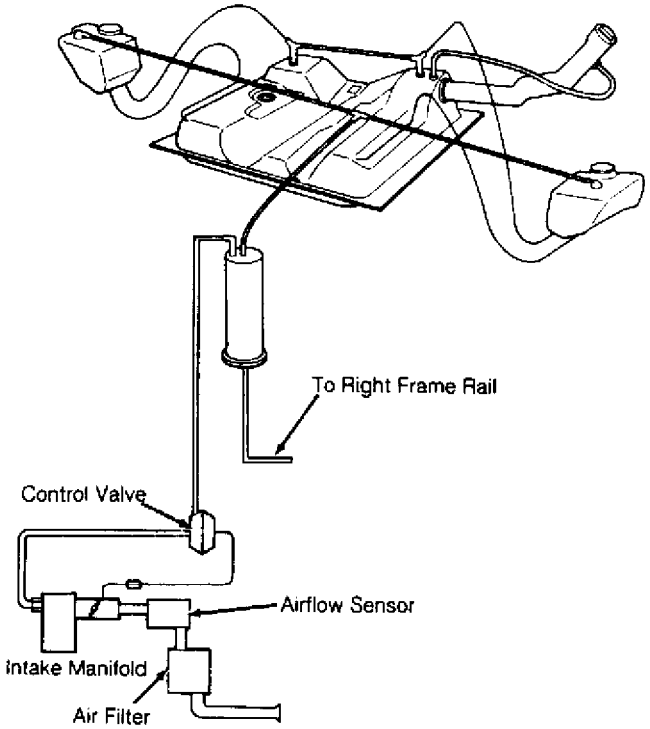

Fig. 2: Identifying Evaporative Emissions System Components
Courtesy of Volkswagen United States, Inc.

Thermostatic Air Cleaner

During cold engine operation, a regulator flap located inside air cleaner assembly is opened so engine can draw warmed air from around exhaust system. Vacuum from throttle valve operates regulator flap. The regulator flap is controlled by a temperature regulator valve located in upper part of air cleaner assembly. When engine warms up, temperature regulator valve closes causing regulator flap to close, blocking warm air flow from around exhaust.

SELF-DIAGNOSTIC SYSTEM

O2 SENSOR WARNING LIGHT

All vehicles are equipped with an O2 sensor warning light, located on the instrument panel. The light illuminates when a mileage counter reaches 60,000 miles, indicating recommended O2 sensor replacement and mileage counter reset.

MISCELLANEOUS CONTROLS

NOTE: Although not considered true engine performance-related systems, some controlled devices may affect driveability if they malfunction.

COOLING FAN

Cooling Fan Motor

The cooling fan is either a 1 or 2-speed motor. For specific On-Off operating temperatures of the different fans, see the COOLING FAN OPERATIONAL SPECIFICATIONS table below.

COOLING FAN OPERATIONAL SPECIFICATIONS

Application	Fan Turns ON at: øF (øC)	Fan Turns OFF at: øF (øC)
Single-Speed Fan	198-207 (92-97)	183-196 (84-91)
Dual-Speed Fan		
Low-Speed		
Without A/C	198-208 (92-98)	183-196 (99-108)
With A/C	183-207 (84-97)	183-196 (99-108)
High-Speed		
Without A/C	210-226 (99-108)	196-220 (91-104)
With A/C	201-220 (91-104)	196-220 (91-104)

After-Run Thermoswitch

An after-run switch is used to help prevent fuel vaporization. The thermoswitch turns cooling fan on when temperatures in engine compartment exceeds 230øF (110øC), and turns it off at 217øF (103øC).

END OF ARTICLE