

E - THEORY/OPERATION - DIGIFANT

Article Text

1991 Volkswagen Vanagon
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ARTICLE BEGINNING

1991 ENGINE PERFORMANCE
Volkswagen Theory & Operation Digifant

Cabriolet, Corrado, Fox, Golf GL, GTI 1.8L,
Jetta, Vanagon

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.

AIR INDUCTION SYSTEM

SUPERCHARGER

Corrado

The supercharger works like an air pump. Driven constantly off the crankshaft by a toothed belt, the supercharger compresses air. This compressed or boosted air is cooled by an intercooler before entering intake manifold.

Excess boost air is controlled by a mechanically-operated boost control valve and idle stabilizer. The boost control valve moves in the opposite direction of the throttle valve. As throttle valve opens, the boost control closes, directing most of the boost air back to the supercharger intake. See Fig. 1.

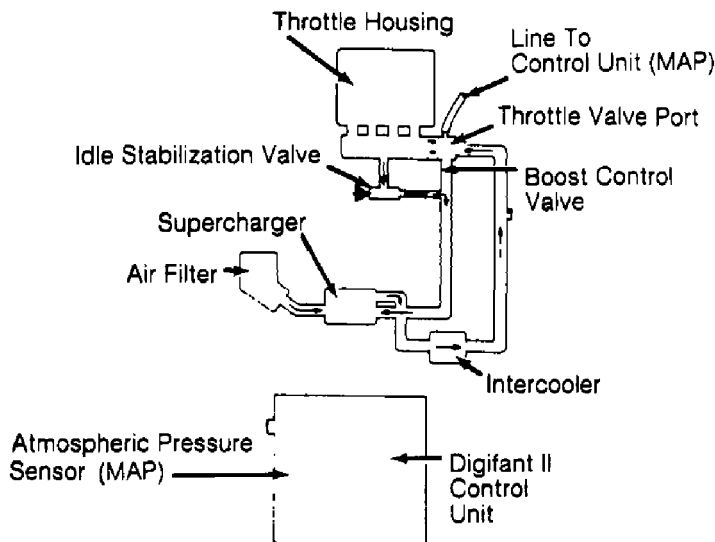


Fig. 1: Identifying Supercharger System Components
Courtesy of Volkswagen United States, Inc.

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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), regulate fuel injection and ignition timing.

ELECTRONIC CONTROL UNIT

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

ECU LOCATION TABLE

Application		Location
Cabriolet, Golf GL, GTI 1.8L & Jetta		Behind Firewall In Left Rear Of Engine Compartment
Corrado		Behind Firewall In Rear Center Of Engine Compartment
Fox		Behind Glove Box Passenger Side
Vanagon		Right Side Of Engine Compartment

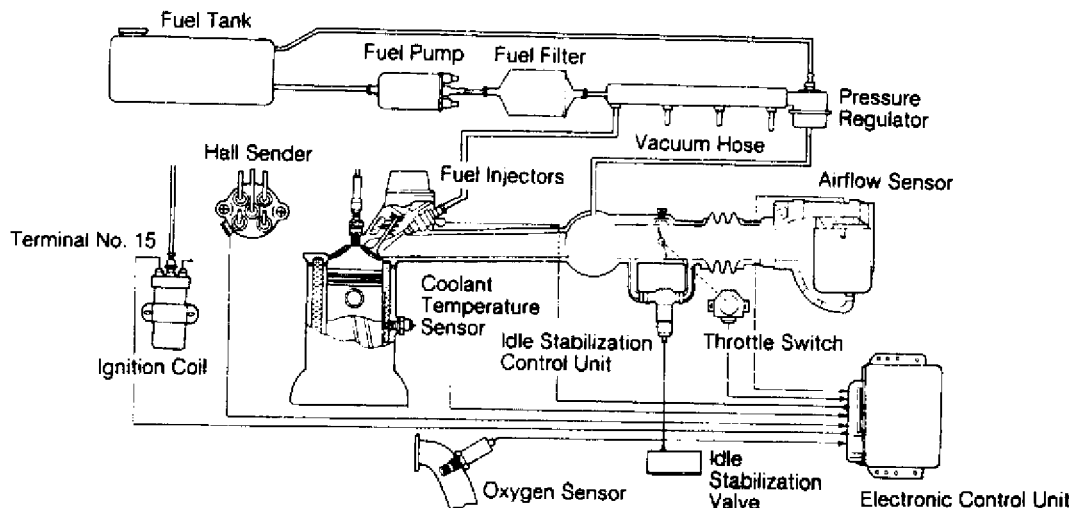


Fig. 2: Identifying Typical Digifant System Components
Courtesy of Volkswagen United States, Inc.

IDLE STABILIZATION CONTROL UNIT

Vanagon

The idle stabilization control unit is located in front of the right-hand taillight assembly. If engine idle speed differs from the value stored in the idle stabilization control unit, the idle air

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stabilizer valve adjusts the volume of air entering the engine at idle. The idle stabilization control unit receives information from the following:

- * Coolant Temperature Sensor
- * ECU Control Relay
- * ECU
- * Oxygen Sensor
- * Power Steering Oil Pressure Switch

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

Airflow Sensor (Except Corrado)

All intake air is drawn through the airflow sensor. The airflow sensor contains a tunnel with a measuring flap and dampening flap. The measuring flap swings with intake air stream against pressure of a spiral spring and is connected to a potentiometer.

The potentiometer transmits an electrical signal determined by measuring flap position to inform ECU of engine load. At idle, the measuring flap is almost closed due to spring pressure. See Fig. 3.

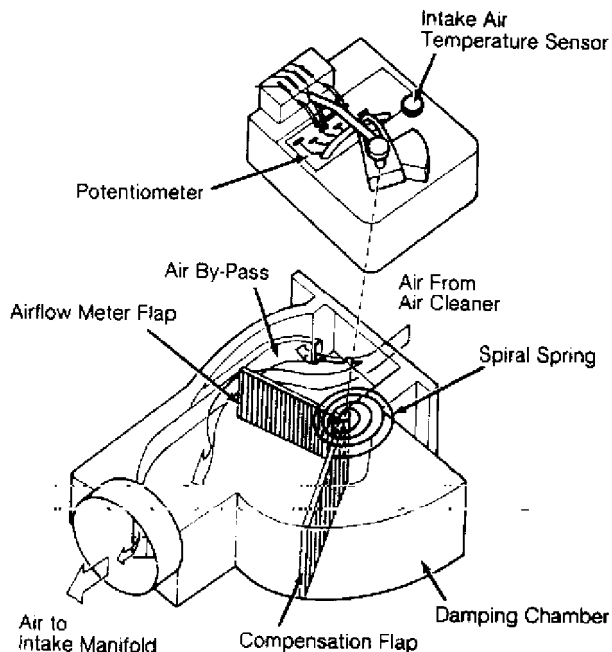


Fig. 3: Cross-Sectional View of Airflow Meter
Courtesy of Volkswagen United States, Inc.

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The potentiometer within the airflow sensor prevents loss of engine power during engine load or sudden acceleration (along with engine speed and coolant temperature) by signaling the ECU of necessary enrichment and timing requirements.

The airflow sensor contains an intake air temperature sensor. An adjustable idle air by-pass screw influences CO levels at low engine speeds. A tamper-proof plug is installed over this screw.

Coolant Temperature Sensor (Digifant I)

The coolant temperature sensor is a temperature sensitive variable resistor sensor (less resistance as temperature increases). This sensor returns signals to the ECU to determine amount of cold start enrichment, ignition timing and idle stabilization during warm-up. The sensor return signal has input to the ECU when the oxygen sensor, idle stabilization, and full throttle enrichment functions are activated.

Coolant Temperature Sensor (Digifant II & Corrado)

The coolant temperature sensor is a temperature sensitive variable resistor sensor (less resistance as temperature increases). This sensor returns signals to the ECU to determine amount of cold start enrichment, enrichment during warm-up and ignition timing control.

CO Potentiometer (Corrado)

The CO potentiometer adjusts CO mixture. Located on the intake air duct before the throttle housing. The adjustment screw has a tamper-proof plug. An air temperature sensor located within the potentiometer housing is used to calculate air density.

Full Throttle Switch (Digifant II)

The full throttle switch closes approximately 10 degrees before Wide Open Throttle (WOT). The ECU uses this signal for full throttle enrichment.

Hall Effect Sensor

See ELECTRONIC IGNITION SYSTEM under IGNITION SYSTEM in this article.

Idle Switch (Digifant II)

Idle switch closes when throttle is closed. The ECU uses idle switch input for idle stabilizer valve, deceleration fuel shut-off and activation of ignition timing map for deceleration. Idle switch opens when throttle is opened approximately one degree.

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 in relation to engine air temperature. Sensor is located inside the airflow meter.

Knock Sensor

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Vibrations in engine block will cause the quartz crystal inside knock sensor to produce a small voltage. The ECU monitors this small voltage. Ignition timing is retarded 3 degrees initially when detonation begins to occur. Timing is retarded only in the cylinder which is detonating.

When detonation stops, ignition timing is advanced in .33 degree increments until a preprogrammed value is reached. If detonation continues or reoccurs in a cylinder, ignition timing can be retarded up to 15 degrees for each cylinder. The difference between any 2 cylinders is limited to 9 degrees.

Manifold Absolute Pressure (MAP) Sensor (Corrado)

MAP is located inside the ECU. The MAP sensor signal is used by ECU to determine engine load and manifold boost pressure. This signal along with RPM and intake air temperature is used to calculate fuel injection quantity.

Oxygen (O2) Sensor

The O2 sensor detects oxygen content in the exhaust gas and sends this information to the ECU. In operation, the ECU 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.

Power Steering (P/S) Pressure Switch

The P/S oil pressure switch signals the ECU when the power steering load is high. The ECU then sends a voltage signal to the idle stabilization valve to increase idle speed with power steering load.

Throttle Potentiometer (Digifant I)

Throttle potentiometer is used by ECU to sense throttle position. This signal is also used for activation of idle stabilization system and deceleration fuel shut-off.

Throttle Potentiometer (Corrado)

Throttle potentiometer is used by ECU to sense throttle position. This signal is also used for activation of idle stabilization system, deceleration fuel shut-off and full throttle enrichment. On vehicles equipped with a 4-speed automatic transmission, 2 throttle potentiometers are used. One throttle potentiometer is used for engine management and the other potentiometer is used for automatic transmission control.

Throttle Valve Switch (Vanagon)

Throttle valve switch supplies ECU with information that throttle valve is closed. If engine is above 1250 RPM with throttle closed, fuel will be shut off to the injectors. At idle speed, this switch signals control unit to regulate amount of fuel injected.

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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 in brackets, to the right of each component.

OUTPUT SIGNALS

- * Idle Air Stabilizer Valve - See IDLE SPEED.
- * Fuel Injectors - See FUEL CONTROL.
- * 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 the fuel pump relay. After the engine has started, control of the fuel pump is through the ignition signal. The fuel pump is sealed unit.

Fuel Pump Relay

When energized by the ignition switch and grounded by the ECU. The 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/cm²) 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 ECM to determine injection pulse width.

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 to

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complete the circuit

Each injector is linked to a resistor (resistor may be external or integral with injector or ECU) to reduce operating voltage to 3 volts and to protect injectors from power surges. The ECU 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).

Fuel Pump After-Run Relay (Corrado)

The purpose of the after-run fuel pump relay system is to reduce the chance of fuel vaporizing in fuel rail. Both transfer pump and fuel pump are used to recirculate fuel. The after-run relay switches the pumps on for 2 minutes after ignition is turned off or when under hood temperature exceeds 194°F (90°C) and fuel pressure is above 17 psi (1.2 kg/cm²). The pumps operate a maximum of 8 minutes.

IDLE SPEED

NOTE: On Vanagon, idle stabilizer valve is controlled by a separate idle stabilizer controller. See IDLE STABILIZATION CONTROL UNIT.

Auxiliary Air Regulator (Fox)

When engine is cold, air is by-passed around throttle plates to raise engine RPM. As engine warms up, an electric heating element warms a bimetallic strip inside regulator gradually closing regulator.

Idle Stabilization System (Fox)

The idle stabilization system uses an idle air by-pass valve and an A/C by-pass valve on vehicles equipped with A/C. The idle air by-pass valve opens to compensate for engine RPM changes at idle. The A/C by-pass valve opens when A/C is activated.

Digital Idle Stabilization (DIS) (Fox)

In addition to the idle stabilization, the ECU is equipped with DIS. If engine RPM changes during idle due to different engine loads, the DIS will adjust engine RPM by adjusting ignition timing to maintain a stable idle speed.

Idle Stabilization System (Except Fox & Vanagon)

The idle stabilization system is ECU controlled. If engine speed varies from a predetermined RPM, the idle stabilizer will adjust engine RPM accordingly.

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

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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 ECU. The ECU 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 sender are sent to the ECU, which produces a pulsating signal to the ignition coil. This computed signal from ECU 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. 4. 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.

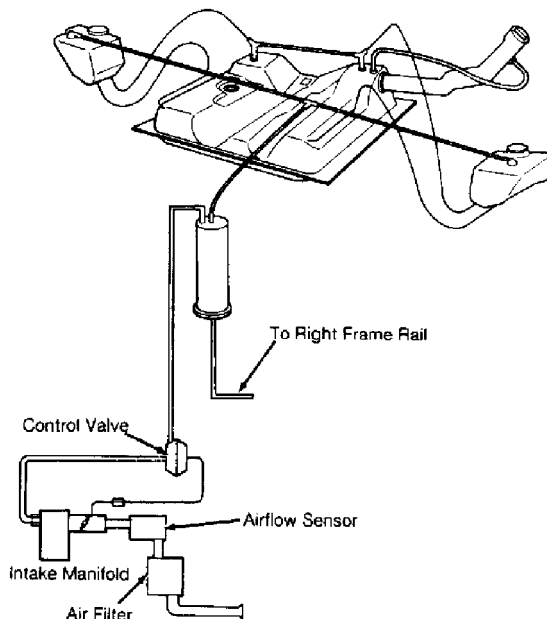


Fig. 4: Identifying Evaporative Emissions System Components
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Thermostatic Air Cleaner

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 becomes warm, temperature regulator valve should close causing regulator flap to close, stopping warm airflow 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 (90,000 miles on Vanagon) indicating recommended O2 sensor replacement and mileage counter reset.

CHECK ENGINE LIGHT

California

California vehicles are equipped with a CHECK engine light and rocker switch on the instrument panel. The light illuminates when the ignition switch is turned to the ON position (for bulb check) and when engine management systems malfunction during normal engine operation. For additional information see appropriate G - TESTS W/CODES article in the ENGINE PERFORMANCE Section.

MISCELLANEOUS CONTROLS

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

CRANKCASE VENT LINE HEATING ELEMENT

A heating element is used in the crankcase vent line to prevent icing during cold engine operation, this element has a 5.5-mm hole in the restrictor plate. See Fig. 5. The circuitry to operate heating element is protected by an in-line 5-amp fuse located in the wiring connector box, in engine compartment.

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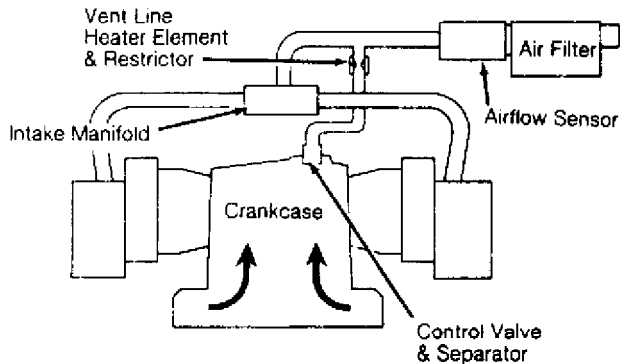


Fig. 5: Locating Crankcase Vent Line Heating Element
Courtesy of Volkswagen United States, Inc.

COOLING FAN

Cooling Fan Motor

The cooling fan is either a 1- or 2-speed motor. If vehicle is equipped with single-speed motor, the fan comes on at 198-207°F (92-97°C) and off at 183-196°F (84-91°C). If equipped with a 2-speed motor, low speed of cooling fan should come on at 198-208°F (92-98°C) on vehicles without A/C, or 183-207°F (84-97°C) on vehicles with A/C. Low speed will shut off at 183-196°F (84-91°C) on all vehicles. High speed comes on at 210-226°F (99-108°C) on vehicles without A/C, or 201-226°F (94-108°C) on vehicles with A/C. High speed will shut off at 196-220°F (91-104°C) on all vehicles.

After-Run Thermostwitch

An after-run switch is used to help prevent fuel vaporization. The thermostwitch turns cooling fan on when temperatures in engine compartment exceed 230°F (110°C), and turns it off at 217°F (103°C).

END OF ARTICLE