Vanagon & it’s ECU

Attention: This is only a small section of the complete manual ECU monitor system. Download the full manual here.

Vanagon ECU System Overview

For the 8691V ECU Monitor System to work for you effectively, it is important that your engine be tuned to its best possible running condition. Spark plugs, spark plug wires, distributor cap and rotor should first be replaced. All basic engine adjustments (timing, etc.) should then be verified. It is also a good idea to check or simply replace either one or both of your fuel filters, depending which fuel filter system you have (one or two filters). We are assuming in this case, that the problem is intermittent, or at temperature, and that your engine is able to be tuned and will run. You can refer to our 8691V Troubleshooting Guide if you have rented the system from www.Van-Cafe.com.

1986 through 1991 Vanagons all utilize the Bosch or Triumph Adler (both are interchangeable) Engine Control Unit, or as we will refer to it, ECU, to electronically enable the fuel pump, and control the fuel injection pulses and ignition timing of your engine. These outputs are modified by the ECU according to the state or level of their respective inputs.

Electrical Wiring

There is not enough room to reproduce the various electrical wiring diagrams that might apply to your particular Vanagon. Our preferred reference book for this, and a lot of other technical information on Vanagons, is the Bentley Green Book that covers 1980 - 1991 Vanagons. In addition to complete engine tear down and rebuilding, the book is divided into several chapters covering all subsystems from brakes to fuel. The wiring references in this document refer to the wiring diagrams on pages 97.201 - 97.233, in Bentley Volkswagen Vanagon edition ISBN 0-8376-0336-6.

If you own a Vanagon, you should own one of these books. It is a Factory Service Manual of the highest quality. The Bentley Book is available at here.

Vanagon ECU Relationships

The ECU is but one component, albeit an important one, in the Vanagon 2.1 Liter engine control system. The ECU collects information from sensors, and controls other units in the engine, depending on those inputs. While the ECU is like the quarterback, all the players must contribute efficiently to make the team run smoothly. The basic requirements for an internal combustion engine to operate are fuel, spark, and air. The modern engine utilizes electronic technology to constantly monitor and control the critical engine variables.

This drawing shows the relationship of the ECU to the other components of your engine that connect to it. Your Vanagon may have either one or two fuel filters installed. There are both versions out there in the real world.
So, the Bosch ECU computer does a lot of work, but it is not rocket science by any stretch of the imagination. The Bosch ECU is a relatively simple microprocessor signal converter and interface, which does the work of previously separate external sub-systems (e.g. the old mechanical choke has been replaced by the fuel injector pulse width (wider pulse = more gas). Variable timing provided by vacuum pressure is replaced by a lookup table of values based on engine parameters provided by sensors. Once you understand what the ECU does, it is much easier to understand problems associated with it.

**Digifant System Components**

**Electronic Control Unit (or ECU)**

The Digifant electronic control unit incorporates all the functions of the fuel system and ignition system and provides both the actuation signal for the fuel injectors and optimum ignition timing point for all engine operating conditions. Injection duration opening signals are provided based on the following inputs:

* Engine speed
* Intake air volume
* Coolant temperature
* Oxygen content in the exhaust gas
* Battery voltage
* Intake air temperature

The injector opening time is taken from a program in the control unit at 16 points for RPM, and 16 points for load, for a total of 256 operational points. Injection times can be determined between these fixed points for a total of 65,000 theoretical different opening points.
Coolant Temperature Sensor

The **coolant temperature sensor** is a negative temperature coefficient resistor (NTC). The voltage signal it produces is used by the control unit to determine:

* The amount of cold-start and warm-up enrichment
* Ignition timing and idle stabilization during warm-up
* When the oxygen sensor, idle stabilization, and full-throttle enrichment functions are activated.

Fuel Pump

The **fuel pump** is a roller cell design. It is driven by a permanent magnet electric motor and is located near the fuel tank. Steel rollers are held in "cut-outs" on the rotor. Centrifugal force seals the rollers against the walls of the pressure chamber as the rotor spins. Fuel is trapped between the rollers and is forced out the delivery port. The pump is designed to be both cooled and lubricated by the fuel flowing through it. The pump delivers several times the amount of fuel needed to operate the engine at any time. Excess fuel is returned to the fuel tank via the fuel pressure regulator.

Air Flow Meter

The **airflow meter** senses the amount of air entering the intake manifold and sends a voltage signal representing this amount to the ECU. Intake air opens the airflow sensor flap, which actuates the potentiometer to determine the voltage level. This signal and the engine speed information provided by the Hall sender are used as the principal inputs for the determination of fuel injection opening duration and ignition timing points. A compensation flap connected to the air sensor dampens sudden movements of the air sensor flap due to oscillations of the intake air.

Intake Air Temperature Sensor

An intake air temperature sensor is located in the airflow sensor housing. It is a negative temperature coefficient (NTC) resistor, which means its resistance value drops as the temperature increases. The signal it supplies to the ECU is used to modify fuel injection rate depending on intake air temperature.

Fuel Pressure Regulator

The system pressure regulator maintains a constant fuel pressure to all injectors by regulating the quantity of fuel returned to the fuel tank. The **fuel pressure regulator** is connected to the intake manifold. It responds to intake manifold vacuum fluctuations, thereby compensating for changes in engine load.

Fuel Injectors

**Digifant fuel injectors** are electronically controlled on/off valves. A solenoid actuates a needle valve allowing fuel to be forced through the injector nozzle. All four injectors open at the same time and inject fuel directly into the intake manifold near the intake valves. Injector quantity is controlled by the amount of time the solenoids are energized. This is in turn is controlled by the fuel injector pulse width, determined by the ECU.

Note: Digifant injectors (yellow body) are NOT interchangeable with AFC (blue body).
Throttle Position Switch

Digifant uses a single throttle position switch to signal the ECU when the throttle plate is fully closed (idle), or fully open (full load) position. This signal enables the ECU to determine that one of three auxiliary functions (idle stabilization, deceleration fuel shut-off, or full load enrichment) is required. The throttle position switch is a normally open switch. A cam activates the contact arm with two eccentrics, attached to the throttle plate shaft. One eccentric closes the contacts in the fully closed position and the other in the fully open position. Correct adjustment is very important. If misadjusted, the engine may surge at idle, or cut out during steady driving or light acceleration. The throttle position switch is available here.

Fuel Filters

Your Vanagon has single fuel filter. The filter is a metal cylinder, which mounts behind the fuel pump. It has a finer filtering mesh to protect the fuel injection components. We suggest that the filters be changed every 30K miles. The filter is available here. Some vans had a small square fuel filter in front of the pump. Volkswagen, back in the day, had a secret campaign to remove this filter. Although it is unlikely that your 2.1Ltr van still has this filter, you should remove it with the help of this kit.

Oxygen Sensor

The oxygen sensor is made of a ceramic material called Zirconium Dioxide. The inner and outer surfaces of the ceramic material are coated with platinum. The outer platinum surface is exposed to the exhaust gas, while the inner surface is exposed to the outside air. The difference in the amount of oxygen contacting the inner and outer surfaces creates a pressure differential, which results in a small voltage signal in the range of 175 - 1,100 millivolts (0.175 - 1.10 volts) supplied to the ECU. The fuel mixture determines the amount of voltage produced. A higher voltage indicates a rich mixture, and a lower voltage indicates a lean mixture. The sensor is electrically heated to keep it at a constant operating temperature. This insures continuous and accurate reaction of the sensor during all operating conditions. The oxygen sensor should be replaced every 60,000 miles. If your oxygen sensor is beyond this limit, or if you are not sure, order a new one. Although we sell a cut and splice O2 Sensor, we prefer to use the complete O2 sensor that comes with the correct length harness and plugs directly in. There is no chance for lost of signal on this version.

Ignition System

The map controlled ignition system operates on the principle of a timing map, which is programmed into the ECU. Information on engine load, speed, and coolant temperature are provided to the ECU in the form of voltage signals. These signals are processed by the ECU so that the ignition coil is controlled via terminal #1 in accordance with the programmed ignition map. The separate ignition control unit and digital idle stabilizer used in the past have been eliminated. An engine speed signal is transmitted from the Hall sender in the distributor, and engine load measurement is accomplished through the signal from the air flow meter potentiometer. These two signals establish the ignition timing point. The engine coolant temperature sensor signals the ECU to determine ignition timing based on engine temperature. The engine's ignition timing is constantly being corrected throughout the engine warm-up phase. Once the engine is warmed up, the internal timing map in the ECU determines the ignition timing.
Idle Stabilization System

The **idle stabilization** system used on the Digifant system ensures the idle speed remains constant at pre-determined levels. The system controls the amount of air bypassing the throttle plate. If engine idle speed varies from the value stored in the ECU, the idle stabilizer valve will adjust the volume of air entering the engine at idle. This maintains idle speed within preset limits. A control unit in the engine compartment near the air cleaner intake hose operates the idle stabilizer valve. This control unit is located behind the passenger side tail light housing. The control unit receives inputs from the following components:

* Throttle Position Switch
* Coolant Temperature Sensor
* A/C Compressor Clutch
* Ignition Coil Terminal #1
* Automatic Transmission Selector Switch (if applicable)
* Power Steering Pressure Switch

With this system, the auxiliary air regulator and digital idle stabilizer used in pre 1996 models have been eliminated, and any periodic idle adjustment is no longer required.

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