



# ***Porsche Diagnostics***

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**December 2021**

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**Porsche....**

## ***There is no substitute***

### **1. Introduction**

The Porsche 928 is one of the finest sports cars Porsche ever made. It is timeless in design and one of a kind in the way luxury and performance are combined. However, this wonderful car is also a complex piece of machinery and from the moment of the first development drafts on, it was clear that electronics would play an important role in the management and controls of this car. Developed in the early 70's the car started life in 1978 as the 928. It then developed into the 928S model, the S2, S4, GT, and GTS. In 1986, Porsche started using advanced Bosch Automotive Electronics for several car functions and engine management, and in 1987 the first controllers that had internal diagnostics and fault memory were fitted.

Porsche developed a few diagnostic tools to cope with these new electronic features such as the 9268. This was a handheld device with a small display providing code messages. It used a simple binary signal to retrieve information from the controllers.

Later Bosch marketed the more advanced KTS300 (Porsche 9288) which became famous under the name of the Bosch "Hammer" because of its shape. This is a more versatile tool than the 9268 and was able to provide test signals, information, check sensor signals, and read fault codes from several models and controllers.

Porsche also developed a PST2 diagnostic PC and the Bosch KTS500 for use in their workshops. These were even more advanced and updated for modern Porsche models of today.

In 2005 Porsche 928 enthusiasts in the Netherlands under the name of "928-ecu-repair" started working on the protocols of this diagnostic system basically to understand and maybe develop an affordable and versatile diagnostic system. Because the 928s are starting to age and show flaws in the electric and electronic systems an affordable diagnostic tool was called for. These age-related problems include the ECU break down and malfunctioning actuators and sensors. Troubleshooting without tools is not the easiest job. This tool was developed to solve this problem. It was developed purely from studying the system and monitoring the data. Therefore, no copyrights have been breached. It is intended for both personal use and workshops. The interface and software deals with Porsche controllers dating from 1987 onwards, thus 928 S4, GT, and GTS models, but also 944s2, 964, 968, and 993 models.

#### **First some information about the Porsche 928 models.**

The 1987 and 1988 models had a 12pin socket to plug in the diagnostic device. This rectangular socket was intended for the 9268 interface that was also used in the 944 models in that time. A separate cable for this version will have to be ordered.

In 1989, Porsche redesigned the diagnostics wiring loom and fitted the 19pin diagnostics connector socket under a cover at the passenger side seat. (LHD)

The Diagnostic Software connects to these interface connections, and communicates with the following 928 controllers (if fitted):

- LH, injection controller;
- EZK, ignition controller;
- RDK, tire pressure controller;
- ABS, anti-locking brake system controller;
- PSD, Porsche Slip Differential controller (built inside the ABS box);
- Alarm, Alarm and central locking controller;
- Airbag, the Airbag controller.

Diagnostic Capability by Model Year

Year	Controller Installed with Diagnostics Functions? (Yes/No)							Diagnostic Port Connector	
	LH	EZK	RDK	PSD	Airbag	Alarm	Digital Instrument Cluster <sup>2</sup>	19-way	12-way
1987	Yes <sup>1</sup>	Yes <sup>1</sup>	No	No	No	No	No	No	Yes
1988	Yes	Yes	No	No	No	No	No	No	Yes
1989	Yes	Yes	M482	No	No	No	Yes	Yes	No
1990	Yes	Yes	Yes	Yes	US only	No	Yes	Yes	No
1991	Yes	Yes	Yes	Yes	Yes <sup>3</sup>	Yes	Yes	Yes	No
1992	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
1993	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
1994	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
1995	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No

Note 1. The late 1987 model was the first 928 with diagnostic capabilities. Diagnostics are only possible if the ecu says DIA on the label or with updated firmware, which brings the ecu up to 1988 standard with the DIA features.

Note2. The digital instrument cluster comes in different software versions K18-K29 with different capabilities.

Note 3. The airbag was an option for the left hand steering 1991 models in RoW and standard in the 1990/1991 US/CDN models. In February 1991 it became standard. Since Porsche changes MY series during summer vacation, you might see an early 1991 without an airbag and a late one with Airbag.

Porsche does model changes during the summer holidays. The new year's model start production after summer. So, it is quite possible that a car manufactured in October has features of the next year model.

## Secondly some information about the other supported Porsche models

Supported modules in the 944-S2 / 964 C2&C4 / 968 / 993:

944-S2, 964, 968 and 993 has several modules which all are connected to the K/L line of the diagnostics bus. The modules are: Motronic, Climate control, PDAS(964-C4), Tiptronic, Airbags, Alarm system and ABS (993). UDT999 supports also all of these modules.

### Motronic 2.1:

- Read ECU identification.
- Read error codes.
- Clear error codes.
- Perform drive link tests: injectors (6x at 964/1x at 944), idle stabilizer, tank vent and resonance plate.
- Read input signals: throttle WOT/idle, Airco, coding, MAF sensor, lambda sensor, idle stab value, air/engine-temp., engine load/speed.

- Read actual values: Speed, MAF, Lambda, Air-temp., Engine-temp, Spark, coding, etc.
- Perform Knock registration.

**Motronic 5.2:**

- Read ECU identification.
- Read error codes.
- Clear error codes.
- Perform drive link tests: injectors, idle stabilizer, variocam, tank vent and resonance plate.
- Read input signals: throttle WOT/idle, Airco, coding, MAF sensor, lambda sensor, idle stab., air/engine-temp., engine load/speed.
- Read actual values: temperatures, Vbat, MAF, speed, load, coding, timings, throttle, etc.

**Airbags:**

- Read ECU identification.
- Read error codes.
- Clear error codes.
- Read downtime.
- Read crash data.

**Climate Control:**

- Read ECU identification.
- Read error codes.
- Clear error codes.
- Read input signals: AC switch, defroster switch.
- Read sensors information: foot well, defroster blower, temperatures.
- Read actual values: Vbat, rear-temp., inside-temp., oil-temp., etc.
- Perform drive link tests: mixing flaps, blowers, foot well, oil cooler, etc

**PDAS:**

- Read ECU identification.
- Read error codes.
- Clear error codes.
- Read input signals: full lock switch.
- Perform drive link tests: bleed procedure, check transverse lock and check longitudinal locks.

**Tiptronic:**

- Read ECU identification.
- Read error codes.
- Clear error codes.
- Read input signals: kick down switch, up/down shift, stop light, selection lever.
- Read actual values: RPM, injection time, modulation pressure, gear, coding etc.
- Perform drive link tests: solenoid 1/2, reverse relay, oil cooler blower, etc.

**Alarm:**

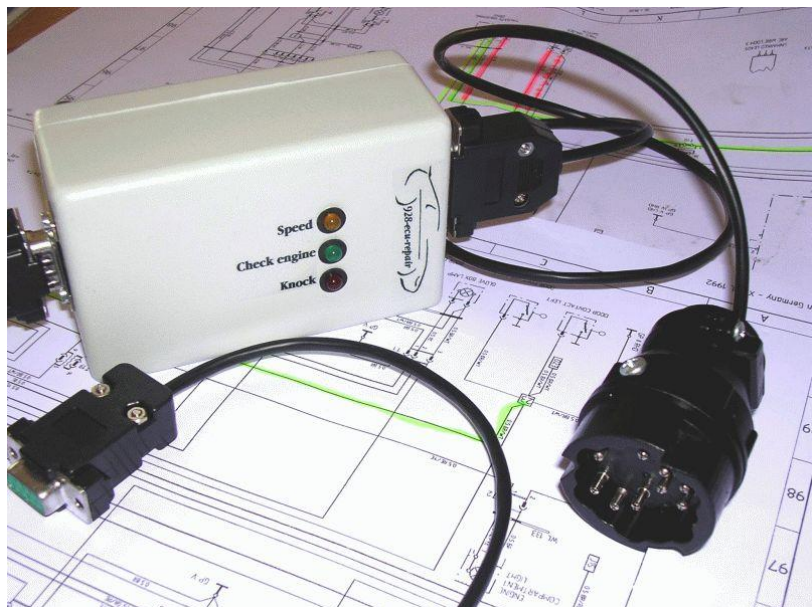
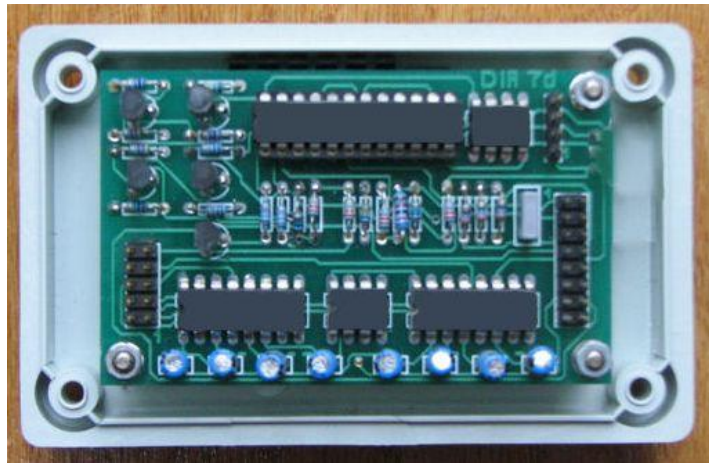
- Read ECU identification.
- Read error codes.
- Clear error codes.
- Perform drive links: activate horn, turn signals, interior lights, locks, etc.
- Read input signals: switches in engine-, luggage-, glove-compartment, etc.
- Select land-coding.
- Select remote control.
- Select car type.
- Select 993-inside security.

**ABS and ABS5 and ABS5 / ABD:**

- Read ECU identification.
- Read error codes.
- Clear error codes.
- Perform drive links: activate abs warning lamp, pump relay, MV front left/right, MV rear etc.
- Read actual values: valve relay, stop light switch, speed sensors, return pump.
- Perform bleed procedure \*\*.

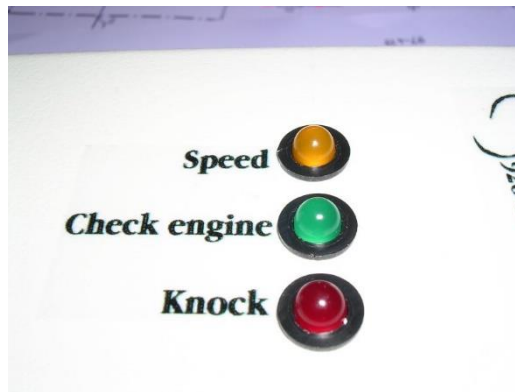
\*\*some functions are only available in the ABS5 / ABD ecu !

This document describes the software and functions used in the Porsche UDT999 Diagnostic System.



Interface module DT9xx, which preceded the UDT999.





LED's on DT9xx and UDT999.

## 2. General

The diagnostic system consists of a cable between the diagnostics port of the Porsche and the interface box plus a cable to the PC RS232 or -USB port, and PC software.

We have been working long and hard to make this software and develop the interface. To prevent someone from stealing and reverse engineering we decided to protect the software. This protection links software and hardware together as a unique pair. You are free to install the software on more than one PC but the software will only work with the one specific interface it is linked to.

**Important:** There are three PC based diagnoses products in our product range:

1. The first series is the **DT9xx**. This series is based on PC-RS232 port (COM port).
2. The second series, the **UDT999**, launched 2011 is based on PC-USB port. The interface is housed in a small box.
3. The third series is the **UDT999**, launched in 2013 and operates PC based using the USB port. This latest version has an OBD2 style 16pin connector that houses the interface and also enables OBD2 style connections. An adapter cable links to a 19pin or 12pin diag socket in your Porsche.

The software on the PC is able to cope with these three series!

### 2.1. Requirements.

The software is very dependent on a good working PC that has a constant performance. This is due to the nature and design of the serial bus in the windows operating system. Therefore, using software that runs simultaneously while the diagnostic system is running, is *\*not\** recommended as this may cause transmission errors and hang-ups.

A basic PC or notebook is required using Windows 2000, XP, Vista, or Windows 7 (32/64) operating system. Other versions are not supported. We recommend a 1 GHz CPU to ensure good stability of the 928 Diagnostics program.

The software also runs fine on a Apple Mac air emulating XP via Virtual box plus a serial to USB convertor as the Mac only supports USB. However, we cannot support the software running on an Apple system.

For **DT9xx** series a serial port is required, but since some newer notebooks lack a serial RS232 port, we have successfully tested a USB to Serial converter, which we can optionally offer. Due to the many compatibility problems with USB converters on the market, we only offer support for the one that we offer.



or

This converter is capable of transferring at 600kbit/s and uses the FTDI chip. This ensures full compatibility with RS232 devices. It is compatible with Windows 98/2000/XP/Vista/Windows7 (32 and 64bits), and Windows 10. We have experienced USB converter problems with very slow PC's, so a 1 GHz CPU is recommended.

The **UDT999** has already a USB connection towards PC so the user does not need an additional converter (in fact the converter is built in the UDT999) but can use the driver of the converter. We supply the appropriate driver on our download server.

Despite meeting system requirements, the diagnostic system software may sometimes experience trouble connecting to any ECU. This is not a bug in the program but a communication design issue. To cope with this, you will notice that each module test handles 3 retries before announcing a failure to connect. Switching the ignition off and on again or manual retry using the connect button may be required upon a failure to connect.

## 2.2. Installing the software

In the package you will receive will not contain software and a driver CD. To avoid CD reading problems and in some countries problems with customs when importing a CD, we decided to only offer the software via download from our server. We also have the latest software, driver and documentation available for you to download from our server. The URL is <http://webserver.jenniskens.eu>

If the USB-converter plus USB-driver (for DT9xx series) or USB- driver only for UDT999 series is used, you will need to install the supplied driver first. This is done by downloading and executing the driver install program (like FTDI driver CDM 2.08.14.exe). New versions of windows (like windows7 or 10) offer a driver search on the internet which should install the driver automatically for you. To manually install the USB software, download it to your PC in a temporary directory like downloads or temp, and run the installer.

The virtual comport driver (VCP) translates the USB signal to a new comport device on your PC. The com port is typically not the Com1 port (default setting) but on Com4 up to Com9. Many laptops have a built-in modem configured for Com1 or Com3. You will not get an error message from the DT/UDT system, but the tool tries to connect to your modem instead of the USB-Serial adapter located on Comport 8 or 9. A successful connect to the modem will not help communicating to the interface port. This is a common mistake.

If you want to setup the USB driver emulating a specific com-port (and change what Windows selected), go to the Windows Device Manager screen, select "View devices by type", then "Ports (COM & LPT)". Select the USB serial port and click Properties. Select the "Port Settings" tab, then click Advanced. Choose the required COM port number from the list and click OK. Please refer to chapter 9.1 for more info.



Installing the (U)DT999 software the download is very easy. Download the installer to a temporary directory. Run the setup “setup\_DT928\_vxxx.exe” (xxx is version number) or “setup\_UDT999\_vxxx.exe” which is located on the downloaded files folder. The setup contains all the necessary files in itself. After download the setup routine takes care of everything for you and sets up the system. It also creates an un-install option to easily remove the program from your system if needed.

With the installed software a number of documentation files are installed on the PC. This manual is one of them, but you will also find various extracts of service manuals to assist in troubleshooting with the (U)DT999. You find these manuals easily via shortcuts in the start menu on your PC.

One common mistake is running the software directly from a folder that has limited access, like c:\programs. That will not work. The program writes in the config file and creates log files and needs to have privileges The setup routine takes care of that. When setting up manually, you need to configure administrator privileges.

## 2.3. Connecting the System

Power to the interface is provided by the car and is active when the car's ignition is switched to the on position. Power consumption is minimal, and it will not drain the battery.

The interface box DT9xx and UDT999 also show LED's for signals. The Red LED is for the “knock” signal, Yellow is “Speed”, and Green is “Check Engine” signal.

These signals will be explained in more detail in the next chapters.

From the '89 models onwards an electronic dash is fitted in the Porsche 928, which is capable of displaying some diagnostic information and providing some test functions. The Porsche Diagnostics software enables you to switch on the special diagnostic mode in the electronic instrument panel.



Model 1 (<2011): Interface module DT9xx with cables connected.



Model 2 ( $\geq 2011$ ): Interface module UDT999 with USB connection. This is the boxed design.



Model 3 ( $\geq 2013$ ): New style Interface module UDT999 with USB connection, OBD2 connection, and an OBD2 to 19pin OBD1 diag connector conversion cable.





The interface cable DT9xx (model 1) to the 19pin diagnostic socket

We decided to connect both PC cable and diagnostic port cable plug into the interface box connector, which makes it very versatile. It enables you to also use a specific cable for the 12pin rectangular socket (1987/1988 model 928s4, similar to the 944s2).



This is the 12pin diagnostic cable for the 1987/1988 Porsche 928 models and one 944S2.

Finally, the serial 9-pin serial cable (for DT9xx series) connects the diagnostic interface to the PC-COM port or USB cable (for UDT999 series) connects the diagnose interface to the PC-USB port.

Default comport setting in the software is com1, but your specific situation may vary and require adjustment. Please refer to chapter 9.1 for setting and testing the comport.

One good check to do now is test if the communication to the ecu's in the car is setup. This can be done by the following procedure:

- Connect the interface and PC , connect the interface to the car.

- Start the software and go to the settings tab.
- Switch on the ignition. The green light will probably go on.
- Verify that you have switched to the correct port.
- Push the K-line button. This triggers the K line to switch state, which should be reflected on the left field showing a response from the system. A response indicates a working communication over the configured port, no more. This is a very useful test to verify serial port communications.

### Porsche 993 series:

All three diagnose tool series are capable to work with the Porsche 993 '> 95'. But these Porsche series has a different connector. These cars use an OBDII-16P connector. For model 1 and model 2 you need a special 16P cable. See below the 16P cable. For model 3 this 16P connector is already integrated and not necessary to buy additionally.

The second difference between this type of car and previous model the 993 '< 96' is that this model has **two K-lines** (two diagnose buses). Some ECU's are connected to the first bus and some to the second bus. That is the reason why there is a small switch mounted on the OBDII-16P connector (applicable for model 1 and 2). If the user is not able to connect to a certain ECU, set the switch to another position and the other diagnose bus of the car is now connected to the UDT999 or DT9xx series. Try again to connect.



This is the first test model of the 16P-OBDII connector with on top a switch to select one of the two diagnoses buses.

The following ECU's in the 993 are connected to the K bus (pin3 of OBDII):

➔ Airbag, Tiptronic, ABS5 or ABS5/ABD, Climate and Alarm.

And which ECU is connected to the other K-bus (pin7 of OBDII):

➔ Motronic.

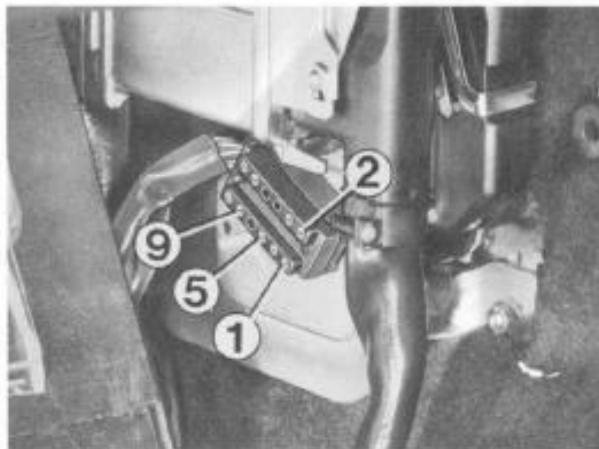
## 2.4. Locating the diagnostic port in your car

The early 928, MY 1987 and 1988 have a 12pin rectangular diag port connector and all 928 models starting 1989 have a 19pin round connector.

The 19-pin cable is connected to the diagnostic port under the side cover next the passenger seat. This cable only fits in only one way so there is no risk of incorrectly connecting it.



The 12 pin socket is located on the ecu mounting bracket very close to the EZK ecu.



The optional 12pin rectangular cable has numbers on the socket assembly that provides orientation and proper installation. Please be aware that the connector must only be installed in the correct way. The pins in the connector must match the ones in the socket. It is as simple as that.

## 2.5. Using the software.

You will notice that each screen has a help button in the lower right corner which is “generic help”, and each tab has a help button too, which provides “specific content help”. When you press the help button, a help window opens with information very similar to content of this manual.

- It is best to start the program and have it running on your PC prior to switching on the ignition of the car. It does happen sometimes that the ecu's of the car get into an undefined state and refuses to communicate. Turning off/on the ignition will resolve this but starting the software first does prevent it.
- When using the software, you need to bear in mind that the electrical power consumption of the 928 is substantial, and a battery is easily depleted

when the engine is not running. Deep discharge of a car battery is bad for its condition and is irreversible. Therefore, you should minimize the time that the ignition is turned on when the engine is not running. Again, it is not the DT928 system that depletes the battery, but it's the car's electrical system.

- The dialogue between car electronics and the software is timing dependent. Do not run any software on the PC simultaneously as this may interfere with diagnostic software and trigger communication errors with the interface and ECU's.
- Moving windows on screen during PC-ECU communication may cause communication errors and may even cause hang-ups of the software. Restarting and reconnecting should fix this.
- If you have a 928 with a digital instrument cluster (89 onwards), the instrument panel will initially show "diagnostic connector attached" when powering up. This is normal behavior of the software communicating with the instrument cluster. A small modification is possible to the early interface units to prevent this. See the documentation on our server.
- We have seen error reports while communicating, related to a broken fuse on one of the ecu's, basically a missing 12v power to the ecu. But any defective ecu may do the same. Since the diagnostic system of the 928 is designed as a bus structure, a failure of one ecu can cause errors in communication to any other (perfectly good) ecu. The error typically reports like "@ERROR BLOCKLENGTH=0xfc" and "@ERROR 0xfc during transmission detected, expected EOM". These messages indicate data link interference of some sort. Resolve by unplugging all the ecu's and switch them on the bus one by one, thus identifying the problem maker.
- If you connect or disconnect the diagnostic system to your car while the engine is running you may experience stalling of the engine. This is caused by the many interrupts that happen when you slide the connector into place. The hundreds of triggers are just too much for the ecu's to handle and the ecu's will stop. You have to restart your engine to resolve. We recommend that the connector is inserted before starting the engine and removed when the engine is shut off.

## 2.6. Interface module lights

The 928 diagnostic system has three LED lights mounted in the box. The lights represent the following signals:

- Yellow: Speed. This is the output of the speed sensor mounted on the center-top of the flywheel. It flickers when the engine is running and is almost steady on when you are driving. When starting you should see the light flash slowly as the engine is turning very low rpm. Absence of the flashing light is a malfunction and will block the car from starting.
- Green: Check engine, warning signal from the ecu's reporting the MIL code. See next chapter for explanation.
- Red, for DT9xx series: Knock, the knock signal is shown by turning the led on. It lights up briefly, as the knock signal only exists for a very short moment.
- Red, for UDT999 series: Ignition on.

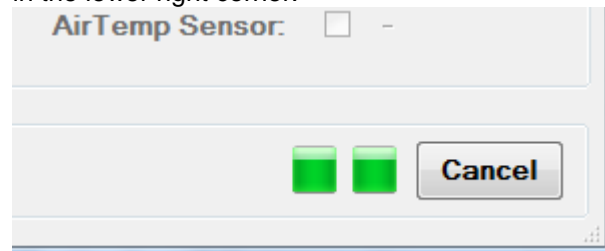


LEDs on DT9xx series (model 1).



## 2.7. Software indicator lights

The UDT999 software version starting v0201 shows two green indicator signals in the lower right corner:



The left indicator is 12v available in the interface. The 12v is supplied by your car over the diagnostics socket. It should always be on when ignition is switched on presuming the UDT communicates correctly to the PC.

The right indicator shows that the engine is running. It is derived from the engine rpm signal that the ecu provides.

## 2.8. 928 Check Engine code

The 928 has two ways of signaling fault conditions: using the check engine light (flashing) or via the bus communication (DTC codes). The “check engine” signal was the first possibility for automotive electronics to report trouble. The MIL (Malfunction Indicator Light) was introduced. From 1991 onwards, Californian legislation prescribes a warning lamp which lights up if a part relevant to the exhaust gas fails. The DTC code was then developed to provide this information and became part of the latter OBD (on Board Diagnosis) systems. In model year 1987 Porsche introduced the first DTC capable ecu’s in the 928s4 models.

Our software reports the DTC codes. You have a “check-engine” light on the interface module that also reports the flash code. Generally speaking, the check engine is the same code as the last two digits of the DTC code. Not all codes are communicated via the check engine feature.

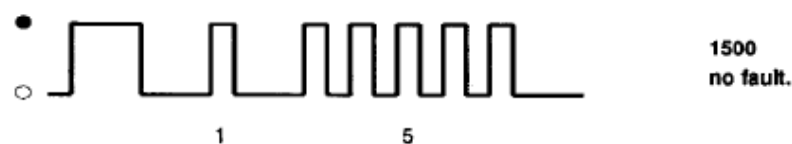
When powering on the interface module by switching on the ignition, the check engine may light up until the interface is connected with the controller. The ecu then controls the check engine light.

The interpretation of the flash signal is explained in the workshop manual vol 1a, page D24/28-29. A short summary:

As a function check of the warning lamp, it lights up when the ignition is switched on and goes out once the engine is running when this is started without depressing the accelerator. The warning lamp has a flashing code to indicate a defective fault path.

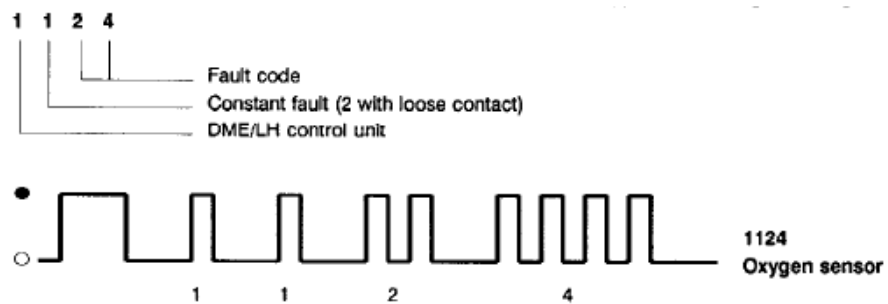
To trigger off the flashing code, fully depress the accelerator pedal with the engine off and the ignition on for 3 seconds until the Malfunction Indicator Lamp flashes. Then remove foot from accelerator. (Be aware: not all 928 models support this function)

If no fault is recorded, i.e. no warning came from the indicator light, there appears the flashing code



○ = Lamp-on ● = Lamp-off

If the warning light did indicate a warning, i.e. there is a fault, there appears a flashing code, e.g.



The check engine light can also be taken directly from the LH ecu pin 22. This is the signal linked to the MIL is presented in your 928 model. You can add a 12v LED to show it if required.

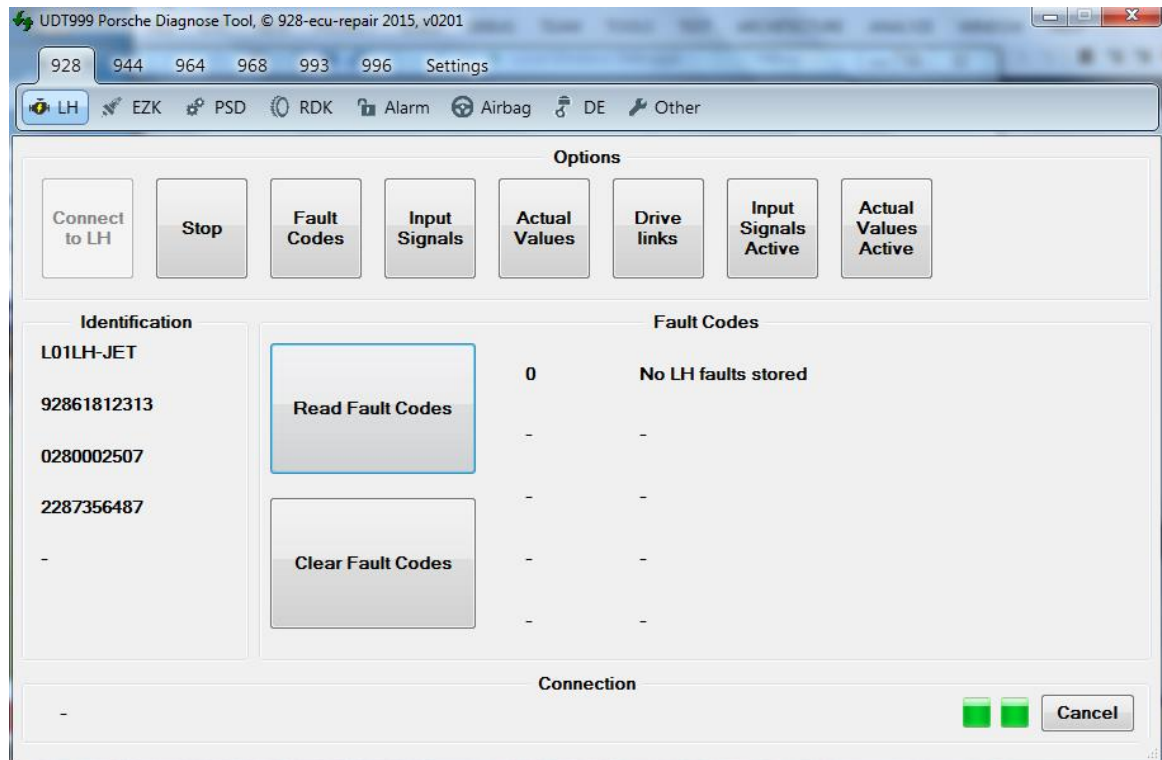
## 2.9. Safety issue

The diagnostic interface and software communicate with the controllers and are able to exercise functionality inside the controllers. It is also possible to start the engine, put the car in gear, and perform some tests while driving. This creates a serious risk. If the diagnostic test triggers the ecu to behave unexpectedly, a harmful situation can develop. Sound advice is to keep the car in neutral or park gear when the engine is running or drive in a safe environment. To avoid accidents, we strongly advise not to drive the car with a laptop on the passenger seat and watch the diagnostics while driving. Get help from someone to drive your car while you watch the diagnostics on the PC perform.

## 2.10. Multi Lingual version

The DT9xx and UDT999 system come in a multi lingual design starting version v178 onwards. This means that the settings tab offers functionality to change the language from English, French, German and Dutch. For the sake of clarity all screens in this manual are shown in English, but you will see in the settings chapter that you can change this to your own likings.

### 3. LH injection controller (928 series)



#### Introduction

The LH controller tab of the diagnostic software starts when the software is run for the first time. The LH controller is responsible for the fuel management in the 928 and takes care of injecting the correct amount of fuel through the injectors at the correct time. To be able to do this, the computer inside the LH module evaluates sensor readings from the MAF (airflow sensor), the Lambda (Oxygen sensor), the EZK (ignition module) and the Temp II sensor (engine temperature).

Interrogating the LH controller creates an extra load on the small CPU power inside the LH controller. Therefore, you will experience that the LH controller will have difficulties connecting when the engine is running. Unstable idle when the engine is running is normal behavior. The LH will stop working with the tool connected at approximately 2500rpm. The engine will stall. At standstill with ignition switched on you should not see any difficulties.

As mentioned before in §2.4, it is best to start the software prior to turning on the ignition.

The following is a brief explanation of functions and controls:

#### **Ignition light:**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

#### **Engine runs**

The right light turns green when the controller knows that the engine is running. This is just verification.

#### **Connect to LH**

When the command button is pushed the software tries to connect to the LH ECU, and tries to retrieve LH version, PCB number, Part number and Software version. All this information is stored in the firmware (software) of the LH controller. If all is o.k., the information will show in the appropriate fields in the screen. This is also verification that communication with the ECU has been established. The system is designed to retry 3 times if a failure to connect exists.

If it still failed to connect, the message "Cannot connect to LH, turn-off and -on the ignition and try again" appears.

These figures will show up on your screen depending on the model year of your car:

1987	S4	L00LH-JET	928.618.123.10	0.280.002.504	2287355832
1988	S4	L00LH-JET	928.618.123.11	0.280.002.504	2287355447
1988	CS/SE	??	928.618.123.12	0.280.002.506	??
1989/90	S4	L01LH-JET	928.618.123.13	0.280.002.507	2287356487
1989/90	GT/CS	L01LH-JET	928.618.123.14	0.280.002.506	2287356486
1991	S4	L01LH-JET	928.618.123.25	0.280.002.508	2287356877
1991	GT	L01LH-JET	928.618.123.26	0.280.002.509	2287356878
1992/95	GTS	L01LH-JET	928.618.123.30	0.280.002.514	2287357477

### Stop

This stops the communication with the LH controller. The Ack signal (bottom left sign) will stop flashing.

### Ack

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running, and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

### Fault memory: check faults

Using this button will interrogate and display the stored fault codes of the LH ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

Fault codes that may be presented by the 928 Diagnostics system are listed below. Additional information regarding DTC codes and troubleshooting can be found in the WSM, Vol. 1A, page. D 24/28-1 through D 24/28-29

*928 Fault Memory of LH control Unit*

<b>DTC Code</b>	<b>WSM Ref Page</b>	<b>Test Point</b>	<b>Description</b>
1_11	D 24-11	1	Power supply voltage too high/too low LH control unit
1_12	D 24-11	2	Idle speed contact (ohm) short to ground
1_15	D 24-12	2	Open circuit (ohms)
1_13	D 24-13	3	Full load contact (ohms)
1_14	D 24-14	4	Engine temperature sensor II (ohms)
1_21	D 24-15	5	Air Mass sensor
1_22	D 24-16	6	Idle speed control (V)
1_23	D 24-17	7	Oxygen regulation (rich)
1_24	D 24-18	8	Oxygen regulator Control (lean)
1_25	D 24-18	9	Oxygen sensor – Open circuit
1_31	D 24-19	10	Injection circuit shut down
1_41	D 24-19	11	Defective control unit

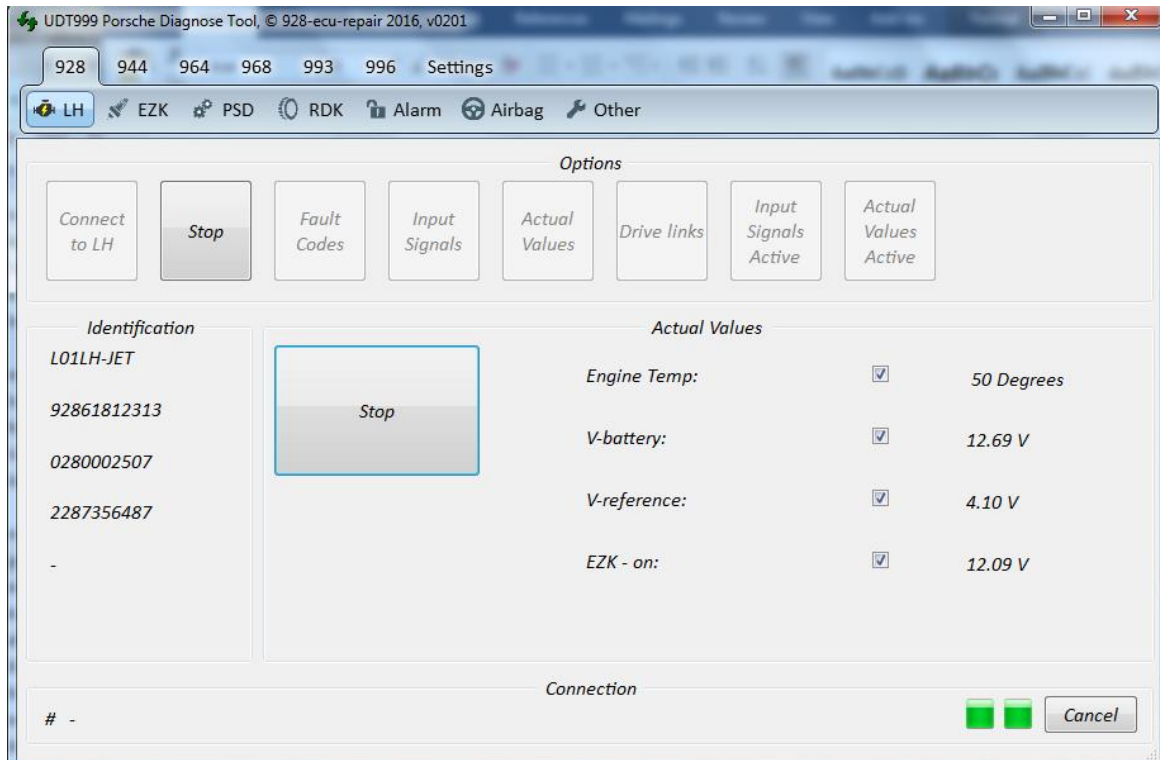
### Fault memory: clear faults

Using this button will send a message to the LH controller to clear all stored fault codes in the LH controller.

### Input signals

This button starts the checks of sensors and displays their current state by turning on or off the adjacent blue light:

- **Idle-speed drop.** This signal is required for the automatic transmission version of the 928. When the transmission lever is in any other than P or N position, a signal is sent to the controller that the idle speed should be lowered 100-200rpm to avoid overheating of the transmission oil. Therefore, the light should go on when the lever is in R-D-3-2 position and off in the P-N position.
- **Airco clutch.** This light signals that power is applied to the Freon pressure switch which feeds the power to the AC compressor clutch, and thus the compressor is actively running and driven by the engine drive belt. By pushing the AC button, the AC clutch is energized via the relay in the AC console. It feeds the evaporator freeze (ice) switch that connects through the pressure switch in serial with the clutch coil. The AC clutch signal that you see is read from the LH ecu electronics and represents the voltage between the ice/freeze switch and the low/high pressure switch. It is interconnected on the CEB. So, you will see this light go on if the AC button is pushed on, the console including the relay works, the freeze/ice switch is closed (no ice), and power is applied to the low/high pressure switch. If that one is closed too (no low pressure and no high pressure), the clutch engages. The high/low pressure switch is located on the side of the drier. The air conditioner compressor is switched off via this switch when reaching a pressure of approx. 27 bar or a lower limit of approx. 2.2 bar. (just to avoid confusion: there's also a high temp switch mounted on top of the AC dryer, but that only signals the cooling fans to go to full mode via the fan controller and is not part of the clutch system)
- **Airco on.** This light signals that the AC button on the dash is pushed and therefore the system is supposed to go active. It is however possible that other switches (like freeze or low pressure) prevent the system from going active. The signal AC on is read from the LH ecu and represents the voltage of the AC-relay output that feeds into the freeze switch. It signals only that you have the system is powered on.
- **Throttle full.** This light signals that the gas pedal has opened the throttle valve under the intake to its wide-open position and activated the micro switch at the valve (switch closed). This switch is also called the WOTS, the Wide-Open Throttle Switch. Worth mentioning is that WOT starts anywhere from about 2/3 to 3/4 throttle as far as the switch is concerned. If full load switch is faulty, always open, there will be no full load enrichment. If full load switch has a short circuit, enrichment will be too early and consequently fuel consumption too high. The ecu will also retard the ignition 10 degrees upon full throttle signal. There is a slight possibility that extensive full throttle operation, but without the switch closing, could result in engine damage on some earlier LH engines. Later engines have the knock sensors to help avoid damage, and the LH automatically enriches the mixture when it sees open throttle operation.
- **Throttle idle.** The light signals that the gas pedal is in idle position and the throttle valve under the intake is closed. This activated the micro switch (closed) at the valve. If idle speed switch has a break, there will be no coasting shutoff. Normally the Idle switch triggers fuel injection cutoff/resume at about 1200 rpm when the idle contact is made. If idle speed switch has a short circuit, there will be a single cut out at high idle speed. One additional note: the idle switch will move the ignition (EZK) to the idle map, 10° BTDC. To improve throttle response, the ignition is immediately advanced when the idle switch opens.



### Actual Values:

You can select each value you want to monitor by tagging the check box on the appropriate field. You can select more than one field if you'd like. Tagging many options at once however will slow down the update. A log file is created, and each field is presented in this log file. This makes importing it into spreadsheets or databases easy. By pushing the Values button, the process of acquiring the actual values is initiated, and it can be stopped by pushing it again. Each field is now discussed in more detail:

### Actual Values: Engine Temp

This value represents the engine temperature as seen by the ecu. The data is derived from the Temp II sensor which informs the ecu about the temperature and the required mixture enrichment to keep the engine run smooth when cold. The ecu picks up the signal from the double temp-II sensor (one part is LH and one is EZK) and feeds it into a analogue/digital converter. The output of that converter is shown on the screen. The value is depending on temperature conditions locally, but 15-30C is a normal value when cold. One thing that is remarkable but normal behavior: the temperature starts off at 75C or so, but as soon as the engine starts to warm up it calibrates to the correct value and gradually climbs up as the engine warms up.

### Actual Values: V-battery

This value represents the measured battery voltage. This is a more precise measurement than the gauge in the dash, as the ecu converts the operating value into a digital output. A typical value is 12.0 volt with engine off and 13.2 volt when the engine is running. A low voltage may cause the ecu to reset and cause erratic behavior.

### Actual Values: V-reference

This voltage represents an internal reference voltage which the ecu uses to precisely manage the fuel mixture. It is part of the lambda closed loop system. A typical value should be 4.00 volt. Any value which is substantially different will cause the system to deliver a wrong mixture and may cause engine damage, high CO values, as well as erratic behavior like severe idle surge and stalling.



**Actual Values: Ezk-on**

This voltage represents the signal that is sent from the EZK ecu to the LH ecu to switch it on. Remember that the EZK will have to be operational and ready before the LH will become active and is able to start fuel injection. Obviously, this signal needs to be active (12v approximately) or the LH will not work, and the engine will not start. The normal voltage is 12v and may differ a bit from the V-battery which you see on the same screen. As soon as the ignition is switched on and the tool is connected properly to the LH (communication running), You should see a 12v signal here.

**Drive Links:****Fuel tank Vent**

The 928 has a fuel tank breather system. This system prevents fuel vapor from escaping to open air. A carbon canister is part of this system and absorbs excess vapor. These filters have to be purged from time to time. The 928 has an automatic system for this. In order to meter the additional fuel quantity correctly that is drawn off from the carbon canister after evaporation has occurred, a solenoid valve is fitted in the line.

Operation: A diaphragm valve controlled by the throttle valve is located in the line off the carbon canister. This valve is operated by the LH ecu when the engine is at operating temperature. At idle, no vacuum is applied, and the valve is closed. When the throttle valve is opened, vacuum is applied at the diaphragm valve, causing the valve to open and allowing the gases to escape to the diaphragm valve. This valve is timed by the LH control unit with a frequency of 6 Hz.

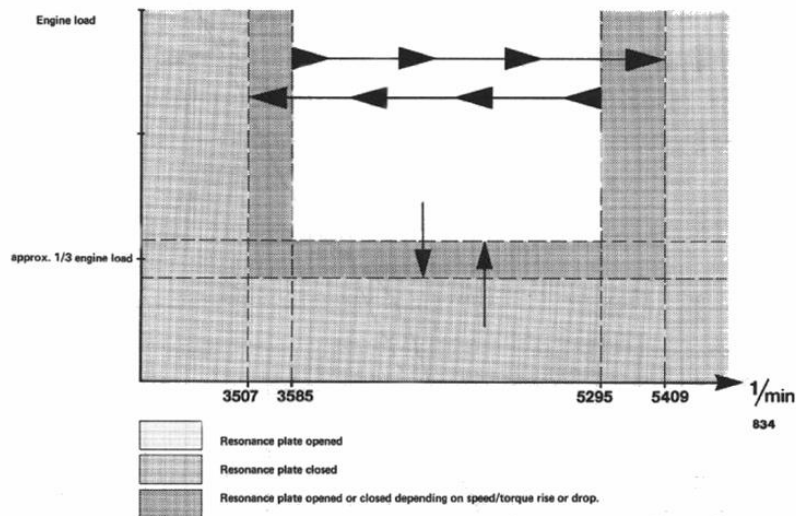
Similar to the trigger signal of the injection valves, the duration of this signal is dependent on the intake air flow rate. When the intake air flow rate is low, the tank ventilation valve receives only a short timer signal, when flow rate is high, the timer signal length increases. This ensures that the correct purge air quantity is added in accordance with the intake air quantity.

Testing this system is done by activating the switch. A faint click can be heard at the valve, just in front of the main windscreen washer tank. The test repeats itself every second until another function is selected.

**Resonance flap**

The V8 engine in the 928 is not using a balanced firing line a flat 6. Have a look at the firing order. This changes the airflow resonances in the intake. What you're aiming to do is match the natural frequency of the container, which in this case is the system of plenum and intake runners, to that of pistons (or the air charge within the cylinder) but also allowing for the valve timing. The Porsche 928 S4 uses a twin plenum set up connecting up equal phase cylinders. The twin plenum set up balance pipe is usually closed, acting as a twin plenum at low speeds, then opens in the mid-range only two become a twin plenum again about 3600 rpm.

The 928 S4, GT and GTS use a resonance flap in the intake manifold balance pipe. Between 3585 and 5409 rpm, the ecu activates the resonance flap. This changes the internal airflow in the "high rise" manifold. By doing this, the airflow is optimized for the lower and upper rpm ranges providing the linear power curve that the 928 is famous for. At 3585 rpm and 1/3 of the load signal, the LH controller sends a signal to a relay in front of the driver-side cylinder bank, which applies vacuum to a vacuum actuator located underneath the intake manifold. This will cause the "flappy" valve to turn 90 degrees. At 5409 rpm it closes again. To avoid oscillation, it has a configured hysteresis. Here's a picture:



A system functional test is performed by clicking on the button “Resonance Flap”. This action can be heard as a rather loud click in the intake body and seen when you remove the rubber cover on top of the intake manifold. It helps to make a marker on the axis of the flappy or attach a magnetic pointer. You will notice the axis of the flappy valve rotate 90 degrees. The test repeats itself every second until another function is selected.

Another test: the flappy is activated briefly, just once, every time the engine is started. You can verify this.

One thing to keep in mind: the actuator operates on vacuum from the vacuum booster. If the system has a severe vacuum leak, the vacuum contained in the system will diminish rapidly and leave the actuator inoperable. This is obviously not a fault in the actuator itself, but in the vacuum system.

Even despite of a running engine, there is sometimes not enough vacuum to engage the system when severe leaks in the system exist. The vacuum actuators in the dash are a commonly seen cause for these leaks. To check for a flappy actuator leak, attach the vacuum from the plenum directly to the flappy vacuum line (the one that goes under the intake from the vacuum relay in front of the coolant temp sensor). When actuated, pinch the supply hose (rubber) and thus remove the vacuum source. The flappy should hold position.

### Idle stabilizer

The 928 has an idle management system that provides a managed idle control by applying a bypass air stream over the closed intake valve. This is the IACV, the **Idle Air Control Valve**, sometimes also called the idle valve or the ISCV, Idle Speed Control Valve. At idle, the throttle idle switch is active, and the system knows it needs to take control of stabilizing the engine rpm at approx. 700. The LH ecu sends a signal to a rotary valve that opens the airflow in the valve-bypass hose. By modulating this 12v signal, the amount of air is regulated and thus the idle rpm is managed. Clicking on this button sends an impulse to the ecu to fully open and fully close the valve. A clear and loud click can be heard under the intake. This is proof that the valve opens fully and closes again after (spring loaded). The LH is unable to find out if the valve is really fully open as the valve is not equipped to provide electrical feedback. This audible feedback is your proof that it works. It should be a clear, regular sound, same pitch over and over. Hesitations could indicate that the valve gets mechanically stuck or doesn't turn smoothly. The device is operated electrically and does not require vacuum. The test repeats itself every second until another function is selected.

### Fuel injectors

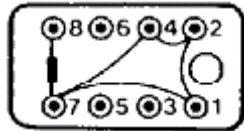
The fuel injectors of the 928 are a multi-point - single control setup. The LH ecu fires all injectors at the same time during normal operation, as one batch. This creates a fuel mixture in the intake cavities that is sucked in during intake when the intake valve opens. When you use this function, all injectors are triggered. At the engine, all eight injectors make a clicking sound simultaneously. It helps to put a screwdriver on a specific injector and put your ear on the screwdriver to listen to the clicks and verify that the injector coil opens the needle to inject fuel. The test repeats itself every second until another function is selected.

### Input signals active

This area is only active when the tool is connected to the LH while the engine is running. Some considerations: the LH experiences difficulties communicating to the diagnostic system and managing the engine properly. This results in over-fueling the engine which causes very rough running and even stalling. This is ok for a short period of time but should be considered bad when doing this for more than 3 minutes continuously. The catalytic converter may become red-hot by the unburned fuel in the exhaust. Be aware of this!

⇒ **Note:** on cars starting 1989 you need a special modification of the interface to perform connection to the LH when the engine is running. Otherwise no LH connection can be made when the engine runs. Please contact us for details. In DT928 systems supplied after May 2008 this modification is already included.

**Coding plug.** This on/off signal is taken from inside the LH ecu and reports what the ecu sees. It is set by the coding plug, externally from the ecu. Failure to show the correct reading may be related to a defective ecu or a wrong coding plug. (I've also seen a coding plug pushed in reversed. The locating pin between 1 and 2 had broken off)



- L-line: is the L-line activity
- Coding 2: this is active on all cars
- Coding 6: this is active on ECE non CAT, coding plug 928.607.431.00 (manual) or 928.607.432.00 (automatic)

### Actual values active

This area is only active when the tool is connected to the LH while the engine is running. Some considerations: the LH experiences difficulties communicating to the diagnostic system and managing the engine properly because of the limitations of the old microprocessor in the LH ecu. The result is over-fueling the engine which causes very rough running and even stalling. This is ok for a short period of time but should be considered bad when doing this for more than 3 minutes continuously. The catalytic converter may become red-hot by the unburned fuel in the exhaust. Be aware of this!

**Note:** on cars starting 1989 you need a special modification of the interface to perform connection to the LH when the engine is running. Otherwise no LH connection can be made when the engine runs. Please contact us for details. In all (U)DT systems supplied after May 2008 this modification is already included.

- **MAF.** This is the actual output of the Mass Airflow Sensor (also called LMM which is abbreviated from the German Language) as evaluated in real time by the ecu. Based on this information the ecu manages the fueling. The function can be activated by flagging the checkbox. The actual value is shown

in the adjacent field and also a bar-graph is shown to visualize. Any too high or too low MAF reading indicates a problem, but not necessarily a defective MAF sensor. Further troubleshooting is required. Here's a small table of what is considered to be a normal reading:

<b>RPM</b>	<b>MAF 928S4</b>	<b>MAF 928GTS</b>
675		0,16 volt
800	0,31 volt	0,35 volt
1000	0,45 volt	0,55 volt
1200	0,57 volt	0,73 volt
1400	0,71 volt	0,88 volt
1600	0,84 volt	1,02 volt
1800	0,96 volt	1,14 volt
2000		1,35

Be aware that a 4.7L, 5L, and 5.4L have different volume at displacement at the same rpm. There are two possible problems. The sensor output gets out of spec, which causes the engine to perform badly, or the sensor breaks down completely (like a broken sensor wire). If the hot wire inside the MAF fails it gives two pre-set fuel injector opening times- 3.5milliseconds when the engine speed is less than 2000rpm, and 6.3mS when the engine speed is over 2000rpm. Because this is a crude approximation the car will run rich or lean, but it's good enough to drive the car to a workshop.

Checking the MAF sensor:

Connections 6 and 9: Specification: 200 - 400 ohms

Connections 6 and B Specification: 130 - 260 ohms

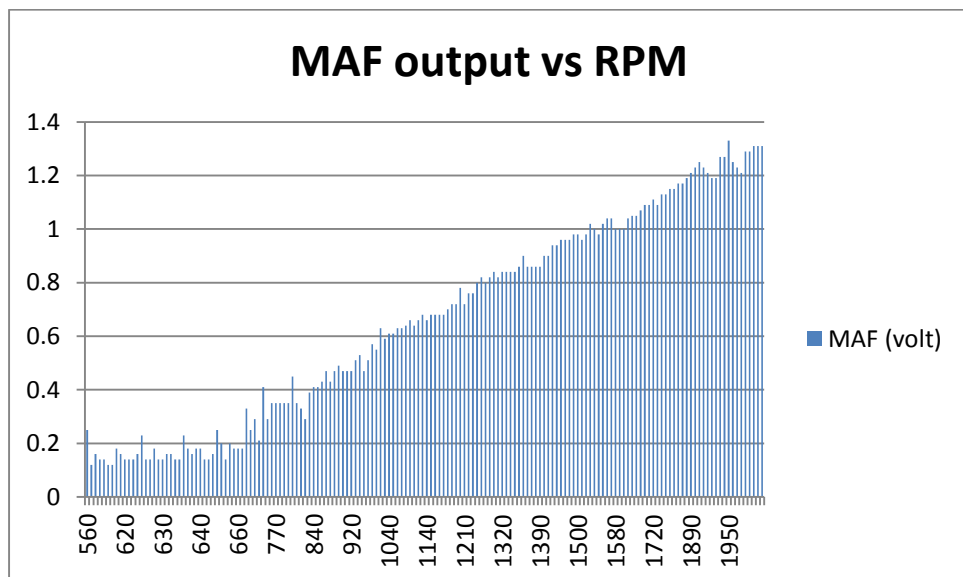
Connections 8 and 9 Specification: 70 - 140 ohms

Connections 6 and 7 Specification: 40 - 300 ohms

Connections 7 and 8 Specification: 100 - 500 ohms

Connections 27 and 6 Specification: 2 - 3 k-ohms at 20 °C / 68 °F

- **Rpm:** This is the actual output of the Mass Airflow Sensor as evaluated in real time by the ecu. Based on this information the ecu manages the fueling. The function can be activated by flagging the checkbox. The actual value is shown in the adjacent field and also a bar-graph is shown to visualize. Since it is possible to log both MAF output and Rpm output (both made active) you can make a graph of the data found in your log file. It should look similar to this graph from my GTS when you present it in Microsoft Excel:



- The LH ecu will not cope with managing higher rpm's while communicating over the diagnostics interface, so it is advised to only test this to about 2000 rpm. Be aware that this graph is for a GTS which is 5.4L. An S4 or GT will have slightly lower values. **Oxy.** This is the actual output of the O2

(Lambda, Oxygen) sensor. Based on this information the ecu manages the fueling. The function can be activated by flagging the checkbox. The actual value is shown in the adjacent graph. It shows 3 states: R, I, and L. "R" is the Rich fueling state, "L" is the lean state. The "I" state is the "inactive" state. This happens when the O2 sensor is warming up (or defective). After about 15 seconds it should be hot and start to operate. While driving the car it will normally switch from Lean to Rich state in a frequency of 3Hz. When idling the frequency may become 1Hz (1x per second switch from R to L). This is how it operates when the diagnostic system is not connected to the ecu.

**However:** due to the limitations of the LH ecu you will not be able to see this behavior completely. As stated before, the LH has difficulties managing both communication and managing the engine, which results in seriously over-fueling the engine, causing a fluctuating idle rpm. The reading of the Oxy will almost always show Rich (R). There're two things you can do to verify the O2 sensor operation:

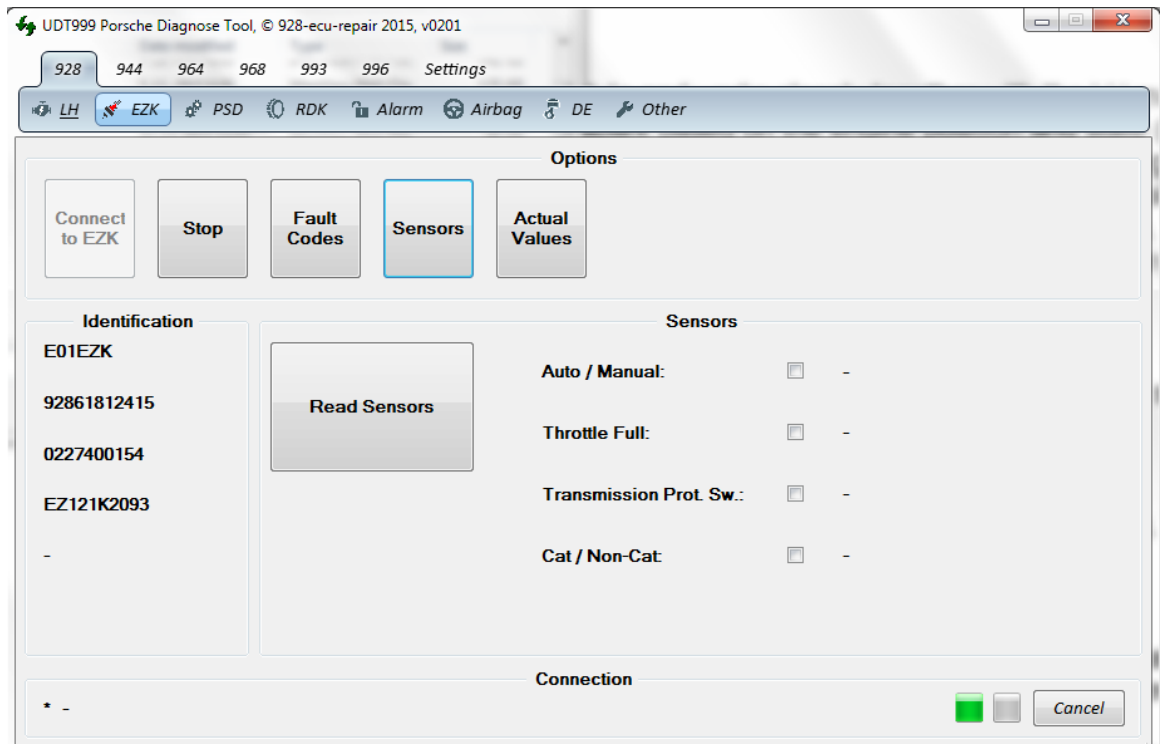
- See that the warm up cycle goes from (I) to (R) in about 15 seconds. Failure to do so will make the ecu stay in open-loop operation, and thus it will never adjust the fuel mixture to the optimum value (Stoichiometric Combustion).
- Push the gas to maybe 2000 rpm and then suddenly lift the gas pedal. The engine will cut fuel which will result in lean condition. As soon as the engine starts fueling it will get rich again.

- **Coding 4 and coding 8**

Coding 4 and coding 8 refer to values taken from the coding plug. Unlike the other coding values these are variable signals and the values are the actual voltages as seen by the ecu analog-digital voltage converter.

- Coding 4: this is active on all cars, and should read a voltage of about 0.16 volt
- Coding 8: This value is related to resistor in a CAT equipped 928 and from the CO potentiometer in a non-CAT 928. This is active when the 150 ohms resistor is in, on all cars except ECE, so CAT equipped cars with coding plug 928.607.438.00, 439.00, 440.00 and 441.00 The normal value you will see is 0.7- volt

## 4. EZK ignition controller (928 series)



### Introduction

The EZK is the ignition module and works closely together with the LH module. Its task is to provide a spark based on the engine position and state (temperature, load, etc.). It is capable of learning the characteristics of the engine and adapting itself to these conditions. Another nice feature is the capability to adjust to differences in fuel quality by adjusting the timing of the ignition. The following functions and controls are common with the EZK tab on the diagnostic tool:

### **Ignition light:**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

### **Engine runs**

The right light turns green when the controller knows that the engine is running. This is just verification.

### **Connect to EZK**

When the command button is clicked on the software tries to connect to the EZK ecu and retrieve EZK version, PCB number, Part number and Software version. All this information is stored in the firmware (software) of the EZK controller. If all is o.k. this information will show in the appropriate fields in the screen. This is also verification that communication with the ecu has been established. The system is designed to retry 3 times if a failure to connect exists. If it fails to connect after three tries then the message "Cannot connect to EZK, turn-off and -on the ignition and try again" appears.

These figures will show up on your screen depending on the model year of your car:

1987	S4	??	928.618.124.10	0.227.400.035	??
1988	S4	E00EZK	928.618.124.11/12/14	0.227.400.035	EZ121K2062
1988	CS/SE	??	928.618.124.13	0.227.400.043	??
1989/91	S4	E01EZK	928.618.124.15	0.227.400.154	EZ121K2093
1989/91	GT/CS	E02EZK	928.618.124.22	0.227.400.164	EZ121K2182
1992/95	GTS	E01EZK	928.618.124.30	0.227.400.197	EZ121K2218



**Stop**

This stops the communication with the EZK controller. The Ack signal (bottom left sign) will stop flashing.

**Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When the engine is running, and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the EZK ecu. Additional information regarding DTC codes and troubleshooting can be found in the WSM, Vol. 1A, page. D 28-1 through D 28-15

*928 Fault Memory for EZK Control Unit*

<b>DTC Code</b>	<b>WSM Ref Page</b>	<b>Test Point</b>	<b>Description</b>
2_12	D 28-5	1	Idle speed contact (ohms ) ground short break
2_13	D 28-6	2	Full load contact (ohm ) ground short
2_14	D 28-7	3	Temperature sensor II (ohm )
2_15	D 28-7	4	Idle or full load contact
2_21	D 28-7	5	Load signal
2_26	D 28-7	6	Transmission protection switch (automatic transmission only)
2_31	D 28-8	7	Knock sensor I (front of engine)
2_32	D 28-9	8	Knock sensor II (rear of engine, air filter side)
2_33	D 28-9	9	Control unit (knock sensor)
2_34	D 28-9	10	Hall signal change
2_33	D 28-10	11	Control unit faulty

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the EZK ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

**Sensors**

This button triggers the adjacent fields to be updated real-time. You can select each value you want to monitor by tagging the check box on the appropriate field. You can select more than one field if you'd like. Each function is explained separately:

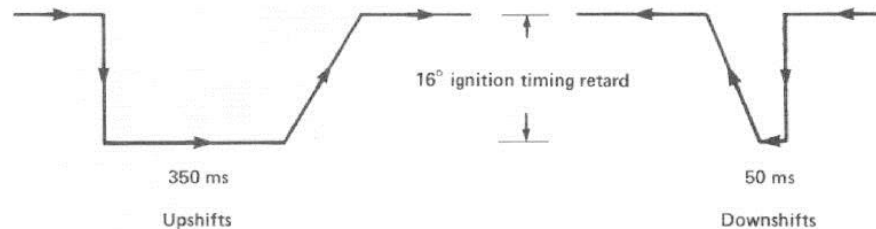
**Throttle full**

The 928 has a throttle position switch, which reports to both LH and EZK the throttle valve position. If the throttle is fully open the signal light turns on. This is also called the WOT position.

**Trans Protect**

When a 928 has an automatic transmission (for 1987 models onwards), the "Automatic Transmission Protective Circuit" is implemented (called "transmission protect" here). Since the engine generates a very high torque which has to be absorbed by the shift elements in the automatic transmission while shifting, the torque has to be reduced for the shifting from 1<sup>st</sup> into 2nd and 3rd gears when making very high partial load or full load shifts at an engine speed of more than 4000 rpm. Therefore, a considerable reduction of engine power for fractions of a second during up shifts 1 to 2 and 2 to 3 as well as down-

shifts 3 to 2 and 2 to 1. The information is used by the EZK to temporarily retard the ignition timing by 16 degrees to prevent damage to the transmission gears when switching under load. Normal ignition timing value is reached again within one second.



For this purpose, the holder of brake band B1 has a switch, which puts out information to the EZK control unit both while opening and closing. The ignition timing is retarded 16 ° for 350 ms immediately after receiving this information, which in turn reduces the engine torque by approximately 25 %. Afterwards the ignition timing is advanced in steps within 150 ms to the original ignition timing value. When downshifting under load there will be the same torque reduction, but only for 50 ms. Should the switch in the transmission be detected as being faulty, quick speed changes, as occurring during shifts, will also cause retarding of the ignition timing (emergency run program).

A normal situation would show the light illuminated only when the transmission is in second gear. The transmission protection switch must close while changing from first to second gear (Display < 1 Ohm, closed) and open when changing from second to third gear (Display infinite Ohm, open). The transmission protection switch must also close when changing down from third to second gear and open when changing down from second to first gear. The EZK triggers on the transition of the signal, not on the state of the signal.

One more remark: the transmission protect switch is a pressure switch. It operates based on fluid pressure in the transmission. So be aware that it needs the engine to run, drive the transmission fluid pump, and generate fluid pressure in the transmission.

### **Coding**

The 928 has a coding information plug which tells the EZK what type of car it is fitted to and what configuration is required. The coding information is shown in two boxes. It will show if this is a car with automatic or manual transmission. Automatic cars have idle speed reduction and retard ignition during 2<sup>nd</sup> to 3<sup>rd</sup> automatic gearshift to avoid damage. You will see this feature in the LH screen, but the coding plug will also have to inform the EZK about the transmission type. The second box will show if the car is equipped with a catalytic converter or not, and for what area in the world the car is preset.

### **Actual Values:**

You can select each value you want to monitor by tagging the check box on the appropriate field. You can select more than one field if you'd like. Tagging many options at once however will slow down the update. A log file is created, and each field is presented in this log file. This makes importing it into spreadsheets or databases easy. By pushing the Values button, the process of acquiring the actual values is initiated, and it can be stopped by pushing it again. Each field is now discussed in more detail:

### **ECTS**

ECTS is the **E**ngine **C**oolant **T**emperature **S**ensor. This sensor is located in the coolant stream, just above the water pump, slightly to the passenger side of the engine (LHD). This NTC sensor has a resistance that varies with the temperature of the coolant. This signal is transferred to the EZK and tells the controller how hot the engine is. This information is required to adjust ignition timing. The sensor is basically a double sensor, and the second part informs the

LH controller about the engine temperature. A normal operating temperature reading is 85C, but it should be within the 80-90 degrees Celsius range. This temperature value is shown in the box next to the button. A blue bar-display to the right helps put the value into perspective of the allowed range.

When starting the engine and immediately connecting to the EZK, pushing the ECTS button and looking at the reading, you may see the calibration process of the ecu. It starts at approximately 60, quickly in about 15 seconds increasing to 255, and then switching to operating mode showing the correct reading of the actual temperature in degrees Celsius, which should gradually increase from maybe 15 to about 80.

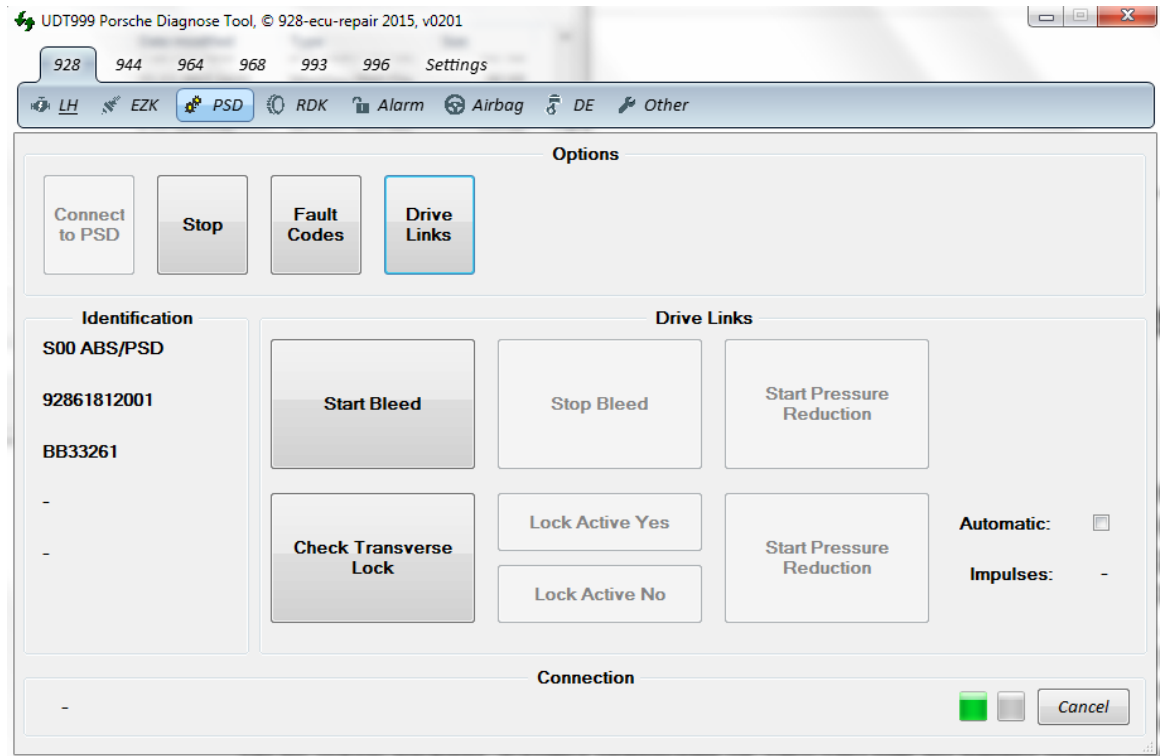
### **RPM**

This tells the EZK how many revolutions per minute the engine is making at the moment. The sensor is located at the back of the engine and uses a hall sensor to detect a marker on the flywheel. This signal is transferred to the EZK and the information is required to adjust ignition timing. A normal idle rpm is  $675 \pm 25$  for a S4 or GTS,  $775 \pm 25$  for a GT. The value is shown in the box next to the button. A blue bar-display to the right helps put the value into perspective of the allowed range.

### **LOAD**

This tells the EZK how much load the engine has to cope with. It is a signal derived from the LH controller and expressed in nanoseconds. The signal is derived from the MAF sensor data and Rpm. The load signal varies with the load on the engine. A value of 70  $\mu$ Sec to 80  $\mu$ Sec at idle speed is normal. The load will increase when you blip the gas or put the engine in gear, moving off. The actual value is shown in the box next to the button. A blue bar-display to the right helps putting the value into perspective of the allowed range.

## 5. PSD Porsche Slip Differential (928 series)



### Introduction

All 928 models starting manufacturing year 1990 are equipped with the electronically controlled Porsche Slip Differential. This slip differential is designed to partially lock and unlock the drive wheels under heavy load. Unlocking is to be understood as disconnecting the drive axles from each other so that power moves from one wheel to the other. This locking ranges from 0 to 100%. A hydraulic slave cylinder on the side of the transmission case is activated by a high-pressure hydraulic system based on requirements. A 3-ton hydraulic pressure compresses the 20 pieces of transmission friction plates to achieve up to 100% locking. Expect pressures of 140-180 bar so safety measures apply when working on the PSD unit. You will find the system fitted in the rear left wheel well after removing the cover plate.

### What it does

It works like this: when the controller detects that the car is moving, and the rear wheels are spinning in relation to the front wheels it is all ok and the system is in rest. But when one of the rear wheels shows excessive revolutions compared to the other wheel a single wheel spin is detected and power is moved to the other wheel to compensate. Also, a potential traction problem at higher speeds is detected, especially in fast curves. There are ranges that the PSD works on:

#### 1. Traction control while moving off.

Pressure depending on wheel acceleration is building up in the transverse lock when the control unit recognizes a slip of a wheel through comparison of the wheel speed values. System pressure is increased in steps, until the slipping wheel again rotates in the permitted speed range and then held constant in a predetermined minimum time. Pressure build up depends on wheel acceleration, in other words: pressure build up happens faster when acceleration is fast. Pressure is dropped in small steps.

## 2. Acceleration from driving in curves

The driven wheel on the inside of the curve tends to slip and propulsion is reduced when driving in curves with high transverse acceleration. A locking torque depending on the vehicle's acceleration, road speed, and recognized curve is introduced to prevent this.

## 3. Ferraria effect (accelerator pedal released in curve)

Rear wheel driven cars tend to oversteer when the pedal is released suddenly while driving in a curve. Oversteer can be reduced considerably through application of correct locking torque.

To be able to perform well the PSD relies on information provided by the ABS sensors and the acceleration sensor. The transverse acceleration sensor is mounted under the driver seat to indicate transverse vehicle acceleration.

For those of you who are looking for the PSD controller box it is a separate PCB inside the ABS controller.

## Flushing and bleeding the PSD system.

The PSD system operates on DOT4 brake fluid, and due to hygroscopic effects of the fluid it needs to be replaced every two years. When replacing hydraulic fluid, the system you must bleed the system to remove any old fluid and air trapped in the system. WSM page D 39-202d explain the process. It does not describe the flushing however. A practical approach is as follows:

1. Carefully clean the reservoir, and both bleed valves.
2. Remove as much fluid as possible from the reservoir.
3. Attach bleed hose to the valve on top of the actuator solenoid.
4. Fill up fluid reservoir. Always avoid sucking in air.
5. Turn on ignition to build up pressure, pump stops when ready.
6. Turn off ignition, pressure remains in the system.
7. Gently open bleed valve and let fluid escape.
8. Close bleed valve.
9. Repeat from step #4 to fill up reservoir until 0.3 L is replaced.
10. Then use the tool and the bleed process to purge and bleed the high-pressure line and the slave cylinder.

## **Diagnostic system PSD functions and controls:**

### **Ignition light**

If 12v is supplied through the car (ignition switch turned on) the light will show red and signals that the system is ready to accept commands.

## **Connect to PSD**

When the command button is pushed the software tries to connect to the PSD ecu, and tries to retrieve PSD version, RB number, and Part number. All this information is stored in the firmware (software) of the PSD controller. If all is o.k. the information will show in the appropriate fields in the screen. This is also verification that communication with the ecu has been established. The system is designed to retry 3 times if a failure to connect exists. After three tries the message "Cannot connect to PSD, turn-off and -on the ignition and try again" appears.

The PSD is a controller which is designed to work with diagnostics only when the engine is not running, so when ignition is merely switched to on.

These figures will show up on your screen depending on the model year of your car:

1990/95	S4/GT/GTS	S00 ABS/PSD	928.618.120.01	BB33261

## **Stop**

This stops the communication with the PSD controller. The Ack signal (bottom left sign) will stop flashing.

**Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the PSD ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

Additional information regarding DTC codes and troubleshooting can be found in the WSM, Vol. 3 page. D 39-201 through D 39-260 and Vol 4 page 45-08 through 45-10

*928 Fault Memory for PSD Control Unit*

<b>DTC Code</b>	<b>WSM Ref Page</b>	<b>Test Point</b>	<b>Description</b>
11	D 39 230	1	Transverse lock valve
12	D 39 232	2	Transverse acceleration sensor - Short/Open circuit
13	D 39 233	3	Transverse Acceleration sensor faulty
14	D 39 234	4	Regulating tolerance - transverse lock
15	D 39 235	5	Control unit
21	D 39 236	6	ABS speed sensor front left
22	D 39 237	7	ABS speed sensor front right
23	D 39 238	8	ABS speed sensor rear right
24	D 39 238	9	ABS speed sensor rear left
31	D 39 240	10	ABS valve front left
32	D 39 240	11	ABS valve front right
33	D 39 240	12	ABS valve rear axle
34	D 39 241	13	Valve relay
35	D 39 245	14	Return pump

Note on PSD and ABS sensor failures: the PSD/ABS ecu is responsible for feeding the ABS speed sensor signal to the RDK via pin 10,12,16,and pin53. Failure of the PSD will cause a RDK error too. Furthermore, the front left ABS sensor output (#16) is used for vehicle speed on model 1991/1992, which changed to rear left sensor (#12) in model 1993. So expect to see these things related to each other.

Note: the PSD will see a difference in wheel diameter front to rear (not standard tires or wheels) as a difference in speed. A structural difference will be cause for the PSD to shut off. One strange thing is that the PSD does not log such a condition as an error.

Note: (yes, one more)... the ABS sensor needs to be electrically isolated from chassis ground. If the sensor wires or internals touch ground the ABS/PSD will shut off. Corrosion of the sensor may cause this, and strangely enough there will be no error in the log. Check the sensors by measuring internal resistance and resistance to chassis. A normal value on the disconnected terminals is 1024 ohms, and infinity to chassis ground.

**Fault memory: clear faults**

Using this button will send a message to the PSD controller to clear all stored fault codes in the PSD controller.



**Bleed: start**

The PSD has two bleed valves. Here is a short description of the fluid renew and system bleed process.

1. remove the rear left wheel
2. remove the wheel arch liner or the cover plate at the rear (depending on manufacturing year of your car)
3. clean the PSD reservoir and cap
4. remove cap and inner filter
5. use a suction to remove all fluid from the reservoir
6. put in new fluid in reservoir
7. locate the bleed valve on top of the pressure valve
8. attach a hose on the bleed valve and open the valve
9. switch on ignition, notice the PSD pump adding more fluid.
10. close valve when new fluid reaches the hose
11. attach a hose on the bleed valve just above the PSD line
12. open the slave bleed valve at the right side of the final drive
13. turn on ignition and bleed the slave cylinder using the diagnostic system (details follow in next paragraph)
14. close bleed valve when fresh fluid reaches the drain hose
15. fill up reservoir, check for leaks and close up

The diagnostic system takes part in bleeding the slave cylinder of the PSD. To start the bleeding process:

- Turn on ignition. When ignition is turned on the pressure pump builds up a pressure of 180 bar in the pressure reservoir and then cuts out.
- Connect the tool to the PSD ecu
- Open the bleed valve on top of the PSD slave cylinder.
- Push the start button. This will send a message to the PSD controller to clock (pulse) the lock solenoid valve and allow fluid to escape from the bleeding valve. After 25 seconds the ecu will start pulsing the lock solenoid which will pulsate fluid into the hydraulic system. The hydraulic pump will build up pressure as soon as the pressure in the pressure reservoir drops below the threshold. You absolutely need to keep an eye on the reservoir and make sure it stays filled to avoid sucking in air. It uses up fluid quite rapidly. You can stop and restart then process any time.
- When you see no more bubbles of old fluid coming from the drain hose, you can close the valve. Make sure you prevent air sucking back into the system. I personally close the valve while the system is bleeding.

**Bleed: stop**

Using this button will stop the bleeding process. The bleeding valve then needs to be closed now. If possible, close the valve while bleeding. The ecu stops sending messages to the solenoid to bleed the system.

**Bleed: reduction**

This is the last step of the bleed process. Using this button releases the pressure from the hydraulic system and the transverse lock will be released. The status will be shown in the additional information box. Close the fluid reservoir cover now. Best is to check for any PSD fault messages in the controller, reset them if present, perform a test drive, and check again for faults.

**Transverse lock: check**

The pressure build up procedure for the transverse lock is started when the button is pushed and increments in steps by pressing again. The number of impulses is shown in the adjacent box. This test enables you to test the partial-locking capabilities of the PSD. You will hear a clear clack-sound from the PSD, which will change in pitch when you have reached the PSD limit. This normally happens when the counter is at 6 pulses. If possible, you should test the actual locking of the final drive by trying to turn the wheels or on a test rig. The Transverse lock check is limited to 20 pulses as this should give a full lock.

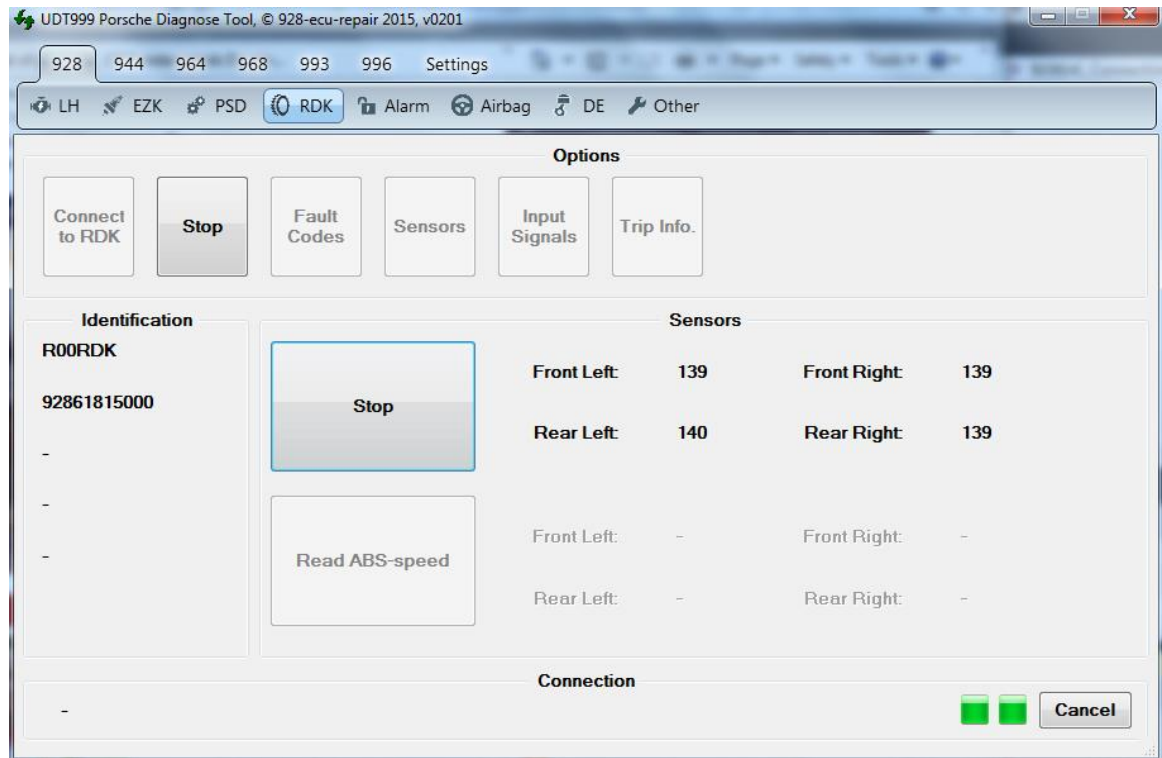
**Transverse lock: reduction**

Using this button will release the pressure in the transverse lock. The status will be shown in the additional information box.

**Transverse lock: automatic**

This is a neat testing feature. The transverse lock buttons are used to manually operate the lock, but there is also an automatic feature implemented like the earlier Hammer has. If this check box is checked, the transverse lock automatically engages to a full lock and the user is instructed on the screen to turn the wheels and verify the lock. Obviously, this requires the car to be lifted at both rear wheels simultaneously.

## 6. RDK tire pressure controller (928 series)



### Introduction

The RDK is short for the German term **R**eifen **D**ruck **K**ontrolle. This is the tire pressure monitoring system and consists of sensors mounted in the wheel rims that function as pressure switches, and High Frequency senders, mounted at the wheel hub assembly. The HF senders produce a High Frequency signal for the pressure switches to operate. Diaphragm switches mounted in the wheel rim pass the HF sender when the wheel turns, and inductive coupling is established.

The diaphragm of the pressure switch mounted in the wheel rim acts as part of an oscillation circuit when the switch is closed. Low pressure will open the switch, and the oscillation circuit is inactive.

Current flows in the pressure switch oscillating circuit are detected by the sender as a load and generate a pulse signal to the RDK.

The information is fed from the RDK to the instrument cluster and shows which wheel is causing a low pressure or pressure loss warning.

The RDK controller comes in different versions. You will see a version R00RDK, R01RDK or R02RDK in the version box. Typically, the R02RDK sends more fault code messages to the diagnostic system. From control unit version 02 (introduced in the 1991 model year) on, the RDK control unit contains an event memory that stores data on any pressure loss events at one or more tires during the last 8 journeys made by the vehicle. It also indicates the road speed at which the event occurred, and whether either one or two pressure-sensing switches were open. This event memory permits conclusions to be reached regarding unnatural pressure losses at one or more wheels. A journey starts when you turn on the ignition. The tool displays events starting from the most recent down to the oldest, and every new event deletes the oldest one from memory.

The startup of the RDK unit is somewhat special. Upon turning on the ignition, the RDK starts by performing a self-test and instrument cluster lamp test. The lamp goes out when you start the engine. Then after driving at least 20 meters

at 5 km/h speed, the RDK enables its active mode and starts to monitor the pressure sensors.

To be able to see that car move, the RDK uses the ABS sensor pulses to determine the wheels turning. This also serves as an interesting way to check the ABS sensors via the RDK. This is pretty special since the ABS itself is not able to do this. The PSD is only able to log an error, no real time data, but the RDK reports the output of the ABS sensors in real time.

The RDK has a temperature compensation, as pressure is related to the tire temperature. Pressure rises 0.1 bar per 10C. However, it can happen that severe temperature drops trigger an alarm. An alarm can also occur at very high speeds, as the air gets pushed to the outside of the tire by the rotational speed. Increase the pressure with 0.3 bar and make pressure on opposite sides equal. It is important to drive the car without pressure alarms and do repairs if the correct pressure does not resolve the problems. Do not over inflate the tire. The correct procedure is to inflate the tire that triggers the alarm by 0.5 bar above the required value and watch for any more warnings. If warnings still appear you need repairs.

Always make sure that the tire pressure is the same on opposite side.

**\*\*note:** when you lift the car on all 4 wheels, don't get confused by misinterpreting the data. Both rear wheels will turn at the same time, causing sensors on both to produce on-screen results. The front wheels are independent.

Overview of RDK controls and functions:

#### **Ignition light:**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

#### **Connect to RDK**

When the command button is pushed, the software tries to connect to the RDK ecu and to retrieve RDK version, and Part number. All this information is stored in the firmware (software) of the RDK controller. If all is o.k., the information will show in the appropriate fields in the screen. This is also verification that communication with the ecu has been established. The system is designed to retry 3 times if a failure to connect exists. If the 928 is equipped with an electronic dash, a warning will be shown on the dash that the RDK system is switched off. This is normal behavior. As soon as the diagnostic system disconnects from the RDK the display will be restored. If it still fails to connect, the message "Cannot connect to RDK, turn-off and -on the ignition and try again" appears.

These figures will show up on your screen depending on the model year of your car:

1990	S4	R01RDK	928.618.150.01
1991/92	S4/GT/GTS	R02RDK	928.618.150.01

The RDK was **M482** option in the 1989 model

#### **Stop**

This stops the communication with the RDK controller. The Ack signal (bottom left sign) will stop flashing.

#### **Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When the engine is running, and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*\*' will flash visible.

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the RDK ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears.

Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

Additional information regarding Fault codes and troubleshooting can be found in the WSM, Vol. 4 page. 44-301 through 44-314

*928 Fault Memory for RDK control Unit*

<b>Fault Code</b>	<b>WSM Ref Page</b>	<b>Description</b>
1	44-306	HF sending unit - rear left
2	44-307	HF sending unit - rear right
3	44-307	HF sending unit - front left
4	44-307	HF sending unit - front right
5	44-307	ABS speed sensor - rear left
6	44-308	ABS speed sensor - rear right
7	44-308	ABS speed sensor - front left
8	44-309	ABS speed sensor front right
9	44-309	RDK warning light – Combi-Instrument
10	44-309	Wiring harness/data RDK to Combi-Instrument
11	n/a	Power supply
18	44-309	Data line - interruption – not present

Note: there is another fault code 18 for RDK as per the WSM, but it is not a real code; it is reported even though no underlying fault condition exists. This condition is a falsely reported error code (pg 44-305) that can be ignored and cleared.

Note on RDK and ABS sensor failures: the PSD is responsible for feeding the ABS speed sensor signal to the RDK via pin 10,12,16,and pin53. Failure of the PSD will cause a RDK error too. Furthermore, the front left ABS sensor output (#16) is used for vehicle speed on model 1991/1992, which changed to rear left sensor (#12) in model 1993. So, expect to see these things related to each other.

**Fault memory: clear faults**

Using this button will send a message to the RDK controller to clear all existing fault conditions from memory.

**HF Sending unit**

The 928 has a High Frequency sending unit at each wheel and the signal at these senders can be checked by pressing the button. A reading of approximately 125-150 will be displayed for each sensor, which is ok. The reading may vary a little when turning the wheel. Wheels are identified as Front Left, Front Right, Rear Left, Rear Right, as seen from behind the car.

**ABS speed sensors**

The test button will activate the ABS pulse detection at each wheel and by turning the wheels you should see the value increment with wheel speed. The reading is per wheel and when driving a straight line, both front sensors and both rear sensors should end up at approximately the same reading.

Testing the RDK can be done at standstill, on a lift, jack, or when slowly driving. If you drive slowly you can see the ABS signal going into higher readings resulting from the wheel speed. The reading will be about 10 to 12 when you drive the car at idle rpm and go up to 20 when driving about 30 km/h. The RDK will stop communicating with the diagnostics when exceeding approximately 35km/h. This is likely a safety feature of the RDK, which is not documented in manuals.

**Pressure switch**

Activate the button and gently rotate each wheel until the lamp signal on the screen for the appropriate wheel changes from off to on, and back to off. That verifies operation. Two pressure switches are fitted in the rim well, positioned 180 degrees apart. The RDK will signal a pressure loss error if the pressure switch is open due to low tire pressure. You should be able to verify the function of each sensor when it gets in range of the HF sender unit.

The pressure switch test also has a counter field to each sensor. This counter field resets when the pressure switch button is pressed. When the wheels turn the light lights up the counter is incremented. This helps identifying intermittent faults. You may experience difference in counter reading when driving slowly. This is normal behavior. We recommend driving very slowly in a straight line and repeat the test several times before drawing any conclusions.

The RDK will stop communicating with the diagnostics when exceeding 30km/h. This is likely a safety feature of the RDK, which is not documented in manuals.

When you lift the car on all 4 wheels for this test, don't get confused by misinterpreting the data. Both rear wheels will turn at the same time, causing sensors on both to produce on-screen results.

**Trip, Pressure loss Trip info (only valid for RDK version v02)**

From new RDK version R02, which was released in 1991, a new feature is available: the Trip log feature. The new RDK keeps track of events during previous journeys, and logs these in the ecu memory.

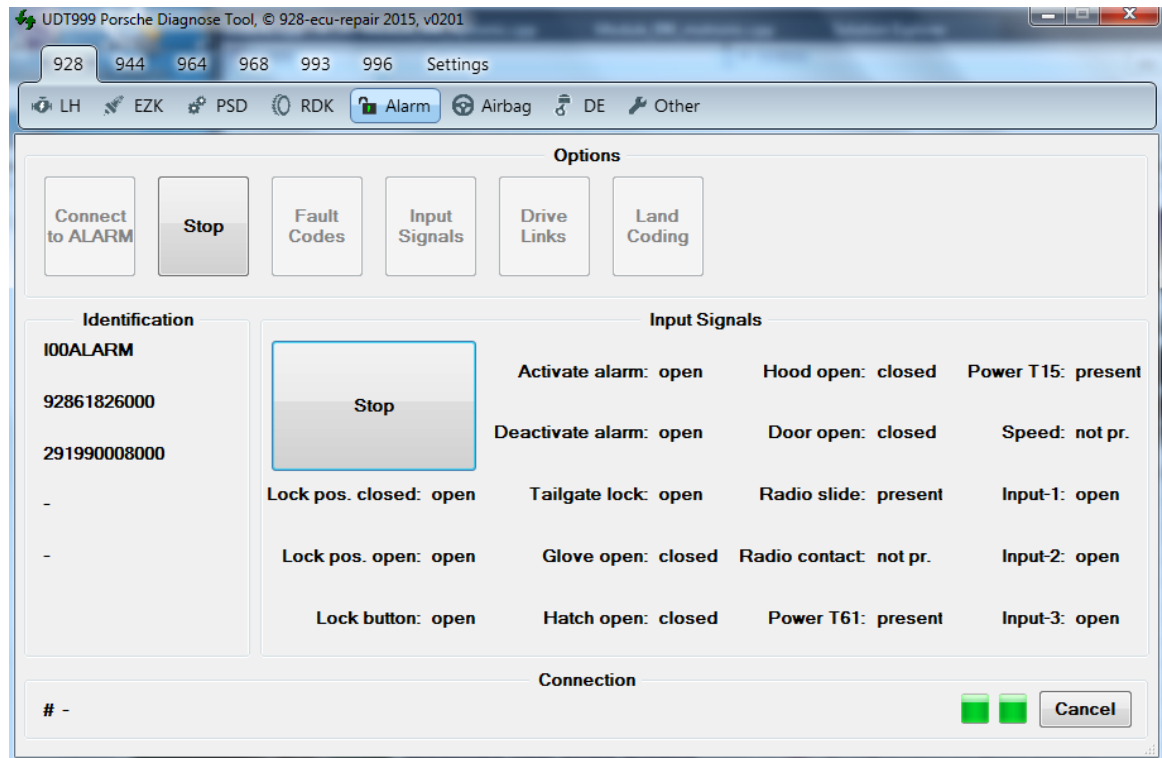
This function can be activated by pushing the info button. The software then interrogates the RDK and displays this event information provided by the RDK. A trip should be understood as each cycle in which the car goes from ignition on to off. Each entry shifts down when you turn on ignition. Journey number -1 is the most recent one. So, the last known error from the log phases out after 8 sequential trip cycles. When you push the button "Trip" the information display will report the RDK events during these last 8 trips.

You will see per wheel the event, and the speed at which it occurred. Understanding the report requires you to read from the oldest entry (-8) back to the most recent entry (-1). Also, combinations of pressure loss on more than one wheel within one trip are possible and shown if applicable.

Intermittent pressure loss reports may indicate pressure to be just too low, too close to the trigger limit, big differences in temperatures, which make pressure fluctuate, or a faulty sensor. In the workshop manual, a pressure loss is not considered a fault in the RDK, so no fault will be reported by the check-fault function. There is no reset function to this event log.

The workshop manual describes a procedure for setting the correct pressure and validating the pressure threshold of the sensors. Refer to WSM vol 4 page 44-413

## 7. Alarm controller (all series)



### Introduction

The Alarm controller in the 928 comes in two versions. The older s4 models have a simple small cigarette box sized black alarm device and a separate window/sunroof controller, both without any diagnostics. Starting in 1991, the alarm controllers were integrated into one unit with diagnostic functions and located under the front passenger seat (LHD). This is the box that has diagnostics and is detailed here.

The alarm controller is not made by Bosch or Hella as you would expect, but by Megamos (Fa. Delphi/Megamos (02261 9710 or [www.megamos.de](http://www.megamos.de)))

This new style Alarm ECU comes in two versions (4 part numbers:

928.618.260.00-928.618.260.03) and is used in a variety of Porsches, like 928, 964, 968, and 993. Porsche is unclear about the differences. When connecting you may see a I00 version or a I01 version. The latter seems to have extra features like a result memory log.

A short overview of controls and functions:

### Ignition light:

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

### Connect to Alarm

When the command button is pushed the software tries to connect to the Alarm ecu retrieve Alarm version, and Part number. All this information is stored in the firmware (software) of the Alarm controller. If all is o.k., the information will show in the appropriate fields in the screen. This is also verification that communication with the ecu has been established. The system is designed to retry 3 times if a failure to connect exists. If after three tries it fails then the message "Cannot connect to Alarm, turn-off and -on the ignition and try again" appears.

These figures will show up on your screen depending on the model year of your car:



1987/91	S4/GT/GTS	I00ALARM	928.618.260.00	081992008012
1987/92	S4/GT/GTS	I00ALARM	928.618.260.01	
none	none		928.618.260.02	
1987/91	S4/GT/GTS		928.618.260.03	

### Stop

This stops the communication with the ALARM controller. The Ack signal (bottom left sign) will stop flashing.

### Ack

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running, and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

### Fault memory: check faults

This button interrogates and displays the stored fault codes of the Alarm ecu. The alarm fault codes are unusual because the controller does not log any alarm incidents during activation, but instead logs the abnormal conditions at the time of activation. If any faults are stored, the software will display the error messages. Three types of error messages are possible. They will be shown sequentially in the information screen.

If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

Additional information regarding fault codes and troubleshooting can be found:

#### 928:

in the Service Info Tech Manual of the 1998 928s4/gt, page 9-5 through 9-21.

#### 964:

964 WSM Vol. 6, Diagnosis / troubleshooting alarm system", page D90-1 through D90-19.

#### 968:

968 WSM, Vol 4, Diagnosis / Troubleshooting Alarm system, page D90-1 through D90-18.

#### 993:

993 WSM, "Diagnose alarm system", page 90-1 through 90-30.

Here are some the error messages that may appear:

Fault #	Alarm Fault Messages:
01	Control unit defective
02	Voltage failure term 30 with active alarm system
03	Voltage failure during alarm output
04	Position of the drives implausible
05	Doors open during activation
06	Engine compartment open during activation
07	Luggage compartment open during activation
08	Glove compartment open during activation
09	Input 2 to ground during activation
10	Central lock button closed during activation
11	Input 1 to ground during activation
12	Input 3 to positive during activation
13	Position switch on drive closed during activation

14	Position switch on drive open during activation
15	radio (closed loop) interrupted during activation
16	Radio contact to ground during activation
17	Tailgate lock switch closed during activation

The fault codes in the Alarm unit work a bit different than the other controllers. The ecu does not report a normal DTC code, but an encoded message that carries multiple fault codes. The software presents them as clear and readable text in the information window.

### **Fault memory: clear faults**

This button will send a message to the Alarm controller to clear all existing fault conditions from memory.

### **Drive links**

This range of functions can be tested individually by pushing the on / off buttons respectively.

1. Function display: This function tests the LED in the doorposts that signals when the system is active. This button turns the led on and off by command. The doors need to be closed for this test.
2. Locks: This function engages and disengages the door locks. The doors need to be closed for this test. You should hear a clear click when the doors lock.
3. Horn: This function activates the horn as if it had been triggered by the alarm. You will hear the horn loud and clear.
4. Turn Signals: This function turns on and off all 4 turn/indicator signals. This is clearly visible at all four corners.
5. Interior lights: This function turns on and off all interior lights. This is clearly visible in the car.
6. Button Light: This will turn the button (button) light in the center console on and off which should be clearly visible.
7. External output: this is not used in standard setup.
8. Anti Drive: this is a feature that prevents the car to drive off when on alarm. An immobilizer. It is not available in a 928 but intended for the 993 versions. Therefore, it is disabled in the 928 system.

### **Remote control**

This is a feature that enables you to remotely switch the alarm on and off by a hand sender. It is not available in a 928 but intended for the 993 versions. Therefore, it is disabled in the 928 system.

### **Car type**

The alarm ecu can be used in different Porsche models. Each has specific features. This control is not available in the 928 version and selecting any car will not make a difference in behavior for a 928.

### **Input Signals**

When the button "Input signals" is pressed the signal, monitoring becomes active and is constantly updated. The lamps provide information on the current state of the switches.

- **Lock Position closed : Position switches at drive motors.** These switches show the position of the lock thus informing the alarm system of locked state. Both doors have a lock position switch. The display will show the closed status. If any door lock is closed, the light will turn on. So if one lock is open and one is closed, both lights (open and closed) will be on. This is an abnormal situation that should not occur in normal operation as both locks lock simultaneously when using the key or button.
- **Lock Position open : Position switches at drive motors.** These switches show the position of the lock thus informing the alarm system of un-

locked state. Both doors have a lock position switch. The display will show the open status. If any door lock is closed, the light will turn on. So if one lock is open and one is closed, both lights (open and closed) will be on. This is an abnormal situation that should not occur in normal operation as both locks lock simultaneously when using the key or button.

- **Door Unlock : Micro switch for deactivation of alarm.** Active when the key is turned to un-lock the system. The un-lock-engage-switch is engaged.
- **Hatch Unlock : Hatch unlock switch.** Active when the hatch is opened with the key. The hatch-open-switch will become engaged. This switch is only briefly active when the lock disengages to open the lock. It is separate from the hatch open switch and mounted in the upper part of the lock assembly.
- **Lock Button : Central locking system button.** This is lit when the central locking button on the center console is pushed.
- **Activate Alarm : Micro switch for activation of alarm.** Active when the key in any door is turned right to lock the system. The lock-engage-switch is engaged.
- **Glove Open : Glove compartment button.** Active when the glove compartment is open. The glove compartment-open-switch is engaged.
- **Hatch Open : Hatch open switch.** This switch is closed when you open the hatch at the rear. It also triggers the interior lights.
- **Hood Open : Engine compartment switch.** Active when the hood is open. The hood-open-switch is engaged.
- **Doors Open : Door contacts.** Active when either door is open. The door-open-switch is engaged. It also triggers the interior lights.
- **Radio : Radio closed loop.** 12v power is routed through the radio. Breaking the 12v loop triggers an alarm condition.
- **Radio slide : Alarm contact radio bracket.** A signal that is grounded to the radio chassis. Removing the radio from the alarm slide triggers an alarm condition by grounding the cable.
- **Power T61 : Term61** is carrying 12v power, basically saying the engine is running as it is charging the battery. This signal will also come on when the interior lights are switch on by the controller (hatch or doors open)
- **Power T15 : Term15** is carrying 12v power, basically saying that the switched power is applied. This power is switched on by turning the ignition key to the on-position, even without starting.
- **Speed : Speed signal.** Active when a speed signal is present. When the wheels turn, the speed signal is seen and causes a trigger.
- **Input 1** Optional input for accessory equipment
- **Input 2** Optional input for accessory equipment
- **Input 3** Optional input for accessory equipment

#### Land Coding

The Alarm controller has the ability to be set to different configurations. There are 3 choices, each changing the alarm signal to a different setup.

- **G1** When pushing the G1 button the alarm is set to the RoW (Rest of World) configuration. If an alarm occurs and set to RoW, the horn sounds in intervals, max 30 seconds, turn signal flashes max 5 minutes together with the interior lights.
- **G2** When pushing the G2 button the alarm is set to the CH (Switzerland) configuration. If an alarm occurs and set to CH, the horn sounds continuously for max 30 seconds.
- **G3** When pushing the G3 button the alarm is set to the USA (United States) configuration. If an alarm occurs and set to USA, the horn sounds in intervals, max 4 minutes, turn signal flashes max 8 minutes together with the interior lights.
- **Status** The status button reports the current configuration of the alarm controller.

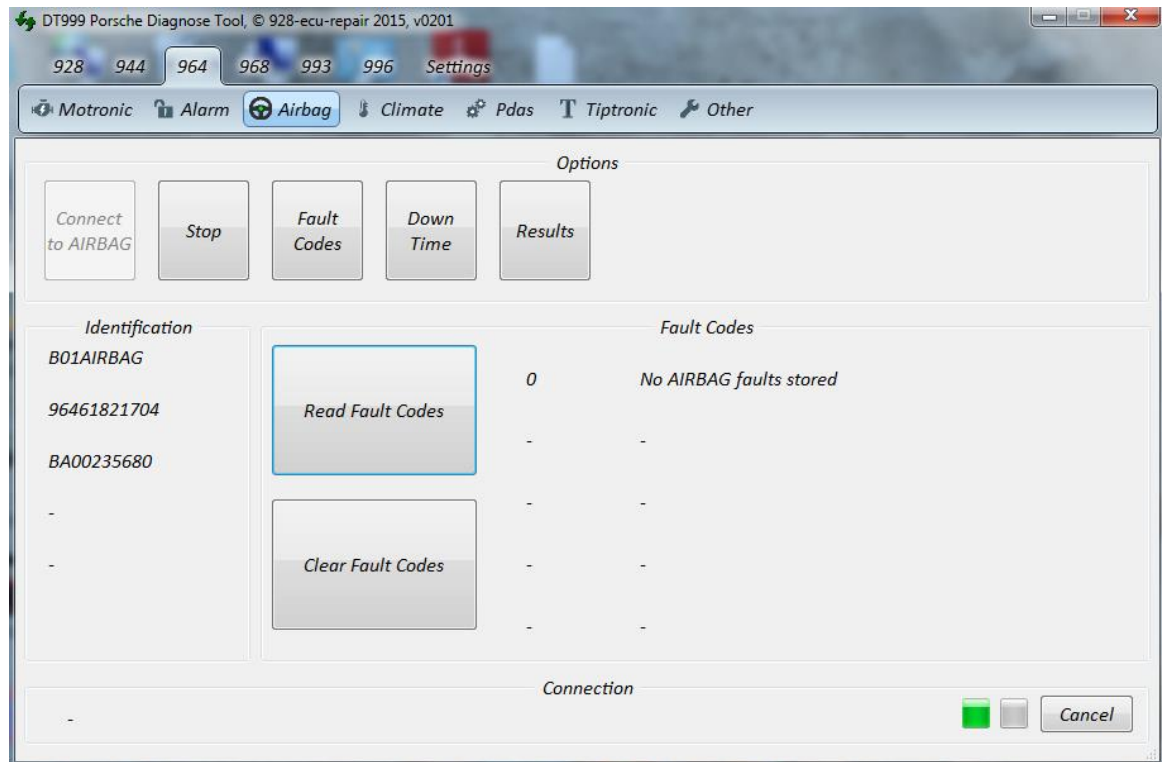
### **993 inside security**

The 993 has an interior monitoring system that can be configured for different models of the 993. This does not apply to the 928 and is therefore not functional.

### **Tips and tricks**

- After enabling the alarm, the led flashes quickly for 10 seconds (sort of a self-test) and then starts to blink slowly, showing it is in armed state.
- If at a fault condition exists when enabling the alarm, there is no quick flashing, and after 10 seconds only the working alarm triggers are enabled and monitored in the alarm controller. This state is shown as a double flash pattern.
- If you turn the key to lock the car, and you hold into the locking position for a few seconds, the system starts to automatically close any open windows and sunroof.
- If you open the hatch without opening the doors, and you close it, the alarm is activated again 10 seconds after closing the hatch.
- You can arm the alarm by turning the lock key 3 times in succession. This enables you to turn the alarm on even if the central locking is inoperative, so despite of the doors being locked.

## 8. Airbag controller (all series)



### Introduction

The Airbag controller manages the airbag system and identifies any possible malfunctions. There are no drive links. Drive links would be to test the function of the airbag which seems not appropriate here.

There are two airbag configurations: one with driver airbag only; and one with both passenger and driver airbags. The 2-airbag system consists of two sensors and two airbags, plus the management controller which is mounted in the center console in the very front of the foot well flap. The driver side airbag has one pickup sensor, as the passenger side has two sensors. The sensors are purely mechanical spring-loaded roller-switches that are designed to move with the right direction and impact to make contact. That triggers the control unit and activates the airbag(s) deployment.

The airbag check light should light when turning on the ignition and go out after approximately 5 seconds. If not, further diagnosis is required. Be aware that this is a safety device that your life may depend on.

For your safety never work on an airbag system with battery power connected, and always wait for 20 minutes after isolating the battery ground strap to allow capacitor discharge in the control unit. (as of software version B01 20min waiting time changed to 5min).

Never change the airbag wiring or mounting.

The Airbag is a controller which is designed to work with diagnostics only when the engine is not running but only when ignition is merely switched to on.

The Airbag controller can be tested for operation readiness in two ways:

- by switching on ignition. The airbag warning light in the dash should go on, and go off after approximately 5 seconds
- by switching the ignition to on and then pulling the instrument cluster fuse for about 30 seconds. That should post a fault code 58 (warning light, short circuit to Ub or ground , no fault present)

As of software release B01 there is a small change:

- by switching on ignition. The airbag warning light in the dash should go on, and go off after approximately 5 seconds (2,5 sec as of production date June 12 1992)
- by switching the ignition to on and then pulling the instrument cluster fuse for about 30 seconds. That should post a fault code 30 (Airbag warning light, signal implausible, no fault present)

A maximum number of 11 faults can be stored in the controller's memory. You should erase the fault that is stored in the controller.

A short overview of controls and functions follows:

### **Ignition light**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

### **Connect to Airbag**

When the command button is pushed, the software tries to connect to the Airbag ecu and tries to retrieve Airbag version, and Part number. All this information is stored in the firmware (software) of the Airbag controller. If all is o.k., the information will show in the appropriate fields in the screen. This is also verification that communication with the ecu has been established. The system is designed to retry 3 times if a failure to connect exists.

If it after three tries it has still not connected then the message "Cannot connect to Airbag, turn-off and -on the ignition and try again" appears.

These figures will show up on your screen depending on the model year of your car:

1990/95	S4/GT/GTS	B01AIRBAG	964.618.217.04	BA00596613
1992/95	GTS	B01AIRBAG	944.618.217.02	AA00054496

### **Stop**

This stops the communication with the Airbag controller. The Ack signal (bottom left sign) will stop flashing.

### **Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

### **Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the Airbag ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

Additional information regarding DTC codes and troubleshooting can be found in the:

### **928:**

WSM, Vol. V, page D 68-1 through D 68-28.



## 928 Fault Memory for Airbag control Unit software version B00

<b>DTC Code</b>	<b>WSM Ref Page</b>	<b>Test Point</b>	<b>Description</b>
3_11	D 68-7	1	Left front sensor closed once
3_12	D 68-7	2	Left front sensor closed several times
3_13	D 68-7	3	Right front sensor closed once
3_14	D 68-7	4	Right front sensor closed several times
3_15	D 68-7	5	Left front sensor closed permanently
3_16	D 68-7	6	Right front sensor closed permanently
3_17	D 68-8	7	Contact resistance to UB from left front sensor
3_18	D 68-8	8	Contact resistance to UB from right front sensor
3_19	D 68-8	9	Contact resistance against earth/ground from left front sensor
3_20	D 68-8	10	Contact resistance against earth/ground from right front sensor
3_21	D 68-8	11	Left front sensor Short-circuit to UB
3_22	D 68-9	12	Right front sensor Short-circuit to UB
3_25	D 68-9	13	Left front sensor Earth/ground resistance too high
3_26	D 68-9	14	Right front sensor Earth/ground resistance too high
3_27	D 68-9	15	Right front sensor Break in feed line
3_28	D 68-9	16	Left front sensor Break in feed line
3_29	D 68-9	17	Left front sensor Line resistance too high
3_30	D 68-10	18	Right front sensor Line resistance too high
3_33	D 68-10	19	Ignition condenser 1 Capacitance too low
3_34	D 68-10	20	Ignition condenser 2 Capacitance too low
3_35	D 68-10	21	Ignition condenser 1 Contact resistance too high
3_36	D 68-10	22	Ignition condenser 2 Contact resistance too high
3_37	D 68-11	23	Ignition pill circuit 1 Contact resistance to UB
3_38	D 68-12	24	Ignition pill circuit 2 Contact resistance to UB
3_39	D 68-12	25	Ignition pill circuit 3 Contact resistance to UB
3_40	D 68-12	26	Ignition pill circuit 1 Short-circuit to UB
3_41	D 68-12	27	Ignition pill circuit 2 Short-circuit to UB
3_42	D 68-12	28	Ignition pill circuit 3 Short-circuit to UB
3_43	D 68-13	29	Ignition pill circuit 1 Contact resistance to earth / ground
3_44	D 68-13	30	Ignition pill circuit 2 Contact resistance to earth / ground
3_45	D 68-13	31	Ignition pill circuit 3 Contact resistance to earth / ground
3_46	D 68-13	32	Ignition pill circuit 1 Short-circuit to earth/ground
3_47	D 68-13	33	Ignition pill circuit 2 Short-circuit to earth/ground
3_48	D 68-13	34	Ignition pill circuit 3 Short-circuit to earth/ground
3_49	D 68-14	35	Ignition pill circuit 1 break
3_50	D 68-15	36	Ignition pill circuit 2 break
3_51	D 68-15	37	Ignition pill circuit 3 break
3_52	D 68-15	38	Ignition pill circuit 1 resistance too low
3_53	D 68-15	39	Ignition pill circuit 2 Resistance too low
3_54	D 68-16	40	Ignition pill circuit 3 Resistance too low
3_55	D 68-16	41	Ignition pill circuit 1 Resistance too high
3_56	D 68-16	42	Ignition pill circuit 2 Resistance too high
3_57	D 68-16	43	Ignition pill circuit 3 Resistance too high
3_58	D 68-16	44	Warning lamp: Short-circuit to UB or earth / ground Fault
3_59	D 68-16	45	Break in circuit at warning lamp
3_60	D 68-17	46	Defective diagnosis unit
3_61	D 68-17	47	Ignition current correct (after crash)
3_62	D 68-17	48	Ignition current correct (after crash)
3_65	D 68-17	49	Ignition pill current has flowed (after crash )
3_67-105	D 68-17	50	Control unit defective (internal fault)

Note: The term UB refers to voltage supply.

Note: Ignition pill circuit 1: driver's airbag, Ignition pill circuit 2 and 3: passenger's airbag

Note: On test point 50 a fault code can be displayed in the range of 67-105. On the 9268 tester, code 60 is always displayed if the fault is in range of 67-105.

Additional information regarding DTC codes and troubleshooting can be found in the:

**964:**

964 WSM, Vol. 5, page D 68-22 through D 68-24.

*928 Fault Memory for Airbag control Unit software from version B01 onwards*

<b>DTC Code</b>	<b>WSM Ref Page</b>	<b>Test Point</b>	<b>Description</b>
10	D 68-23	1 2 3 4 5 6	Ignition circuits: - closed once - closed several times - permanently closed - contact resistance to Ub - contact resistance to ground - coupled 1/3 or 2/3
11	D 68-24	7	Left front sensor – resistance too high
12	D 68-24	8	Right front sensor – resistance too high
21	D 68-25	9	Ignition pill circuit 1 – resistance too high/low
22	D 68-26	10	Ignition pill circuit 2 – resistance too high/low
23	D 68-26	11	Ignition pill circuit 3 – resistance too high/low
30	D 68-26	12	Warning light Airbag – signal implausible
31	D 68-26	13	Warning light Airbag – control unit defective
40-47	D 68-26	13	Warning light Airbag – control unit defective
50-54	D 68-26	13	Warning light Airbag – control unit defective
60-62	D 68-26	13	Warning light Airbag – control unit defective
70			Crash entry – only if airbag is triggered

Any other faults: Check secondary ignition circuits and reset fault.

Additional information regarding DTC codes and troubleshooting for 993 can be found in the:

**993:**

- 993 WSM, page 68-1 through D 68-18 for B02 version.
- 993 WSM, page 68-19 through 68-37 for B03 version.

**Fault memory: clear faults**

Using this button will send a message to the Airbag controller to clear all existing fault conditions from memory.

**Downtime**

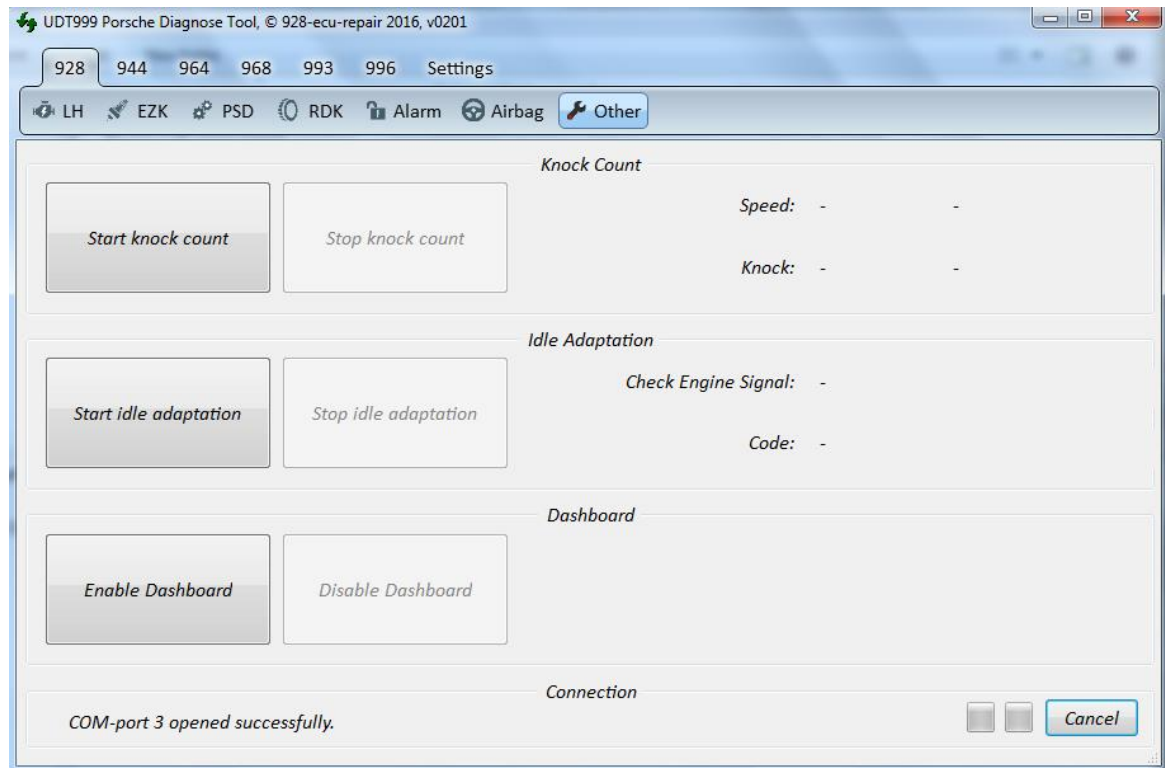
Pushing this button checks the controller for any downtime registered. Any downtime is displayed in the adjacent boxes on the screen. Downtime is something the controller detects whenever an unexpected power failure occurs. The ecu registers the period of time the power failure existed. As soon as the car starts up the digital dash checks the airbag controller and finds out if any downtime exists. If so, a red warning will be shown on the digital instrument cluster. When the reset lever at the steering column is used to clear the message, a warning light for airbag problems remains on while driving. The only way to reset the alarm on the instrument cluster is to reset the controller. This airbag alarm condition can be reset by using the clear fault memory button.

One more thing to mention: the controller logs downtime to a maximum of 99 hours and 59 minutes. If this maximum downtime is exceeded the ">" sign will be shown.

**Date of Crash (Result)**

Pushing this button checks the controller for any crash information stored in the controller. This is useful to determine if and when the unit has been part of an accident. The date and time will be shown in the information window and should be zero.

## 9. Other (928 series)



### Introduction:

The “other tab” manages different features. Features which are supported when the diagnose tool is not within a session.

### Knock registration: start

The 928 uses two knock sensors, both mounted inside the “V “ of the engine. These piëzo pickups listen to the engine and detect any pre-detonation. This information is sent to the EZK, which retards timing to prevent further knocks. Knocking can be recognized by knocking combustion (maybe caused by poor grade of gasoline) or mechanical engine noise. It sounds like marbles in the engine hitting the pistons.

In the normal load range of the engine it is very close to the knock limit of the ignition curve, through which combustion knocks and therefore also ignition timing corrections for each cylinder occur more or less frequently. If a knock is sensed during combustion, the ignition timing for the relevant cylinder is retarded by 3°. If the knock condition persists, ignition is retarded up to 9° in steps of 3° for each knock occurring, if the engine speed is above 3500 rpm. At speeds below 3500 rpm, correction is performed. If no knock condition is detected anymore, ignition timing is returned in small increments up to the optimal value. This correction process may take several seconds to settle again. The knock system is able to detect which cylinder is showing the knock, using the info from the knock sensor (front/rear), hall sensor (1<sup>st</sup> or 2<sup>nd</sup> part of the 4 stroke).

A sensor malfunction would make the ignition timing advance to where it damages the engine. The EZK is designed to detect a sensor fault and if this happens it retards the timing by 6 degrees. This seemed like a safe margin when the EZK was designed.

It is recommended that a fault diagnosis be carried out prior to registering the engine knocks, in order to exclude other factors that might influence knock regulation. When running the knock test the engine must be at operating temperature, and the test performed while test driving the car or with the car on a roller dynamometer.

The number of “knocks” registered by the sensors is calculated each time for 10,000 ignition firings. The registration of knocks should be performed if there are customer complaints about, for example, poor engine performance or high fuel consumption.

By clicking the start button the test starts. Speed and number of knocks detected are shown in the adjacent boxes. The test will terminate itself after 10,000 firings. A perfectly good working engine should normally register 5-20 knocks, especially when test-driving in an aggressive manner and using roz95 or roz98 fuel. Roz100 (V-power or similar high octane rated fuels) may help to reduce the number of knocks. A knock report of over 50 knocks must be considered as abnormal and needs further investigation. Knocks will make the EZK retard the engine to prevent this from occurring and thus performance will suffer. A defective knock sensor will be reported as an error when checking the fault code report.

**Knock registration: stop**

This terminates the knock registration test.

**Adaptation: start**

The 928 has a LH ecu that is able to adjust itself to the car's conditions via adaptation. It has a learning mode where it knows how rpm, airflow, fuel pulse width and lambda values are related and uses this information to maximize fuel economy, performance, and comfort.

Adaptation is called for when the car has problems running a smooth idle, lacking power, or is using excessive amounts of fuel. This may be caused by misinterpreted sensor signals or by using signals which are influenced by a previous technical problem. The ecu then needs to be reset to start a fresh adaptation. When performing the adaptation, it attempts to set the idle rpm to 675 or 775 if it is low for whatever reason. However, if the idle is high, you may be looking at an air leak and the LH is not able to compensate for that other than shutting down the idle control valve. A typical phenomenon if a leak or bad MAF exists, is that the idle gets very high (1000+ rpm) after the idle adaptation, and only resets temporarily after battery power disconnect.

The adaptation starts with a warm engine, i.e. the car needs to be at normal operating temperature. Disconnect the LH from power briefly to clear any stored parameters. Then Click on the “start” button in the adaptation pane to initiate a dialogue that needs to be followed strictly. In the additional information window, you will get instructions.

- First step: check if the Throttle idle switch operates as expected. The pre 1991 ecu's will not perform the adaptation routine when the idle switch is not closed.
- Next: Shut down the engine. If you click on the “start” button while the engine is still running, you will get a message that says: “please turn ignition OFF and press button <Start> again”.
- Next step: click on the <Start> button. This message will appear: “please turn ignition ON and start the engine within 6 seconds”. Please start the engine as instructed.
- Next step: now the adaptation phase runs and the system searches for optimal values. Please be patient. You will notice engine sound and rpm fluctuate. The Adaptation check light will become active (green) and blink the code 1411 as a sequence. After one minute, the routine ends, and you can shut

down the engine. A trick to adjust also to worst conditions is to run the headlights during adaptation. This will give a slightly higher rpm at normal idle but a more stable rpm when lights are on.

The Idle adaptation takes time. The ECU sends a sequence of 2 times 4 digits: 1411. Like Morse code. After the first 4 digits (when decoded correctly) it does another sequence and awaits the 1411 code again. Finally, it says Idle adaptation ready. It is the ECU itself that actually performs the idle adaptation, and not the diagnostic system.

A normal idle rpm for a considered:  
S4 or GTS is  $675 \pm 25$   
GT is  $775 \pm 25$

Porsche states in the WSM (D24-28) that it is best to remove the 12v from the ecu (battery cable) prior to performing the adaptation test. We have not seen any difference in the outcome when leaving the 12v connected. Removing the 12v clears any previously stored parameter values from the ecu memory. Porsche also says that it is a good thing to perform this adaptation test after each inspection routine to assure optimal fine adjustment.

#### **Adaptation: check**

This is derived from the check-engine light that informs the software about the adaptation process. It will flash during the process and ends with the 1411 code.

#### **Enable dashboard**

From 1989 onward 928s were equipped with a "digital dash". The digital dash is capable of displaying sensor information, fault conditions, and providing some function tests. The first step in enabling this function is by clicking on the "enable Dashboard Diagnostics" button. Once pressed the light between the buttons illuminates. "Disable Dashboard Diagnostics" switches this function off.

The second step is to push the left lower column lever to the front for at least 3 seconds. Then you will see the display respond with diagnostic messages and software version of the cluster. If you pull the lever back, you enter the language setting mode (not available on all models).

The digital dash will respond with a diagnostic announcement and then report a software version. Some versions support an extended error check.

K18	First version (1989->)	Fixed language setting (German, French, Italian or English) which cannot be changed. Units can be changed from metric to US by pulling the stalk twice in a second
K21	Modified version 1989->	Error check available, language choice available but volatile when power is disconnected. Airbag?
K25	90 S4 model	Error check available. Language setting can be changed via the diagnostic mode (enabled on the diagnostics socket). Airbag error detection implemented?
K26	90 GT model	Error check available, the system loses the language and units settings when power is off for a long time. It enables a user to set a new 0-km pcb to the correct setting (just once)
K28	model?	No error check possible, settings are preserved when power is disconnected
K29	1992-> GTS model	No error check possible, settings are preserved when power is disconnected



The different versions also have different test capabilities.

K25 and K26 - K, E, L, R, P

K29 – only K

Others not known

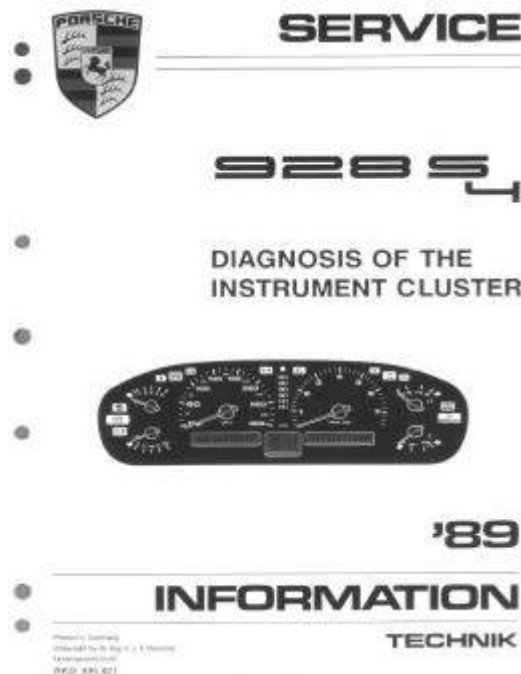
The extended error check of this instrument cluster is not documented, but this is how it works. First turn the ignition and switch on the instrument cluster diagnostics. This enables the pin 5 and 13 on the connector.

Then push the operating lever forward for a few seconds. That will make the instrument display PORSCHE - DIAGNOSE.

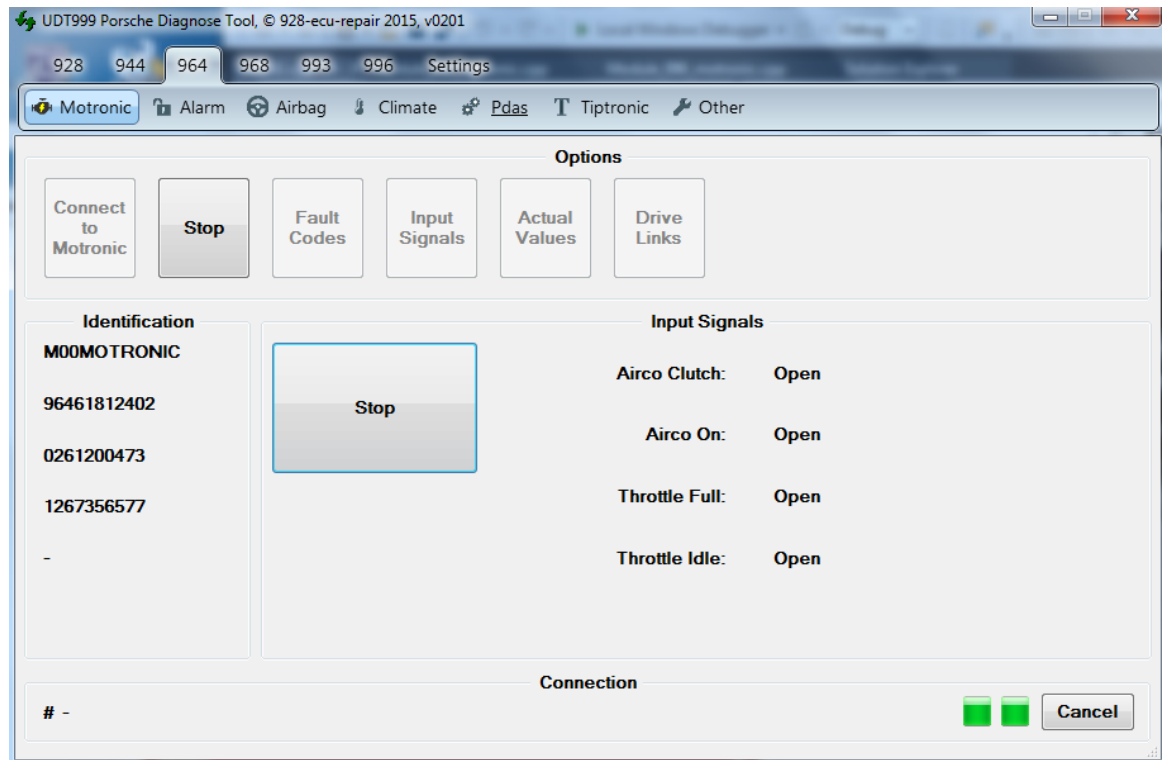
Next push the lever down for a few seconds and depending upon the software version you will see in the display: S-R-N-M-L-K-H-G-E-D-B-A subsequently. Possibly: E=EZK, K=Kombi instrument, L=LH jectronic, R=RDK, S=ABS/PSD, A=Alarm. An error may look like Fehler01 K18 03/250 We cannot provide a clear error description at this moment.

There is a separate manual on diagnosis using the digital dash instrument panel which can be downloaded from our web server at: <http://forum.jen-niskens.eu> . The digital dash instrument can provide additional information and functions to what the diagnostic software can offer. Just to name a few: outside temp sensor value, Term15 actual voltage, oil pressure value, Term61 alternator voltage, coolant pressure switch state, CAT monitor, etc. It has another fine feature. It is able to store some fault conditions like oil pressure alarm or toothed belt alarm. This enables you to check for conditions that may have happened in the past.

For your reference here is a picture of the front of the manual is provided here:



## 10. Motronic controller (944/964 series)



### Introduction

The Motronic controller manages the engine in the 944s2, 968 and 964 models. This ecu manages fuel injection and ignition. The diagnostic software module checks the system and identifies any possible malfunctions. There are several drive links. The Motronic ecu was used in 944, 968 and 964 models. The software checks the version of the ecu and adjusts some of the controls as they are not applicable for the version of the ecu.

The following is a brief explanation of functions and controls:

### **Ignition light:**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

### **Engine runs**

The right light turns green when the controller knows that the engine is running. This is just verification.

### **Connect to Motronic**

When the command button is pushed the software tries to connect to the Motronic ECU, and tries to retrieve Motronic version, PCB number, Part number and Software version. All this information is stored in the firmware (software) of the ECU. If all is o.k. the information will show in the appropriate fields in the screen. This is also verification that communication with the ECU has been established. The system is designed to retry 3 times if a failure to connect exists. If it still failed to connect, the message "Cannot connect to Motronic, turn-off and -on the ignition and try again" appears.

The Motronic is designed to connect also when the engine is running, as long as 2000 rpm are not exceeded.

### **Stop**

This stops the communication with the Motronic controller. The Ack signal (bottom left sign) will stop flashing.

**Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running, and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign “\*” will flash visible.

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the Motronic ECU. If the system reports an “unknown fault”, the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

Fault codes that may be presented by the Diagnostics system are listed below. Additional information regarding DTC codes and troubleshooting can be found in the:

964 WSM, Vol. 1, DME diagnosis, page D 24/28-1 through D 24/28-33.

*Fault Memory of Motronic control Unit*

DTC code	WSM ref page	Test-point	Description
11			Battery voltage, too low
12			Idle switch, short to ground
13			Full load switch, short to ground
14			Engine temperature
15			Idle contact
21			Airflow sensor
22			Activation of idle stabilizer
23			Lambda control, outside min. range
24			Lambda control, short to ground
25			Air temp sensor, short to ground
31			Knock sensor 1
32			Knock sensor 2
33			Knock computer
34			Hall signal
41			Computer defect
43			Tank ventilation, op. circ/ground short
44			Resonance plate, op. circ/ground short
45			Fault lamp, op. circ/ground short
51			Injection valve cylinder 1, op. circ/ground short
52			Injection valve cylinder 2, op. circ/ground short
53			Injection valve cylinder 3, op. circ/ground short
54			Injection valve cylinder 4, op. circ/ground short
55			Injection valve cylinder 5, op. circ/ground short
56			Injection valve cylinder 6, op. circ/ground short

**Fault memory: clear faults**

Using this button will send a message to the Motronic controller to clear all stored fault codes in the Motronic controller.

**Input signals**

This button starts the checks of sensors and displays their current state by turning on or off the adjacent blue light:

- **Airco clutch.** This light signals that power is applied to the AC compressor clutch via the pressure switch, and thus the compressor is actively running and driven by the engine drive belt. By pushing the AC button the AC clutch is energized via the relay in the AC console. It feeds the evaporator freeze (ice) switch that connects through the pressure switch in serial with the

clutch coil. The AC clutch signal that you see is read from the LH ecu electronics, and represents the voltage between the ice/freeze switch and the low/high pressure switch. It is inter connected on the CEB. So will you see if the AC console including the relay works, the freeze/ice switch is closed (no ice), and power is applied to the low/high pressure switch. If that one is closed too (no low pressure and no high pressure), the clutch engages. The high/low pressure switch is located on the side of the drier. The air conditioner compressor is switched off via this switch when reaching a pressure of approx. 27 bar or a lower limit of approx. 2.2 bar. (just to avoid confusion: there's also a high temp switch mounted on top of the AC dryer, but that only signals the cooling fans to go to full mode via the fan controller and is not part of the clutch system)

- **Airco on.** This light signals that the AC button on the dash is pushed and therefore the system is supposed to go active. It is however possible that other switches (like freeze or low pressure) prevent the system from going active. The signal AC on is read from the Motronic ecu and represents the voltage of the AC-relay output that feeds into the freeze switch. It signals only that you have the system is powered on.
- **Throttle full.** This light signals that the gas pedal has opened the throttle valve under the intake to its wide open position and activated the micro switch at the valve (switch closed). This switch is also called the WOTS, the Wide-Open Throttle Switch. Worth mentioning is that WOT starts anywhere from about 2/3 to 3/4 throttle as far as the switch is concerned.
- **Throttle idle.** The light signals that the gas pedal is in idle position and the throttle valve under the intake is closed. This activated the micro switch (closed) at the valve.

#### Fuel tank Vent

The 944s2/968/964 have a fuel tank breather system. This system prevents fuel vapor from escaping to open air. The Motronic controller opens the electric valve in the intake distributor for a longer or shorter period as function of the load during engine operation at operating temperature. The opening period is determined by a ground pulse from the control unit. The valve is not activated permanently. The test must be performed within 7 minutes from starting the engine at operating temperature. After this, interrupt the tank venting valve operation for 75 sec and then continue. This tank vent connects the fuel tank breather hose to the intake, thus sucking the gasses into the engine intake. Testing this system is done by activating the switch. A faint click can be heard at the valve in the engine bay. The test repeats itself every second until another function is selected. Refer to Carrera 2/4 WSM page D24/28 -19

#### Resonance plate

The 944s2/968/964 have a tuning flap in the intake manifold. The DME control unit activates a vacuum controlled diaphragm valve which either opens or closes the resonance flap.

The resonance flap is closed between 3.000 rpm and 5.500 rpm and at a throttle angle of  $> 60^\circ$ .

Due to the ignition sequence, the intake system is alternatively supplied by both tanks. Due to the firing order, air is drawn in alternating manner from both intake tank systems. If resonances occur, the intake frequency of one row of cylinders matches the natural frequency of the pressure vibrations in the respective tank. The natural frequency is determined by the geometry of the intake pipes, the resonance pipe, and the tanks. A crucial factor however, is the total length of the pipe from the actual intake cylinder to the next cylinder being supplied, the distribution into intake and resonance pipe lengths as well as the depth of the tank in the direction of the flow. In the no-current state, the resonance flap is open. As soon as the ignition is switched on, however, it is triggered and closed. If the DME control unit detects that the engine is being started, the resonance flap is opened again.

A system test is performed by clicking on the button "Resonance Plate". This action can be heard as a rather loud click in the intake body. You will notice

Please be aware: the text in this chapter is **Preliminary** and subject to changes. The yellow highlighted areas are under review.

the axis of the valve rotate 90 degrees. The test repeats itself every second until another function is selected.

One thing to keep in mind: the actuator operates on vacuum from the vacuum booster. If the system has a severe vacuum leak, the vacuum contained in the system will diminish rapidly and leave the actuator inoperable. This is obviously not a fault in the actuator itself, but in the vacuum system. Even despite of a running engine, there is sometimes not enough vacuum to engage the system when severe leaks in the system exist.

#### **Idle stabilizer**

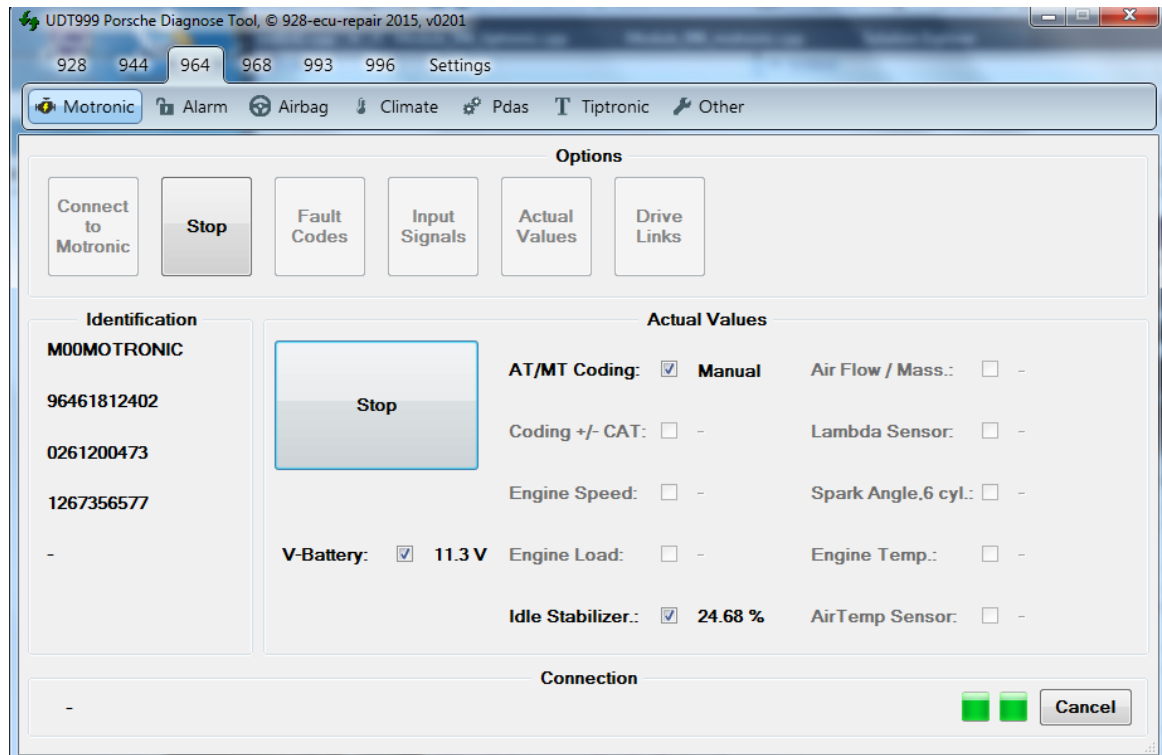
The car has an idle management system that provides a managed idle control by applying a bypass air stream over the closed intake valve. This is the IACV, the **Idle Air Control Valve**. At idle, the throttle idle switch is active, and the system knows it needs to take control of stabilizing the engine rpm at approximately 800 (880 +/-40 for a 964). The Motronic ecu sends a signal to a rotary valve that opens the airflow in the valve-bypass hose. By modulating this 12v signal, the amount of air is regulated, and rpm managed. Clicking on this button sends an impulse to the ecu to fully open and fully close the valve. A clear and loud click can be heard under the intake. The test repeats itself every second until another function is selected.

#### **Fuel injectors**

The fuel injectors of the 964 are a multipoint- multi control setup, but the 944s2 and 968 are single-control. The diagnostic software adapts to this condition. The Motronic 944/968 ecu fires all injectors at the same time during normal operation and the 964 can fire individually. This injector firing creates a fuel mixture in the intake cavities that is sucked in during intake when the intake valve opens. When you use this function, the selected injector is triggered. At the engine the selected injector(s) make(s) a clicking sounds. The sound is damped and faint. It helps to put a screw driver on a specific injector and put your ear on the screwdriver to listen to the clicks and verify that the injector coil opens the needle to inject fuel. The test repeats itself every second until another function is selected.

### Actual Values:

You can select each value you want to monitor by tagging the check box on the appropriate field. You can select more than one field if you'd like. Tagging many options at once however will slow down the update. A log file is created, and each field is presented in this log file. This makes importing it into spreadsheets or databases easy. By pushing the Values button, the process of acquiring the actual values is initiated, and it can be stopped by pushing it again. Each field is now discussed in more detail:



### Actual values: AT/MT coding

This indicates if the car is equipped with a manual or an automatic transmission.

### Actual values: Coding +/- Cat

This indicates if the car is equipped with a Catalytic converter.

### Actual values: Engine Speed

This indicates the actual rpm of the engine in revolutions per minute. A normal value is about 800 at idle, not in gear. (880 +/- 40 for a 964)

### Actual values: Engine Load

This indicates engine load at the given time in ms. A normal value is 1.750 ms at idle and warm in a 944s2.

### Actual values: Idle Stabilizer

This indicates the activation of the idle stabilizer. It shows a percentage of the activation of the idle stabilizer, reflecting the opening angle and thus the amount of air bypassing the closed throttle valve in the intake. 60% is a normal value for a 944s2.

### Actual values: Air Flow / Mass

This indicates actual value of the MAF airflow sensor as it is seen by the Motronic ecu. A normal value is 0.177 at a 944s2 at idle.



**Actual values: Lambda Sensor**

This indicates actual value of the Lambda Oxygen sensor as it is seen by the Motronic ecu. The lambda sensor is a narrowband type. This means that it fluctuates between 0.4 and 0.7 volts in cycles of about 100 msec. This results in a rich/lean adjustment every time the transition is made. If you look at the reading on the screen it does not give you a steady value, but it will be unstable. If it gives a steady value, there's something wrong. Further analysis of the sensor data would be required to see if it works properly and in the right frequency. A slowly changing (lazy) lambda sensor is also cause for trouble and will result in a overly rich or lean engine with related problems like High CO or hesitation at accelerating.

One more thing: the lambda needs to be hot to operate. A 12v heater element is embedded to aid the warm up process, but effectively you need to have a warm engine (exhaust) to get useful data.

**Actual values: Spark Angle 6 cyl**

This indicates spark advance. The normal advance value is about 0 +/- 3 degrees at 880 rpm +/- idle and warm.

**Actual values: Engine Temp**

This indicates actual value of the Engine temp sensor as it is seen by the Motronic ecu. A normal value is 85 at a 944s2 at idle and operating temperature.

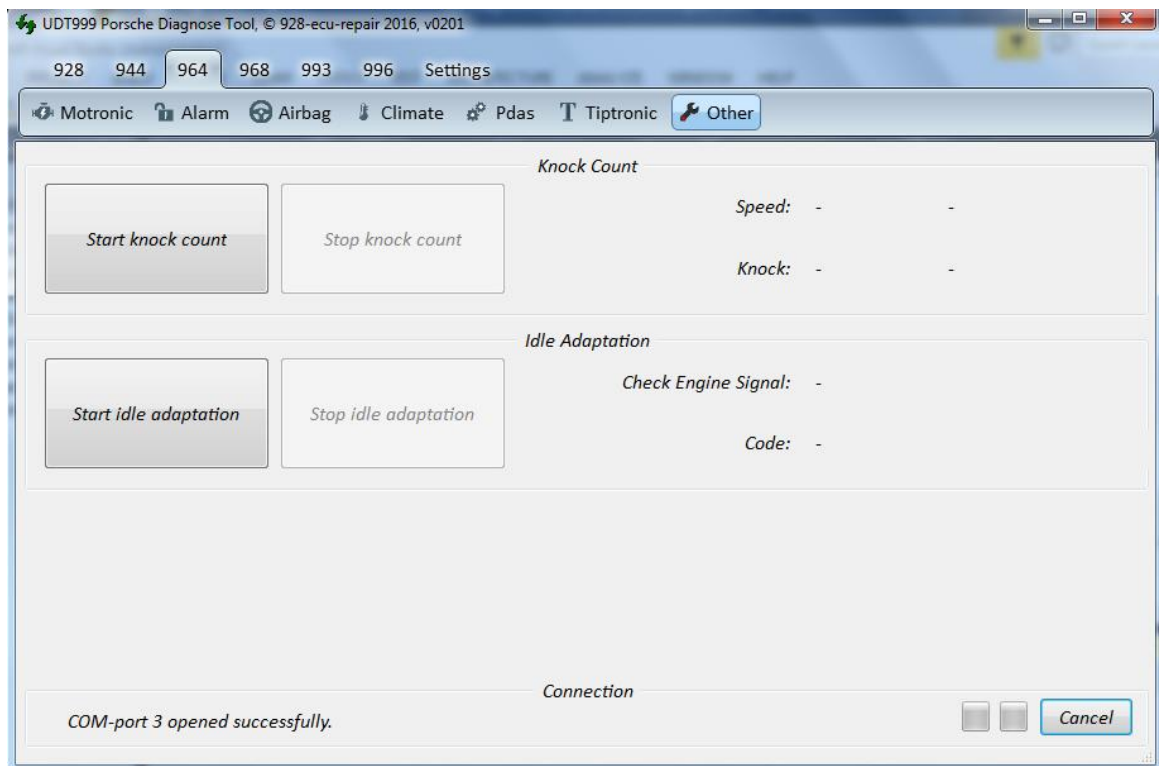
**Actual values: Air Temp Sensor**

This indicates actual value of the Air temp sensor as it is seen by the Motronic ecu. A normal value is 32 at a 944s2 at idle and operating temperature, but this is depending on environment conditions like ambient temperature of course.

**Actual values: Vbat**

This indicates actual value of the Battery voltage as it is seen by the Motronic ecu. A normal value is 13 to 13.5 volt.

## 11. Other (944/964 series)



### Knock registration: start

The 944s2/968/964 use two knock sensors, both mounted on the engine. These piezo pickups listen to the engine and detect any pre-detonation. This information is sent to the Motronic ECU which retards timing to prevent further knocks.

Knocking can be recognized by knocking combustion (maybe caused by poor grade of gasoline) or mechanical engine noise. It sounds like marbles in the engine hitting the pistons.

In the normal load range of the engine it is very close to the knock limit of the ignition curve, through which combustion knocks and therefore also ignition timing corrections for each cylinder occur more or less frequently. The number of "knocks" registered by the sensors is calculated each time for 10,000 ignition firings. The registration of knocks should be performed if there are customer complaints about, for example, poor engine performance or high fuel consumption.

It is recommended that a fault diagnosis be carried out prior to registering the engine knocks, in order to exclude other factors that might influence knock regulation. When running the knock test the engine must be at operating temperature, and the test performed while test driving the car or with the car on a roller dynamometer.

By clicking the start button the test starts. Speed and number of knocks detected are shown in the adjacent boxes. The test will terminate itself after 10,000 firings. A perfectly good working engine should normally register 5-20 knocks, especially when test-driving in an aggressive manner and using roz95 or roz98 fuel. Roz100 (V-power or similar high octane rated fuels) may help reduce knocks. A knock report of over 50 knocks must be considered as abnormal and need further investigation. Knocks will make the ECU retard the engine to prevent this occurring and thus performance will suffer. A defective knock sensor will be reported as an error when checking the fault code report.

**Knock registration: stop**

This terminates the knock registration test.

**Adaptation start**

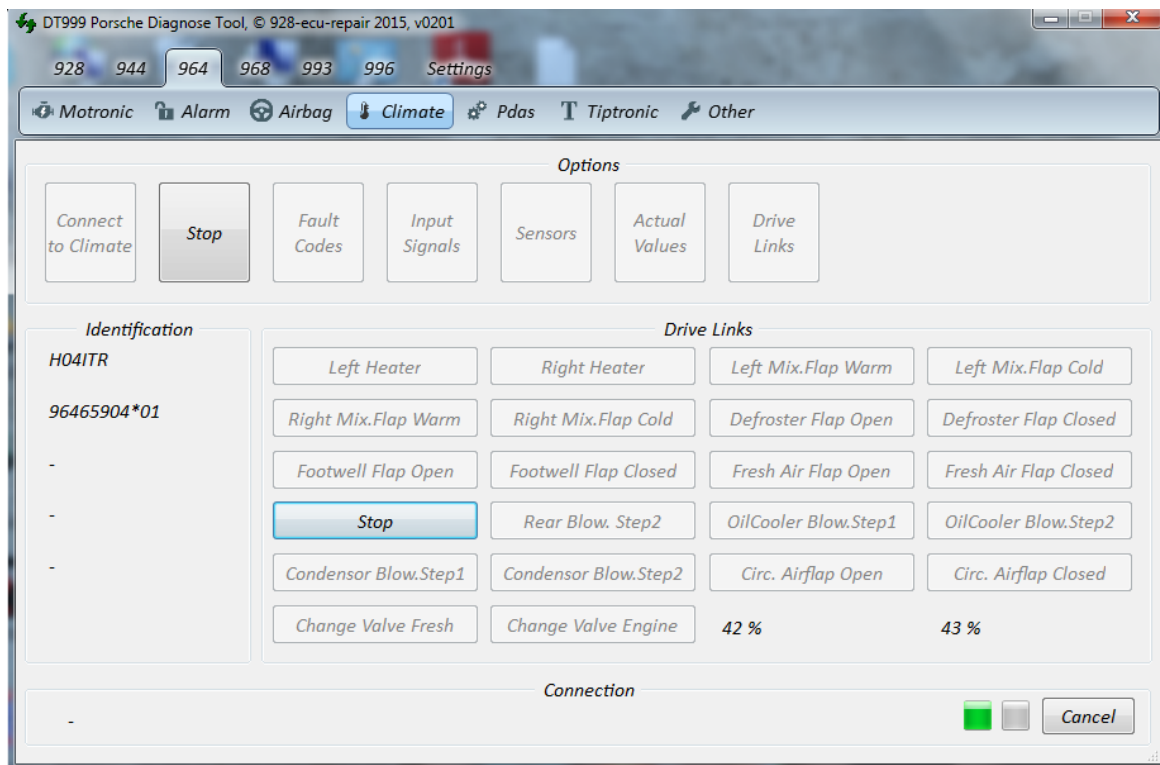
The Motronic ecu is able to adjust itself to the car's conditions via adaptation. It is a learning mode where it knows how ignition timing, airflow, fuel pulse width and lambda values are related and uses this information to maximize fuel economy, performance, and comfort.

Adaptation is called for when the car has problems running a smooth idle, lacking power, or is using excessive amounts of fuel. This may be caused by misinterpreted sensor signals or by using signals which are influenced by a previous technical problem. The "brain" then needs to be reset to start a fresh adaptation.

The adaptation starts with a warm engine, i.e. the car needs to be at normal operating temperature. Clicking on the "start" button in the adaptation pane initiates a dialogue that needs to be followed strictly. In the additional information window you will get instructions.

- First step: check if the Throttle idle switch operates as expected. The ecu will not perform the adaptation routine when the idle switch is not closed.
- Next: Click on the "start" button. You will get a message that says: "please turn ignition OFF and press button <Start> again". Please do so.
- Next step: click on the "start" button again. This message will appear: "please turn ignition ON and start the engine within 6 seconds". Please start the engine as instructed.
- Next step: now the adaptation phase runs and the system searches for optimal values. Please be patient. You will notice engine sound and rpm fluctuate. After one minute, the routine ends, and you can shut down the engine. A trick to adjust also to worst conditions is to run the headlights during adaptation. This will give a slightly higher rpm at normal idle but a more stable rpm when lights are on.

## 12. Climate Ecu (964/993 series)



### Introduction

The Climate controller manages the HVAC system in the 964 and 993 models. The diagnostic software module checks the system and identifies any possible malfunctions. There are several drive links to test functionality and locate problems.

When the vehicle speed is over 0km/h, mixing chamber temperature is over 80C, rear fan is over 95C or oil temperature is over 105C, then the diagnostics is automatically cancelled or disabled by the ecu. These are pre-requisites.

**Further the first heater units with identification H00 support ONLY fault code reading and clearing.**

The following is a brief explanation of functions and controls:

### **Ignition light:**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

### **Engine runs**

The right light turns green when the controller knows that the engine is running. This is just verification.

### **Connect to Climate**

When the command button is pushed the software tries to connect to the Climate ECU, and tries to retrieve Climate version, PCB number, Part number and Software version. All this information is stored in the firmware (software) of the ECU. If all is o.k. the information will show in the appropriate fields in the screen. This is also verification that communication with the ECU has been established. The system is designed to retry 3 times if a failure to connect exists. If it still failed to connect, the message "Cannot connect to Climate, turn-off and -on the ignition and try again" appears.

**Stop**

This stops the communication with the Climate controller. The Ack signal (bottom left sign) will stop flashing.

**Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running, and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the Climate ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

Fault codes that may be presented by the Diagnostics system are listed below. Additional information regarding DTC codes and troubleshooting can be found for:

**964:**

964 WSM, Vol. 6, page D 80/87-1 through D 80/87-8.

**993:**

993 WSM, page 80-1 through 80-33.

*Fault Memory of Climate control Unit*

DTC code	WSM 964 ref page	Test-point	Description
	80/87-3	1	Power supply to heater/air conditioner
8-11	80/87-3	2	Inside temperature sensor
8-12	80/87-3	3	Left mixing chamber temperature sensor
8-13	80/87-3	4	Right mixing chamber temperature sensor
8-14	80/87-3	5	Evaporator temperature sensor
8-15	80/87-3	6	Rear fan temperature sensor
8-21	80/87-4	7	Oil cooler temperature sensor
8-22	80/87-4	8	Defrost flap motor
8-23	80/87-4	9	Foot well flap motor
8-24	80/87-4	10	Fresh air flap motor
8-31	80/87-4	11	Left mixing flap motor
8-32	80/87-5	12	Right mixing flap motor
8-33	80/87-5	13	Left heater blower motor
8-34	80/87-5	14	Right heater blower motor
8-41	80/87-5	15	Condenser blower motor
8-42	80/87-5	16	Oil cooler blower motor
8-43/46	80/87-6	17	Rear blower motor speed 1
8-44/47	80/87-6	18	Rear blower motor speed 2
8-45	80/87-6	19	Inside sensor blower motor
Xxx	(80-22)	20	Unknown fault code

**Fault memory: clear fault**

We have seen fault code 16 reported in a 964 using the 993 climate ecu. Fault code 16 refers to the outside temperature sensor (OTS) that is used in the later 993 CCU's and is located in the vent opening in the left front fender. Porsche 964's and early 993's do not have this sensor. If the 964 CCU was replaced with a 993 CCU then fault 16 will be shown as the OTS is not present, but the CCU will operate normally. The sensor protects the A/C from turning on when it's too cold and the interior heater from turning on when it's

too hot. There are 4-6 wiring changes that are needed along with purchasing the sensor and mounting bracket if it is to be installed. The Porsche 964 with an OBC tachometer had an additional identical outside temperature sensor adjacent to the CCU OTS on the same bracket. Both the Porsche 964 and 993 fault files should show fault code 16 as many 964 CCU's were replaced with later 993 CCU's, which is the current Porsche part number.

**Fault memory: clear faults**

Using this button will send a message to the Climate controller to clear all stored fault codes in the Climate controller.

### Input signals

This button starts the checks of sensors and displays their current state by turning on or off the adjacent blue light:

- **AC.** This light signals that power is applied to the AC compressor clutch via the pressure switch, and thus the compressor is actively running and driven by the engine drive belt. By pushing the AC button, the AC clutch is energized via the relay in the AC console. It feeds the evaporator freeze (ice) switch that connects through the pressure switch in serial with the clutch coil. The AC clutch signal that you see is read from the ecu electronics. AC and ACmax only exist in the H06 version of the ecu
- **Ac max.** This light signals that the AC button on the dash is pushed and the system is running at max power. AC and ACmax only exist in the H06 version of the ecu
- **Air circ.** This light signals indicates the re-circulation of internal air is switched on. No fresh air is taken from outside.
- **Defr sw.** This light signals indicates the defroster switch is engaged, defrosting the window shield quickly by applying electrically heated air.

### Input signals

These buttons activate the sensor reading of each item as a bar graph for easy readout.

- **Foot well.** the foot well temp sensor reading is displayed
- **Defroster.** The defroster temp sensor reading is displayed
- **Blower.** The rear Blower temp sensor reading is displayed
- **Temp.** Interior temp sensor reading is displayed
- **Reverse gear.**

### Actual Values

The actual values are showed for the following items:

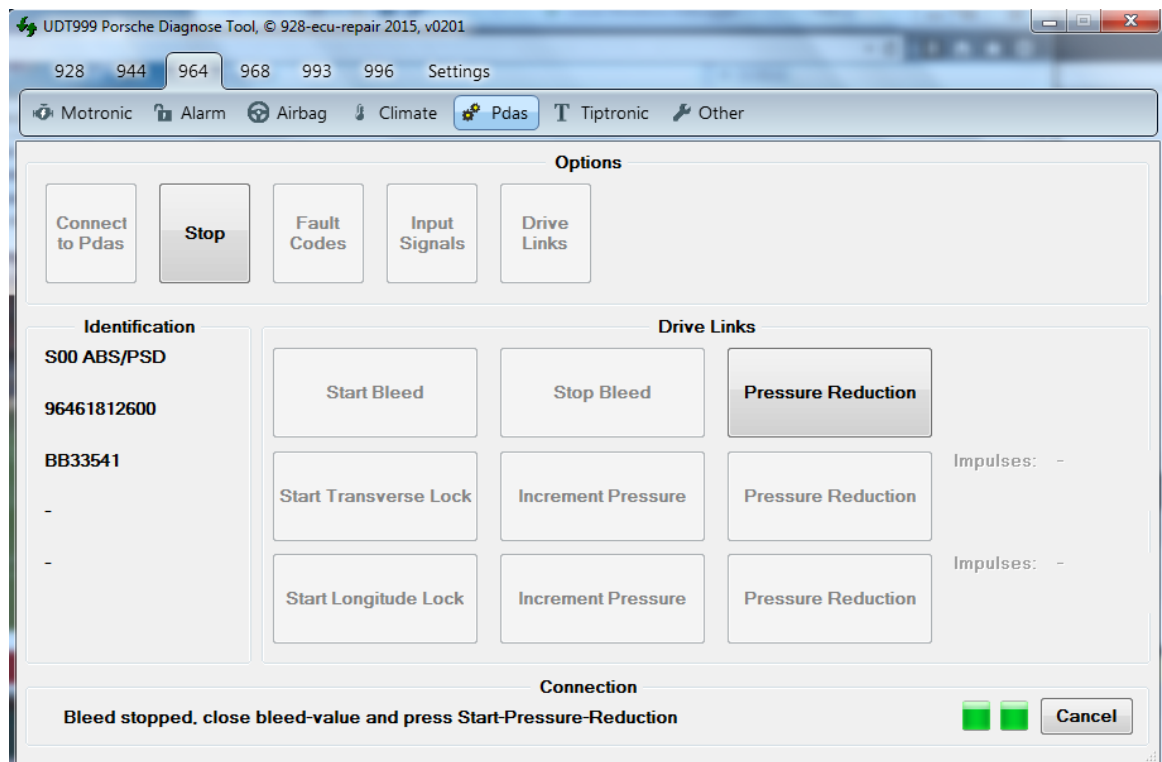
- **Vbat.** The battery voltage value is shown
- **Inside temp.** The inside temperature value is shown.
- **Rear temp.** The rear blower temperature value is shown.
- **Evap temp.** The evaporator temperature value is shown.
- **Mix Left.** The Left Mix chamber temperature value is shown.
- **Mix Right.** The Right Mix chamber temperature value is shown.
- **Oil temp** The Oil temperature value is shown.
- **Outside temp** The Outside temperature sensor value is shown.

### Drive Links

These switches active functions to be tested in the ecu for following items:

- **Left Heater.** Turn heater on/off
- **Right heater.** Turn heater on/off.
- **Circulation air flap** Closes outside air entry.
- **Changeover valve.** Turn valve on/off
- **Left Mixing Flap W.** Left Mixing Flap Cold
- **Left Mixing Flap C.** Left Mixing Flap Cold
- **Right Mixing Flap W.** Right Mixing Flap Warm
- **Right Mixing Flap C.** Right Mixing Flap Cold
- **Defroster Flap O.** Defroster Flap Open
- **Defroster Flap C.** Defroster Flap Closed
- **Foot well Flap O.** Foot well Flap Open
- **Foot well Flap C.** Defroster Flap Closed
- **Fresh Air Flap O.** Fresh Air Flap Open
- **Fresh Air Flap C.** Fresh Air Flap Closed
- **Rear blower st1.** Rear Blower step 1 activated
- **Rear blower step 2.** Rear Blower step 2 activated
- **Oil cooler blower step 1.** Oil Cooler step 1activated r
- **Oil cooler blower step 2.** Oil Cooler step 2 activated
- **Condenser blower step 1.** Condenser blower step 1
- **Condenser blower step 2.** Condenser blower step 2

## 13. PDAS Ecu (964-C4 series)



### Introduction

The PDAS controller manages the engine in the 964 C4 models. This ecu manage Porsche Dynamisch Allrad Steuerung, something like Porsche Dynamic Allwheel Management. The diagnostic software module checks the system and identifies any possible malfunctions. There are several drive links that can be exercised. The PDAS ecu can only be interrogated when the engine is off due to safety precautions.

The software checks the version of the ecu and adjusts some of the controls as they are not applicable for the version of the ecu.

The following is a brief explanation of functions and controls:

### **Ignition light:**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

### **Engine runs**

The right light turns green when the controller knows that the engine is running. This is just verification.

### **Connect to PDAS**

When the command button is pushed the software tries to connect to the PDAS ECU, and tries to retrieve PDAS version, PCB number, Part number and Software version. All this information is stored in the firmware (software) of the ECU. If all is o.k. the information will show in the appropriate fields in the screen. This is also verification that communication with the ECU has been established. The system is designed to retry 3 times if a failure to connect exists. If it still failed to connect, the message "Cannot connect to PDAS, turn-off and -on the ignition and try again" appears.

### **Stop**

This stops the communication with the PDAS controller. The Ack signal (bottom left sign) will stop flashing.



**Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the PDAS ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

Fault codes that may be presented by the Diagnostics system are listed below. Additional information regarding DTC codes and troubleshooting can be found in the:

964 WSM, Vol. 4, PDAS diagnosis / troubleshooting, page D 39/45-1 through D 39/45-45.

*Fault Memory of PDAS control Unit*

DTC code	WSM 964 ref page	Fault	Description
12	39/45-16	2	Lateral acceleration sensor Short-circuit / break in circuit
13	39/45-17	3	Lateral acceleration sensor Implausible signal
14	39/45-18	4	Lateral lock Deviation in regulating values
15	39/45-19	5	Control unit defective
21	39/45-20	6	Front left speed sensor
22	39/45-20b	7	Front right speed sensor
23	39/45-20b	8	Rear right speed sensor
24	39/45-20b	9	Rear left speed sensor
31	39/34-20c	10	Front left ABS valve
32	39/34-20e	11	Front right ABS valve
33	39/34-20e	12	Rear right ABS valve
34	39/34-20f	13	Valve Relay
35	39/45-20j	14	Return pump
41	39/45-20k	15	Front-Rear differential lock valve
42	39/45-20l	16	Front-Rear acceleration sensor Short-circuit / line break
43	39/45-20l	17	Longitudinal acceleration sensor Implausible signal
44	39/45-20l	18	Front-Rear differential lock control deviations
45	39/45-20m	19	Full differential locking button

**Fault memory: clear faults**

Using this button will send a message to the PDAS controller to clear all stored fault codes in the PDAS controller.

**Input signals**

This button starts the checks of sensors and displays their current state by turning on or off the adjacent blue light:

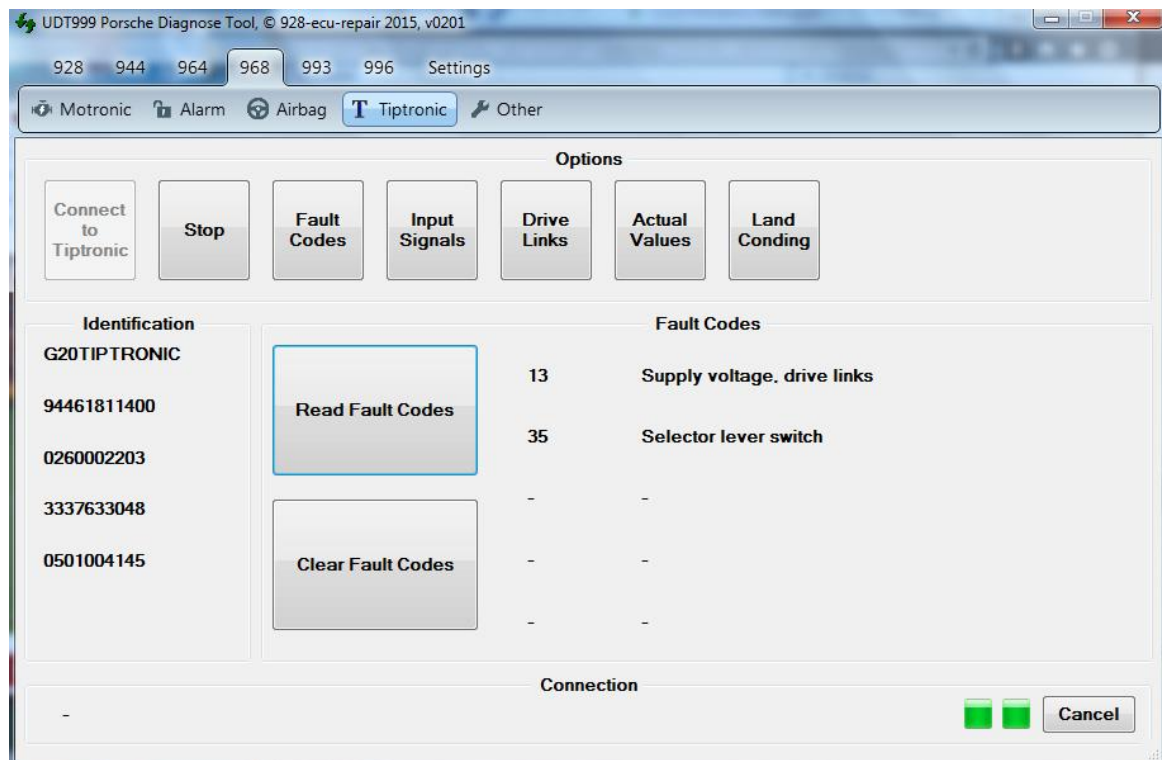
- **Full Lock switch:** this shows whether the full lock button was pressed and the signal was received by the PDAS ecu. It provides a full lock of the differentials.

**Drive Links**

These switches active functions to be tested in the ecu for following items:

- **Bleed**
  - Start
  - Stop
  - Reduce
- **Transversal Lock**
  - Start
  - Increment
  - Reduce
- **Longitudinal lock**
  - Start
  - Increment
  - Reduce

## 14. Tiptronic Ecu (964/968/993 series)



### Introduction

The Tiptronic controller manages the transmission in the 993, 968 and 964 models. This ecu manages gear changes. The diagnostic software module checks the system and identifies any possible malfunctions. There are several drive links.

The A50 Tiptronic gearbox was introduced with the release of the Carrera 2 in 1990. The first fully automatic gearbox offered for the 911 range as a successor to the semi-automatic Sportomatic gearbox offered on the 911SC during 1978-1983.

The four speed Tiptronic gearbox uses electronic controls to manage the gear changes - whether it be in fully automatic mode or in its "tiptronic" manual mode. When in manual mode the driver decides when up and down changes are made, but the electronics actually make the changes. The gear and final drive ratios are given below.

	A50/01	A50/02	A50/03	A50/04
Spur pinion	1.100	1.100	1.100	1.100
1st gear	2.479	2.479	2.479	2.479
2nd gear	1.479	1.479	1.479	1.479
3rd gear	1.000	1.000	1.000	1.000
4th gear	0.728	0.728	0.728	0.728
Reverse	2.086	2.086	2.086	2.086
Final drive	3.667	3.667	3.555	3.667

The Tiptronic gearbox was only offered for the 2 wheel drive versions of the 964 although in all body styles except wide bodied Coupes since the only non-Turbo wide bodied Coupes were all 4WD Carrera 4s.

The following is a brief explanation of functions and controls:

**Ignition light:**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

**Engine runs**

The right light turns green when the controller knows that the engine is running. This is just verification.

**Connect to Tiptronic**

When the command button is pushed the software tries to connect to the Tiptronic ECU, and tries to retrieve Tiptronic version, PCB number, Part number and Software version. All this information is stored in the firmware (software) of the ECU. If all is o.k. the information will show in the appropriate fields in the screen. This is also verification that communication with the ECU has been established. The system is designed to retry 3 times if a failure to connect exists. If it still failed to connect, the message "Cannot connect to Tiptronic, turn-off and -on the ignition and try again" appears.

**Stop**

This stops the communication with the Tiptronic controller. The Ack signal (bottom left sign) will stop flashing.

**Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running, and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the Tiptronic ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

Fault codes that may be presented by the Diagnostics system are listed below. Additional information regarding DTC codes and troubleshooting can be found:

**964:**

964 WSM, Vol3, Tiptronic Diagnosis / Troubleshooting, page D37/38 - 100 through D37/38 – 130.

**968:**

968 WSM, Vol. II, Diagnosis Tiptronic, page 37/38-201 through 37/38-234.

**993:**

993 WSM, Diagnose / troubleshooting Tiptronic, page 37-44 (1313) through 37-84.

*Fault Memory of Tiptronic control Unit*

DTC code	WSM ref page	Fault	Description
11			Signal Implausible
13			Voltage for drive links failed
14			Voltage for sensors failed
21			RPM signal from DME failed
22			Load signal from DME failed
23			Throttle Pot. Failed
24			Change of ignition timing
31			Solenoid valve 1 failed
32			Solenoid valve 2 failed
33			Solenoid valve torque converter clutch failed
34			Pressure regulator failed
35			Selector lever switch/transmission failed
36			Transmission speed sensor failed
37			Transmission temp. sensor failed
38			Selector lever switch/ transmission partial failure
42,43,44			Transmission control unit failure
45,46			Downshift fault in rev limiter
51			Manual program switch failed
52			Tip. Switch up and down failed
53			Kick down switch failed
54			Transverse accel. Sensor failed
55			Speed signal 1 from ABS control unit failed
56			Input to combination instrument failed
57			Input to combination instrument failed
58			Transmission oil cooler blower relay failed
59			Switch R-position failed
60			Reverse light relay failed

**Fault memory: clear faults****Fault memory: clear faults**

Using this button will send a message to the Tiptronic controller to clear all stored fault codes in the PDAS controller.

**Input signals**

This button starts the checks of sensors and displays their current state.

- Kick-down, Downshift and upshift.
- Manual program.
- Selector lever.

**Drive Links**

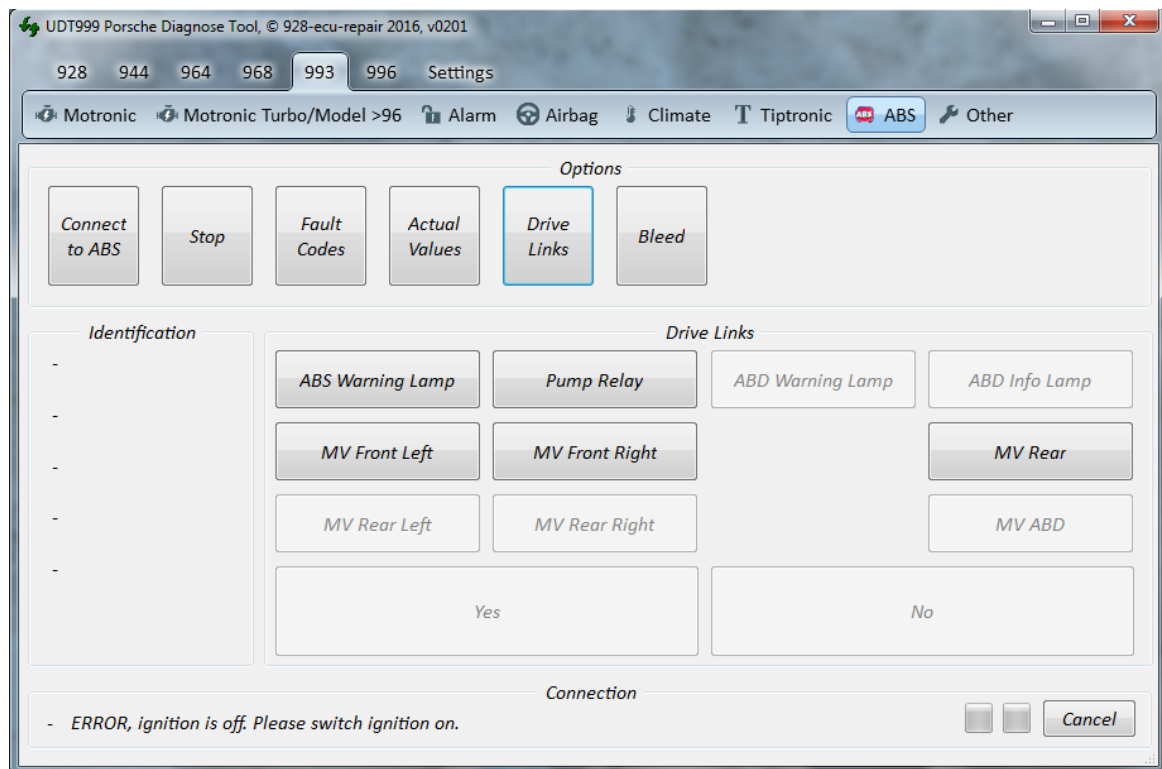
These switches active functions to be tested in the ecu for following items:

- Solenoid-1, and -2 (-3 and -4 for Porsche model 968)
- Torque converter clutch.
- Gear / shift indicator.
- Reverse relay.
- Ignition timing change.

**Actual values**

You can select each value you want to monitor by tagging the check box on the appropriate field. You can select more than one field if you'd like. Tagging many options at once however will slow down the update. A log file is created, and each field is presented in this log file. This makes importing it into spreadsheets or databases easy. By pushing the Values button, the process of acquiring the actual values is initiated, and it can be stopped by pushing it again.

## 15. ABS5 Ecu (993 series)



### Introduction

The ABS controller manages the abs in the 993 model. The diagnostic software module checks the system and identifies any possible malfunctions. There are three versions of the ABS ecu available.

- 1) ABS5 – 3-channel system (recognize with sticker with black edge)
- 2) ABS5 / ABD – 4 channel system (to end 94, recognize with sticker with yellow edge)
- 3) ABS5 / ABD – 4 channel system (from 94, recognize with sticker with red edge). This ecu is used in rear and four-wheel drive models.

### **Ignition light:**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

### **Engine runs**

The right light turns green when the controller knows that the engine is running. This is just verification.

### **Connect to Abs**

When the command button is pushed the software tries to connect to the Abs ecu, and tries to retrieve Abs version, PCB number, Part number and Software version. All this information is stored in the firmware (software) of the ECU. If all is o.k. the information will show in the appropriate fields in the screen. This is also verification that communication with the ecu has been established. The system is designed to retry 3 times if a failure to connect exists.

If it still failed to connect, the message "Cannot connect to Abs, turn-off and - on the ignition and try again" appears.

**Stop**

This stops the communication with the Abs controller. The Ack signal will stop flashing.

**Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the ABS ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

Fault codes that may be presented by the Diagnostics system are listed below. Additional information regarding DTC codes and troubleshooting can be found in the:

**993:**

993 WSM, Diagnosis / troubleshooting Anti-Lock System, page 45-01 (1351) through 45-45.

**Fault memory: clear faults**

Using this button will send a message to the ABS controller to clear all stored fault codes in the ABS controller.

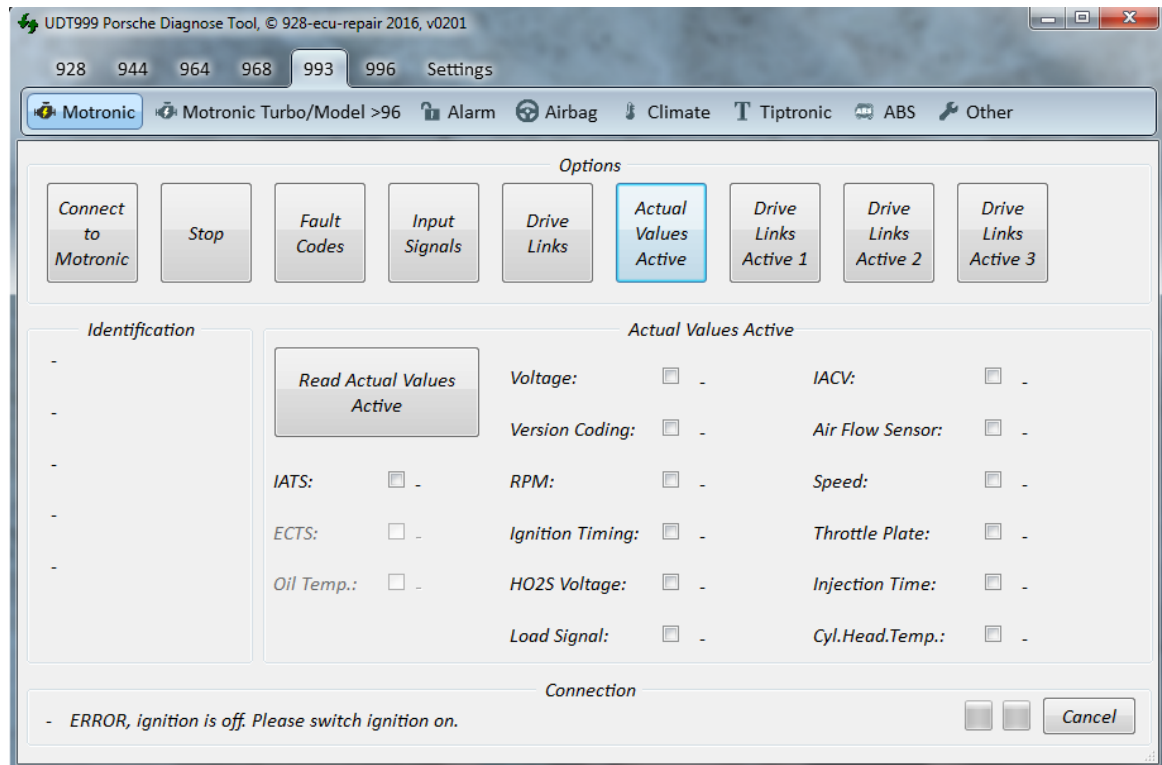
**Actual values**

You can select each value you want to monitor by tagging the check box on the appropriate field. You can select more than one field if you'd like. Tagging many options at once however will slow down the update. A log file is created and each field is presented in this log file. This makes importing it into spreadsheets or databases easy. By pushing the Values button, the process of acquiring the actual values is initiated, and it can be stopped by pushing it again.

**Bleed**

The bleed option is only available on ABS5 / ABD ecu's not on ABS5 ecu's. See details in the 993 Workshop manual

## 16. Motronic Ecu (968/993 series)



### Introduction

The Motronic manages both ignition and fuel injection in the 968 and 993 models. The diagnostic software module checks the system and identifies any possible malfunctions. There are several drive links to test functionality and locate problems.

The following is a brief explanation of functions and controls:

### **Ignition light:**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

### **Engine runs**

The right light turns green when the controller knows that the engine is running. This is just verification.

### **Connect to Motronic**

When the command button is pushed the software tries to connect to the Motronic ECU, and tries to retrieve Motronic version, PCB number, Part number and Software version. All this information is stored in the firmware (software) of the ECU. If all is o.k. the information will show in the appropriate fields in the screen. This is also verification that communication with the ECU has been established. The system is designed to retry 3 times if a failure to connect exists. If it still failed to connect, the message "Cannot connect to Motronic, turn-off and -on the ignition and try again" appears.

### **Stop**

This stops the communication with the Motronic controller. The Ack signal will stop flashing.



**Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the Motronic ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

Fault codes that may be presented by the Diagnostics system are listed below. Additional information regarding DTC codes and troubleshooting can be found in the:

**993:**

993 WSM, "DME diagnosis", page 24-1 through 24-55.

**968:**

968 WSM, Vol.1, "DME diagnosis / Troubleshooting", D24/28-1 through D24/28 – 31.

*Fault Memory of Motronic control Unit (993)***DTC Versions**

Version 1- Signal implausible / Implausible Component Section / Malfunction

Version 2- Interruption / No Signal

Version 3- Short to Ground / Below Lower Limit / Lean Mixture Limit

Version 4- Short to B+ / Above Upper Limit/ Rich Mixture Limit

**Malfunction Indicator Light MIL (Check engine)**

0- MIL is not triggered with this fault

1- MIL is on and Freeze Frame is stored in memory

2- MIL is on and a previous Freeze Frame is overridden

3- MIL is blinking and a previous Freeze Frame is overridden

DTC code	DTC Vers1	DTC Vers2	DTC Vers3	DTC Vers4	Mil	Description
115	P0101		P0102	P0103	1	Mass Air Flow Sensor
124			P0112	P0113	0	Air Intake Temperature Sensor
123	P0115		P0117		1	Engine Temperature Sensor
117			P0122	P0123	1	Throttle Position Sensor
10	P0130	P0134	P0131	P0132	1	HO2S behind TWC cylinders (1-3)
15			P0133		1	Aging of HO2S Ahead of TWC cylinders (1-3)
16			P0133		0	Aging of HO2S Ahead of TWC cylinders (1-3)
12	P0136	P0140	P0151	P0152	1	HO2S behind of TWC cylinders (1-3)
17			P0139		0	Aging of HO2S Behind of TWC cylinders (1-3)
18	P0150	P0154	P0151	P0152	1	O2S Behind of TWC cylinders (4-6)
21			P0153		1	Aging of HO2S Ahead of TWC cylinders (4-6)
22			P0153		0	Aging of HO2S Ahead of TWC cylinders (4-6)
20	P0156	P0160	P0157	P0158	1	HO2S behind of TWC cylinders (4-6)

23			P0159		0	Aging of HO2S Behind of TWC cylinders (4-6)
62	P0300				2	Misfire emission related
75	P0300				3	Misfire, damaging to TW
50	P0301				2	Misfire, cylinder 1, emission related
63	P0301				3	Misfire, cylinder 1, damaging to TWC
51	P0302				2	Misfire, cylinder 2, emission related
64	P0302				3	Misfire, cylinder 2, damaging to TWC
52	P0303				2	Misfire, cylinder 3, emission related
65	P0303				3	Misfire, cylinder 3, damaging to TWC
53	P0304				2	Misfire, cylinder 4, emission related
66	P0304				3	Misfire, cylinder 4, damaging to TWC
54	P0305				2	Misfire, cylinder 5, emission related
67	P0305				3	Misfire, cylinder 5, damaging to TWC
55	P0306				2	Misfire, cylinder 6, emission related
68	P0306				3	Misfire, cylinder 6, damaging to TWC
210	P0326				0	Knock Sensor 1
211	P0331				0	Knock Sensor 2
111	P0336				1	Crank Position Sensor
112	P0341				1	Camshaft Position Sensor
80	P0410				1	Secondary Air System Cylinders (1-3)
40			P0420		1	TWC Converting, cylinders (1-3)
45			P0430		1	TWC Converting, cylinders (4-6)
93			P0441		1	Fuel Tank Ventilation System
98		P0444	P0445	P0445	1	Fuel Tank Ventilation Valve
120	P0501				1	Vehicle Speed
32			P0506	P0507	1	Idle Air Control
101	P0604				1	ECM faulty (internal RAM)
102	P0604				1	ECM faulty (external RAM)
104	P0604				0	ECM faulty (DTC Memory)
103	P0605				1	ECM faulty (EPROM)
13			P1115	P1102	1	Heating of HO2S 1 ahead of TWC
14			P1117	P1105	1	Heating of HO2S 1 behind of TWC
5			P1119	P1107	1	Heating of HO2S 2 ahead of TWC
4			P1121	P1110	1	Heating of HO2S 2 behind TWC
27			P1123	P1124	2	Oxygen Sensing, Area 1 cylinders (1-3)
35			P1125	P1126	2	Oxygen Sensing, Area 1 cylinders (4-6)
26			P1127	P1128	2	Oxygen Sensing, Area 2 cylinders (1-3)
34			P1129	P1130	2	Oxygen Sensing, Area 2 cylinders (4-6)
121	P1140				1	Load Signal
150		P1237	P1225	P1213	1	Fuel Injector, Cylinder 1
151		P1238	P1226	P1214	1	Fuel Injector, Cylinder 2
152		P1239	P1227	P1215	1	Fuel Injector, Cylinder 3
153		P1240	P1228	P1216	1	Fuel Injector, Cylinder 4
154		P1241	P1229	P1217	1	Fuel Injector, Cylinder 5
155		P1242	P1230	P1218	1	Fuel Injector, Cylinder 6

#### Fault memory: clear faults

Using this button will send a message to the Motronic controller to clear all stored fault codes in the Motronic controller.

#### Input signals

This button starts the checks of sensors and displays their current state by turning on or off the adjacent blue light:

- **Throttle Idle.** The throttle switch at the intake valve is engaged, signaling that the idle circuit must manage the idle rpm
- **Throttle Full.** The full throttle contact is engaged signaling that the maximum performance is required. This makes the fuel mixture become a bit rich and the management goes into open loop operation, ignoring lambda values.
- **Ign Timing.** This shows the amount of pre-ignition set by the ecu.

- 
- **TR (only 993)** This needs more details
  - **AC switch.** This shows that the AC button is pressed and the ecu must respond by managing idle rpm at a slightly higher level
  - **Sign Heat (only 993)** This needs more details
  - **Ref Mark.** This signals the reference mark on the flywheel. The Ref mark is detected and evaluated by the motronic ignition circuits.
  - **Cool Fluid.** This needs more details

#### Drive Links

These switches active functions to be tested in the ecu for following items:

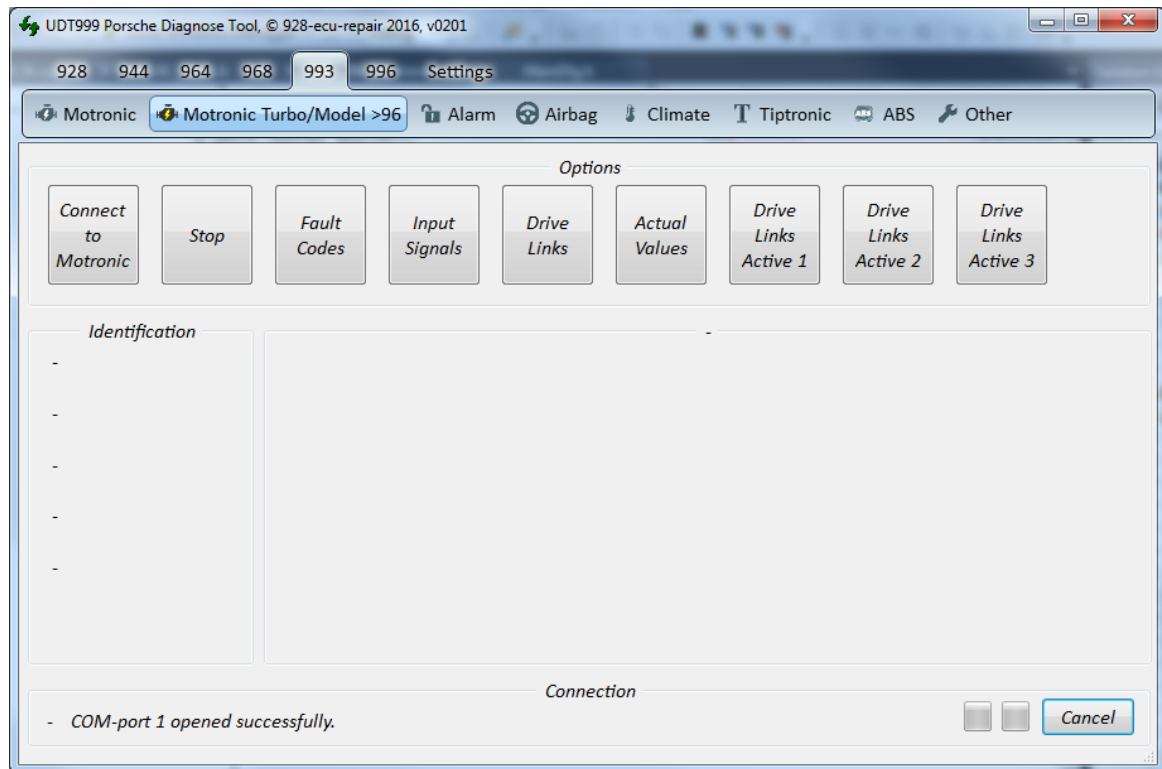
- **Inj1.** Cylinder 1 Fuel Injector (small clicking sound as it is opened, then closed; repeatedly. [FWIW -- 1,6,2,4,3,5 is the engine's firing order in a 993.]
- **Inj2.** Cylinder 2 Fuel Injector (small clicking sound)
- **Inj3.** Cylinder 3 Fuel Injector (small clicking sound)
- **Inj4.** Cylinder 4 Fuel Injector (small clicking sound)
- **Inj5 (only 993).** Cylinder 5 Fuel Injector (small clicking sound)
- **Inj6 (only 993).** Cylinder 6 Fuel Injector (small clicking sound)
- **Idle Stab.** ISV, Idle Speed Control; ISV (big click as activated)
- **Tank Vent.** Tank Venting Valve (big click as activated)
- **Resonance flap.** Resonance Plate (BIG click as activated)
- **Varioram (only for 993).** This activates the varioram control
- **AC relay.** AC relay is activated increasing the idle rpm
- **Variocam (only for 968).** This activates the variocam control

#### Actual Values

The actual values are showed for the following items:

- **Vbat.** The battery voltage value is shown
- **Oil temp** The Oil temperature value is shown.
- **Outside temp** The Outside temperature sensor value is shown.

## 17. Motronic Ecu (993-T/993-US series)



### **Introduction**

The Motronic manages both ignition and fuel injection in the 993 models (Model year > 1995 and 993 Turbo). The diagnostic software module checks the system and identifies any possible malfunctions.

### **Ignition light:**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

### **Engine runs**

The right light turns green when the controller knows that the engine is running. This is just verification.

### **Connect to Motronic**

When the command button is pushed the software tries to connect to the Motronic ECU, and tries to retrieve Motronic version, PCB number, Part number and Software version. All this information is stored in the firmware (software) of the ECU. If all is o.k. the information will show in the appropriate fields in the screen. This is also verification that communication with the ECU has been established. The system is designed to retry 3 times if a failure to connect exists. If it still failed to connect, the message "Cannot connect to Motronic, turn-off and -on the ignition and try again" appears.

### **Stop**

This stops the communication with the Motronic controller. The Ack signal will stop flashing.

**Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the Motronic ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

*Fault Memory of Motronic control Unit (993)***DTC Versions**

Version 1- Signal implausible / Implausible Component Section / Malfunction

Version 2- Interruption / No Signal

Version 3- Short to Ground / Below Lower Limit / Lean Mixture Limit

Version 4- Short to B+ / Above Upper Limit/ Rich Mixture Limit

**Malfunction Indicator Light MIL (Check engine)**

4- MIL is not triggered with this fault

5- MIL is on and Freeze Frame is stored in memory

6- MIL is on and a previous Freeze Frame is overridden

7- MIL is blinking and a previous Freeze Frame is overridden

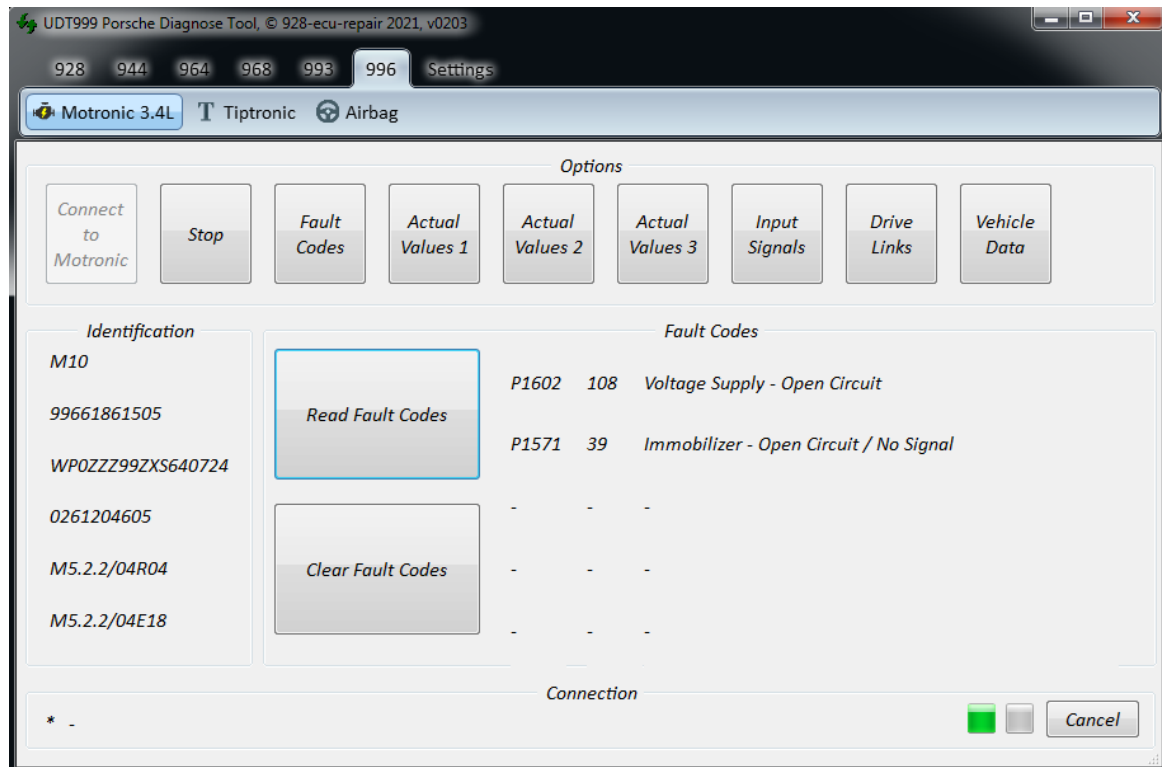
DTC code	DTC Vers1	DTC Vers2	DTC Vers3	DTC Vers4	Mil	Description
115	P0101		P0102	P0103	1	Mass Air Flow Sensor
124			P0112	P0113	0	Air Intake Temperature Sensor
123	P0115		P0117		1	Engine Temperature Sensor
117			P0122	P0123	1	Throttle Position Sensor
10	P0130	P0134	P0131	P0132	1	HO2S behind TWC cylinders (1-3
15			P0133		1	Aging of HO2S Ahead of TWC cylinders (1-3)
16			P0133		0	Aging of HO2S Ahead of TWC cylinders (1-3)
12	P0136	P0140	P0151	P0152	1	HO2S behind of TWC cylinders (1-3)
17			P0139		0	Aging of HO2S Behind of TWC cylinders (1-3)
18	P0150	P0154	P0151	P0152	1	O2S Behind of TWC cylinders (4-6)
21			P0153		1	Aging of HO2S Ahead of TWC cylinders (4-6)
22			P0153		0	Aging of HO2S Ahead of TWC cylinders (4-6)
20	P0156	P0160	P0157	P0158	1	HO2S behind of TWC cylinders (4-6)
23			P0159		0	Aging of HO2S Behind of TWC cylinders (4-6)
62	P0300				2	Misfire emission related
75	P0300				3	Misfire, damaging to TW
50	P0301				2	Misfire, cylinder 1, emission related
63	P0301				3	Misfire, cylinder 1, damaging to TWC
51	P0302				2	Misfire, cylinder 2, emission related
64	P0302				3	Misfire, cylinder 2, damaging to TWC
52	P0303				2	Misfire, cylinder 3, emission related
65	P0303				3	Misfire, cylinder 3, damaging to TWC
53	P0304				2	Misfire, cylinder 4, emission related

66	P0304				3	Misfire, cylinder 4, damaging to TWC
54	P0305				2	Misfire, cylinder 5, emission related
67	P0305				3	Misfire, cylinder 5, damaging to TWC
55	P0306				2	Misfire, cylinder 6, emission related
68	P0306				3	Misfire, cylinder 6, damaging to TWC
210	P0326				0	Knock Sensor 1
211	P0331				0	Knock Sensor 2
111	P0336				1	Crank Position Sensor
112	P0341				1	Camshaft Position Sensor
80	P0410				1	Secondary Air System Cylinders (1-3)
40			P0420		1	TWC Converting, cylinders (1-3)
45			P0430		1	TWC Converting, cylinders (4-6)
93			P0441		1	Fuel Tank Ventilation System
98		P0444	P0445	P0445	1	Fuel Tank Ventilation Valve
120	P0501				1	Vehicle Speed
32			P0506	P0507	1	Idle Air Control
101	P0604				1	ECM faulty (internal RAM)
102	P0604				1	ECM faulty (external RAM)
104	P0604				0	ECM faulty (DTC Memory)
103	P0605				1	ECM faulty (EPROM)
13			P1115	P1102	1	Heating of HO2S 1 ahead of TWC
14			P1117	P1105	1	Heating of HO2S 1 behind of TWC
5			P1119	P1107	1	Heating of HO2S 2 ahead of TWC
4			P1121	P1110	1	Heating of HO2S 2 behind TWC
27			P1123	P1124	2	Oxygen Sensing, Area 1 cylinders (1-3)
35			P1125	P1126	2	Oxygen Sensing, Area 1 cylinders (4-6)
26			P1127	P1128	2	Oxygen Sensing, Area 2 cylinders (1-3)
34			P1129	P1130	2	Oxygen Sensing, Area 2 cylinders (4-6)
121	P1140				1	Load Signal
150		P1237	P1225	P1213	1	Fuel Injector, Cylinder 1
151		P1238	P1226	P1214	1	Fuel Injector, Cylinder 2
152		P1239	P1227	P1215	1	Fuel Injector, Cylinder 3
153		P1240	P1228	P1216	1	Fuel Injector, Cylinder 4
154		P1241	P1229	P1217	1	Fuel Injector, Cylinder 5
155		P1242	P1230	P1218	1	Fuel Injector, Cylinder 6

#### **Fault memory: clear faults**

Using this button will send a message to the Motronic controller to clear all stored fault codes in the Motronic controller.

## 18. Motronic Ecu (996 series)



### Introduction

The Motronic manages both ignition and fuel injection in the 996 models. The diagnostic software module checks the system and identifies any possible malfunctions.

### **Ignition light:**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

### **Engine runs**

The right light turns green when the controller knows that the engine is running. This is just verification.

### **Connect to Motronic**

When the command button is pushed the software tries to connect to the Motronic ECU, and tries to retrieve Motronic version, PCB number, Part number VIN number. All this information is stored in the firmware (software) of the ECU. If all is o.k. the information will show in the appropriate fields in the screen. This is also verification that communication with the ECU has been established. The system is designed to retry 3 times if a failure to connect exists. If it still failed to connect, the message "Cannot connect to Motronic, turn-off and -on the ignition and try again" appears.

### **Stop**

This stops the communication with the Motronic controller. The Ack signal will stop flashing.

**Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the Motronic ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

**DME 5.2.2 Error codes:**

P0101	Mass air flow sensor
P0102	Mass air flow sensor
P0103	Mass air flow sensor
P0112	Intake air temperature sensor
P0113	Intake air temperature sensor
P0115	Engine temperature sensor
P0117	Engine temperature sensor
P0118	Engine temperature sensor
P0122	Throttle position sensor
P0123	Throttle position sensor
P0130	Oxygen sensor ahead of catalytic converter
P0131	Oxygen sensor ahead of catalytic converter
P0132	Oxygen sensor ahead of catalytic converter
P0133	Aging of oxygen sensor ahead of catalytic converter
P0134	Oxygen sensor ahead of catalytic converter
P0136	Oxygen sensor after catalytic converter
P0137	Oxygen sensor after catalytic converter
P0138	Oxygen sensor after catalytic converter
P0139	Aging of oxygen sensor after catalytic converter
P0140	Oxygen sensor after catalytic converter
P0150	Oxygen sensor ahead of catalytic converter
P0151	Oxygen sensor ahead of catalytic converter
P0152	Oxygen sensor ahead of catalytic converter
P0153	Aging of oxygen sensor ahead of catalytic converter
P0154	Oxygen sensor ahead of catalytic converter
P0156	Oxygen sensor after catalytic converter
P0157	Oxygen sensor after catalytic converter
P0158	Oxygen sensor after catalytic converter
P0159	Aging of oxygen sensor after catalytic converter
P0160	Oxygen sensor after catalytic converter
P0197	Oil temperature sensor
P0198	Oil temperature sensor
P0300	Misfire damaging to catalytic converter
P0301	Misfire, cylinder 1, damaging to catalytic converter
P0302	Misfire, cylinder 2, damaging to catalytic converter
P0303	Misfire, cylinder 3, damaging to catalytic converter
P0304	Misfire, cylinder 4, damaging to catalytic converter
P0305	Misfire, cylinder 5, damaging to catalytic converter
P0306	Misfire, cylinder 6, damaging to catalytic converter
P0336	Crankshaft position sensor
P0341	Camshaft position sensor 1
P0410	Secondary air injection system
P0420	Catalytic converter conversion
P0430	Catalytic converter conversion



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P0440	Fuel Tank Ventilation System – Above Limit
P0441	Fuel Tank Ventilation System – Above Limit
P0442	Fuel tank ventilation system (micro-leak)
P0444	EVAP canister purge valve
P0445	EVAP canister purge valve
P0446	EVAP canister shutoff valve
P0447	EVAP canister shutoff valve
P0448	EVAP canister shutoff valve
P0450	Tank pressure sensor
P0452	Tank pressure sensor
P0453	Tank pressure sensor
P0455	Fuel tank ventilation system (major leak)
P0501	Vehicle speed
P0506	Idle air control
P0507	Idle air control
P0600	CAN timeout
P0603	Control module
P0604	Control module
P0605	Control module
P1102	Oxygen sensor heating
P1105	Oxygen sensor heating
P1107	Oxygen sensor heating
P1110	Oxygen sensor heating
P1115	Oxygen sensor heating
P1117	Oxygen sensor heating
P1119	Oxygen sensor heating
P1121	Oxygen sensor heating
P1123	Oxygen sensing system
P1124	Oxygen sensing system
P1125	Oxygen sensing system
P1126	Oxygen sensing system
P1127	Oxygen sensing system
P1128	Oxygen sensing system
P1129	Oxygen sensing system
P1130	Oxygen sensing system
P1140	Load sensing
P1157	Engine compartment temperature sensor
P1158	Engine compartment temperature sensor
P1213	Fuel injector, cylinder 1
P1214	Fuel injector, cylinder 2
P1215	Fuel injector, cylinder 3
P1216	Fuel injector, cylinder 4
P1217	Fuel injector, cylinder 5
P1218	Fuel injector, cylinder 6
P1225	Fuel injector, cylinder 1
P1226	Fuel injector, cylinder 2
P1227	Fuel injector, cylinder 3
P1228	Fuel injector, cylinder 4
P1229	Fuel injector, cylinder 5
P1230	Fuel injector, cylinder 6
P1237	Fuel injector, cylinder 1
P1238	Fuel injector, cylinder 2
P1239	Fuel injector, cylinder 3
P1240	Fuel injector, cylinder 4
P1241	Fuel injector, cylinder 5
P1242	Fuel injector, cylinder 6
P1265	Airbag signal
P1275	Aging of oxygen sensor ahead of catalytic converter
P1276	Aging of oxygen sensor ahead of catalytic converter
P1313	Misfire, cylinder 1, emission relevant
P1314	Misfire, cylinder 2, emission relevant
P1315	Misfire, cylinder 3, emission relevant
P1316	Misfire, cylinder 4, emission relevant

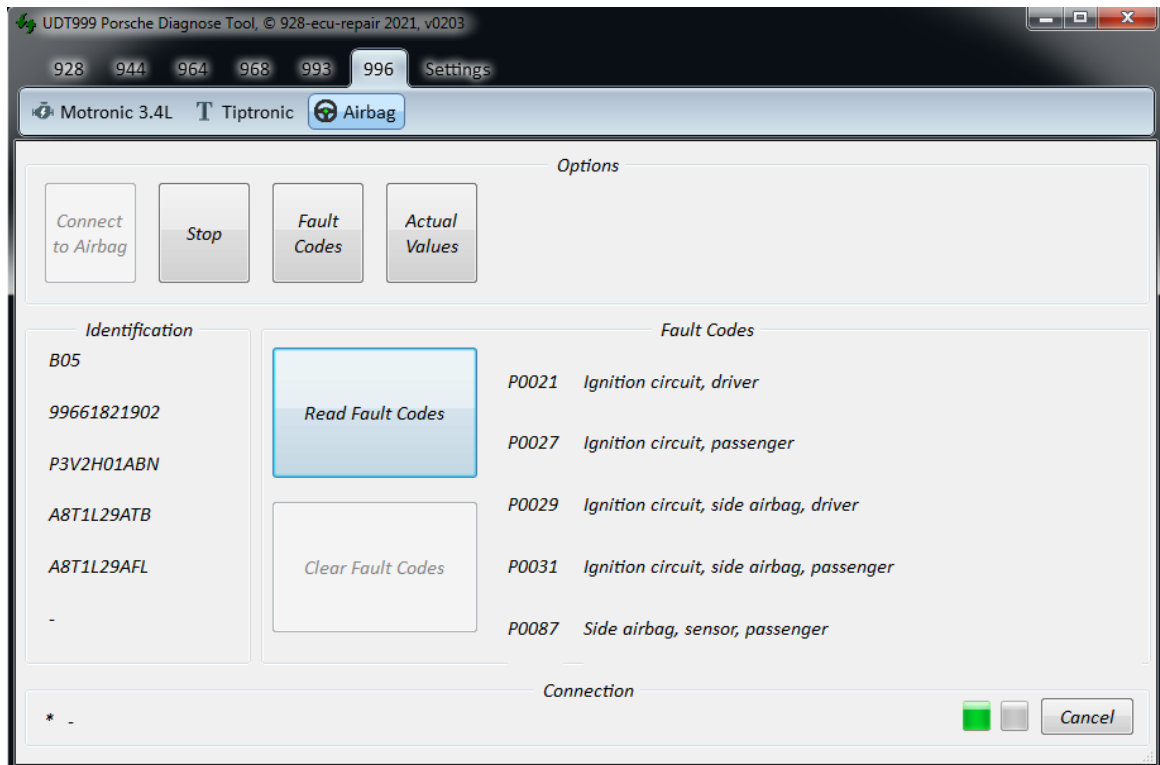
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P1317	Misfire, cylinder 5, emission relevant
P1318	Misfire, cylinder 6, emission relevant
P1319	Misfire, emission relevant
P1324	Timing chain out of position, bank 2
P1340	Timing chain out of position, bank 1
P1384	Knock sensor 1
P1385	Knock sensor 2
P1386	Knock control test pulse
P1397	Camshaft position sensor 2
P1411	Secondary air injection system
P1455	A/C compressor control
P1456	A/C compressor control
P1457	A/C compressor control
P1501	Fuel pump relay output stage
P1502	Fuel pump relay output stage
P1510	Idle air control valve
P1512	Intake manifold switchover 1
P1513	Idle air control valve
P1514	Idle air control valve
P1515	Intake manifold switchover 1
P1516	Intake manifold switchover 1
P1524	Camshaft adjustment, bank 2
P1530	Camshaft adjustment, bank 1
P1531	Camshaft adjustment, bank 1
P1539	Camshaft adjustment, bank 2
P1541	Fuel pump relay output stage
P1551	Idle air control valve
P1552	Idle air control valve
P1553	Idle air control valve
P1570	Immobilizer
P1571	Immobilizer
P1585	Misfire with empty fuel tank
P1600	Voltage supply
P1601	Voltage supply
P1602	Voltage supply
P1640	Control module faulty
P1671	Engine compartment purge fan output stage
P1673	Fan output stage
P1689	Control module faulty
P1691	MIL (Check Engine)
P1692	MIL (Check Engine)
P1693	MIL (Check Engine)
P1782	Engine engagement / nominal engine torque

**Fault memory: clear faults**

Using this button will send a message to the Motronic controller to clear all stored fault codes in the Motronic controller.

## 19. Airbag Ecu (996/Boxster series)



### Introduction

The Airbag controller manages the airbag system and identifies any possible malfunctions. There are no drive links. Drive links would be to test the function of the airbag which seems not appropriate here. This module is probably also used in another Porsche: Boxster.

### **Ignition light:**

If 12v is supplied through the car (ignition switch turned on) the left light will show green and signals that the system is ready to accept commands.

### **Engine runs**

The right light turns green when the controller knows that the engine is running. This is just verification.

### **Connect to Airbag**

When the command button is pushed the software tries to connect to the Airbag ECU, and tries to retrieve Airbag version, PCB number, Part number VIN number. All this information is stored in the firmware (software) of the ECU. If all is o.k. the information will show in the appropriate fields in the screen. This is also verification that communication with the ECU has been established.

The system is designed to retry 3 times if a failure to connect exists.

If it still failed to connect, the message "Cannot connect to Airbag, turn-off and -on the ignition and try again" appears.

### **Stop**

This stops the communication with the Airbag controller. The Ack signal will stop flashing.

**Ack**

The Ack (acknowledgement) left bottom sign: when active and signals communication of data between controller and software. It is normal that it blinks during a session. When engine is running and the session is busy the sign # will flash visible. If session is busy with only ignition on, the sign '\*' will flash visible.

**Fault memory: check faults**

Using this button will interrogate and display the stored fault codes of the Airbag ECU. If the system reports an "unknown fault", the message "Please send the information CMD + Data on screen to [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)" appears. Please inform us and we will get in touch with you. We will try to diagnose your problem and provide a software upgrade if required.

**Airbag Error codes:**

P0001	Airbag Warning Light
P0002	Airbag Warning Light
P0003	Power Supply
P0004	Ignition circuit, driver
P0005	Ignition circuit, driver
P0006	Belt tensioner, driver
P0007	Belt tensioner, driver
P0008	Belt tensioner, passenger
P0009	Belt tensioner, passenger
P0010	Ignition circuit, passenger
P0011	Ignition circuit, passenger
P0012	Ignition circuit, side airbag, driver
P0013	Ignition circuit, side airbag, driver
P0014	Ignition circuit, side airbag, passenger
P0015	Ignition circuit, side airbag, passenger
P0020	Ignition circuit, driver
P0021	Ignition circuit, driver
P0022	Belt tensioner, driver
P0023	Belt tensioner, driver
P0024	Belt tensioner, passenger
P0025	Belt tensioner, passenger
P0026	Ignition circuit, passenger
P0027	Ignition circuit, passenger
P0028	Ignition circuit, side airbag, driver
P0029	Ignition circuit, side airbag, driver
P0030	Ignition circuit, side airbag, passenger
P0031	Ignition circuit, side airbag, passenger
P0036	Ignition circuit, driver
P0037	Belt tensioner, driver
P0038	Belt tensioner, passenger
P0039	Ignition circuit, passenger
P0040	Ignition circuit, side airbag, driver
P0041	Ignition circuit, side airbag, passenger
P0044	Belt buckle, driver
P0045	Belt buckle, driver
P0046	Belt buckle, driver
P0047	Belt buckle, passenger
P0048	Belt buckle, passenger
P0049	Belt buckle, passenger
P0050	Belt buckle, driver
P0051	Belt buckle, passenger
P0052	Side airbag, sensor, driver
P0053	Side airbag, sensor, driver

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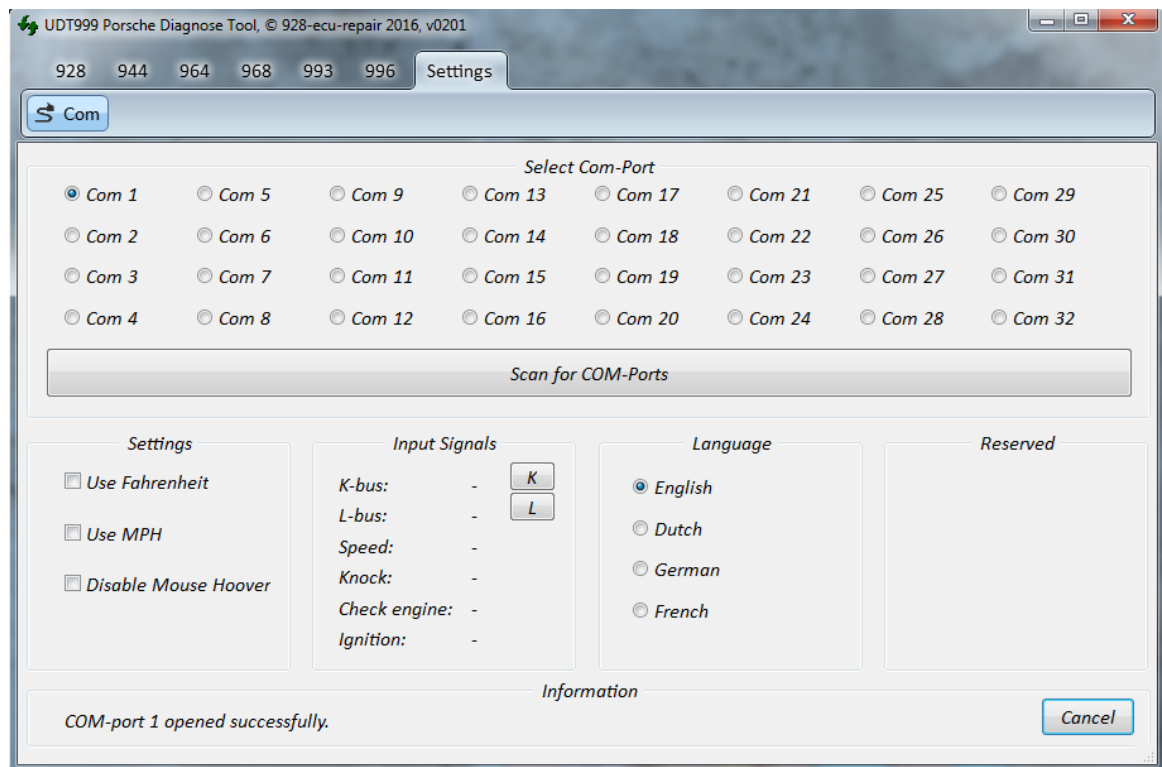
P0055	Side airbag, sensor, passenger
P0056	Side airbag, sensor, passenger
P0063	Seat occupancy detection, passenger
P0064	Seat occupancy detection, passenger
P0065	Seat occupancy detection, passenger
P0066	Child seat detection
P0067	Child seat detection
P0068	Child seat detection
P0069	Child seat detection
P0085	Side airbag, sensor, driver
P0086	Side airbag, sensor, driver
P0087	Side airbag, sensor, passenger
P0088	Side airbag, sensor, passenger

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## 20. Tiptronic Ecu (996 series)

<under construction>

## 21. Settings



This Tab is intended to provide access to specific settings.  
A short overview of controls and functions follows:

### 21.1. Com port settings

This feature enables you to select the desired language. The software uses an external text table which resides in a subdirectory of the application. Based on your

The software uses the COM port of the PC to communicate with the interface to the Porsche ecu's.

On the DT9xx series the com port is a serial 9pin port located on the interface fox. Optionally a serial to USB converter is used.

The UDT999 series have a USB cable that goes directly to the PC. This com-port is normally the COM1, but since you may use a different hardware configuration, you can adjust the default comport by using the comport selector control. Your selection is saved in the file "UDT999\_settings.txt" file as a default preference. The existing ports in your configuration are shown, non-existing ports are grey-ed out. Be aware that your previous port is remembered. If you use a USB connection it needs to be connected to be able to select the port. The system will automatically try to use the last selected port which is recorded in the settings. If your configuration has changed since last saved setting, you may end up communicating to a non-existing port which will obviously fail. Press the "scan for COM ports" button to check which ports are available for your tool.

When you start to use the USB to serial converter or direct USB connection with the UDT999, you may need to install a driver. This depends on what Windows version your PC is running and if it is connected to internet for driver download.

The driver for the UDT999 is normally automatically detected and installed on newer systems, and it also available on our download server for use with older

operating systems like XP that do not auto detect the driver. Install this driver in case your operating system does not automatically detect the USB device.

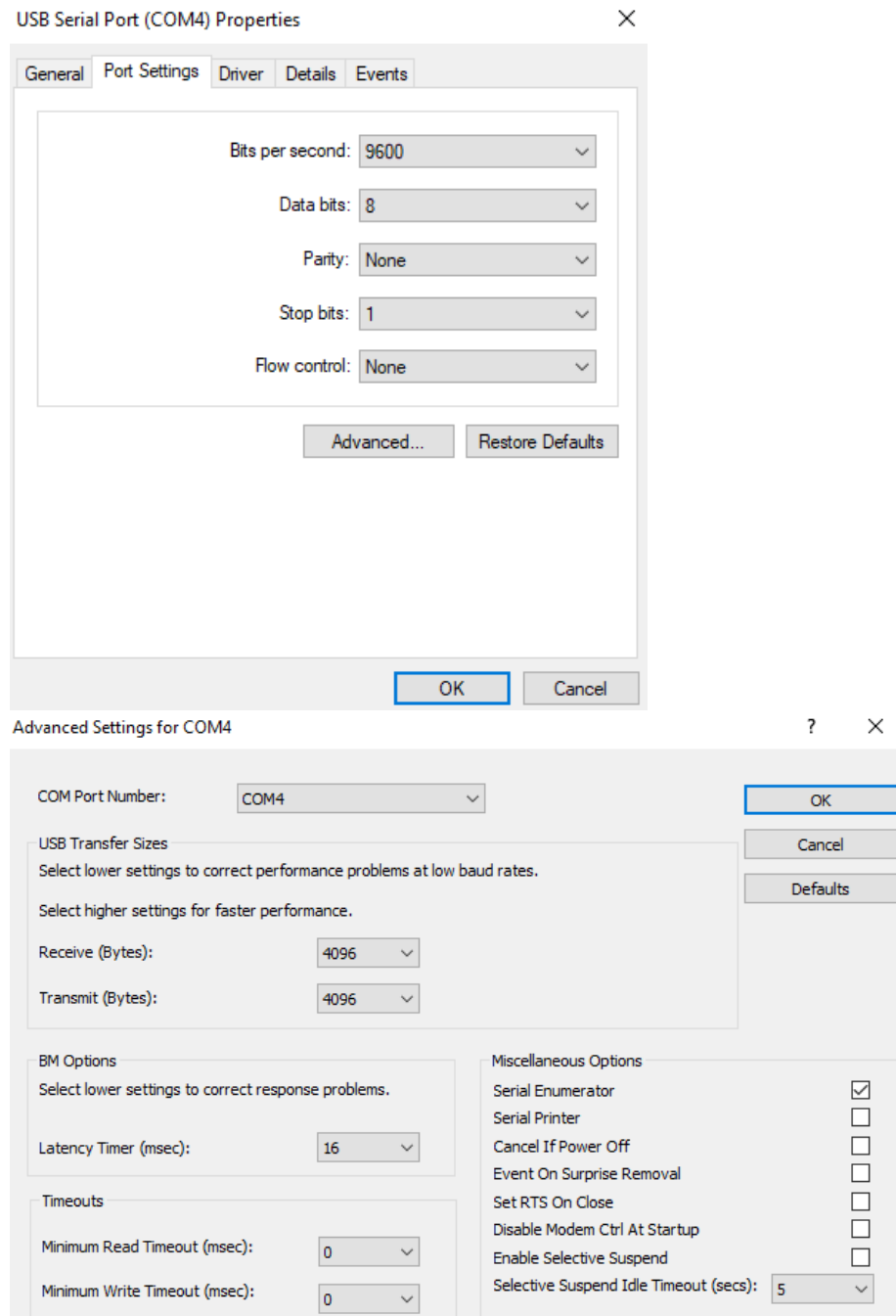
This USB driver translates the USB signal to a virtual com port on your PC. It will show up on your PC like this:



In this example the port is assigned to com4.

Windows automatically assigns a new comport to your system when a new USB comport device is connected. If a system has seen many different adapt-ers it is possible that is has assigned a com port beyond com9. If you use dif-ferent USB ports on your PC, please notice that the comport number differs. To correct a comport assignment, please go into the system hardware device manager of your windows PC, select the port, select advanced options, and open the com port number dialog. This is where you can define your preferred port number. (on a Win10 system simply type "Computer Management" in the search field of the task bar)





Make sure you don't overlap with an existing port. Vista requires a PC to re-boot to make the change effective. Windows 10 and XP do not.

A total absence or serial ports may trigger a message from the application software that informs you about the port configuration problem. Please look into this at your PC. This is designed behavior.

One of the things you must be aware of, is that port recognition of the UDT999 software only happens when you start the program or rescan the ports. So, connecting the USB interface will have to be done prior to starting the program. Otherwise you will not see the USB-com port in the application software.

So, a simple quick ref:

DT9xx: connect serial cable to comport on your PC. Check what comport you are using. Run the program. Select the correct comport on the settings tab, and you're ready to go.

DT9xx with USB converter: connect USB converter to the serial port on the interface box. Install the USB driver that came with the converter. Connect the

USB converter to your PC. Run the program. Select the correct comport on the settings tab, and you're ready to go.

UDT999: connect the USB cable to your PC. The driver will automatically install over the internet. Run the program. Select the correct comport on the settings tab, and you're ready to go.

## 21.2. Input signals

The interface module uses some signals to communicate with the car's electronics. The signals are shown here. An explanation is documented below:

Check Engine	Engine MIL light, signals engine flash code
Speed	Speed signal from the flywheel sensor
Knock	Knock sensor signal from the ecu
K-line	K line signal from the diagnostic bus
Ignition	Ignition switched on (12v)
L-line	L line signal from the diagnose bus (only applicable for UDT model 3)

There's one neat function button: "K". Pushing this button triggers the K line to switch state, which should be reflected on the left field showing a response from the system. A response indicates a working communication over the configured port, no more. This is a very useful test to verify serial port communications. The best procedure is this:

Start the software and go to the settings tab, connect the interface to the car and to the PC, turn ignition on, notice the green light on the interface and on the screen (check engine LED), verify the K-counter when pushing then K-line button. Now, to avoid the possibility that you are looking at an internal modem port or such, unplug the RS232 cable between PC serial port and the interface, and test the K-line again. It should not be responding anymore as the cable is now disconnected!!! If it still responds you are probably setting the wrong PC port to communicate with.

## 21.3. Temp in Fahrenheit

This checkbox makes all temperature presentations show in Fahrenheit when checked. Otherwise all temperatures are shown in degrees Celsius. Your selection is saved in the file "udt999\_settings.txt" file as a default preference.

## 21.4. Speed in MPH

This checkbox makes all speed presentations show in MPH (Miles Per Hour) when checked. Otherwise all speed is shown in RPM (Rotations Per Minute). Your selection is saved in the file "udt999\_settings.txt" file as a default preference.

## 21.5. Disable Mouse Hoover

When you move the mouse above a button, after three seconds a window appears with a small note with the function of the button. Default this feature is enabled. But you can disable the mouse hoover when you select this setting.

## 21.6. Language setting

This feature enables you to select the desired language. The software uses an external text table which resides in a subdirectory of the application. Based on your language selection and the TAB you select on the screen; a different text file is used. Currently the tool supports four languages "English, Dutch, French and German".

## 21.7. Service and Support

The hardware and software that we offer was thoroughly tested before shipping. For the unlikely event that the product fails to function according to specification we offer one year full repair warranty (send in and return). Transportation and any tampering or misuse is excluded from this warranty.

Despite of our thoroughness it is still possible that some error condition is shown wrong or missed in the design. We ask for your understanding, as we had to reverse engineer almost all functions and features since Porsche did not share this information publicly. We would like to know if any conditions exist and encourage you to get in touch with us via email ([928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)). We will provide bug fixes and updates free of charge for everyone who bought the product.

The diagnostic interface uses a standard RS232 interface. Many new notebooks only carry USB ports so a USB to serial interface converter is called for. Due to the many compatibility problems with USB converters on the market, we only provide support for the one that we offer.

Last, but not least, we would like to bring our **928 LH ecu repair service** to your attention. We offer diagnose and repair of broken LH ecu's and MAF's at a fair price. Please visit our website at <http://www.928-ecu-repair.com> or <http://928gts.jenniskens.eu>

We hope that our product will be very useful for you and appreciate your comments and thoughts to improve it.

## 21.8. Contact

If you would like to get in touch with us, please do not hesitate to contact us via e-mail at one of these addresses:

Theo Jenniskens: [928-diag@jenniskens.livedsl.nl](mailto:928-diag@jenniskens.livedsl.nl)

Paul Moers: [928-ecu-repair@hetnet.nl](mailto:928-ecu-repair@hetnet.nl)

We would appreciate any testimonials, and suggestions or comments that you might have to improve our product.

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## 22. References and Acknowledgements

Several resources have been used to design, develop and build this diagnostic system. Just to name a few:

Internet:

Andy Whittaker's website on OBD and OBD2

Rennlist Discussion Forum

<http://www.troublecodes.net/>

<http://freediag.sourceforge.net/>

<http://www.obd2-interface.netfirms.com/>

Porsche manuals:

928 S4 '89 - Diagnosis of the Instrument Cluster

928S4 PSD

Test Plan ABS 928 944 all yrs

928 Diagnosis w 9288 (Hammer)

928 Airbag System

Oxygen Sensor & Catalytic Converter

87 Test Plan EZF and LH

944S 928S4 '89 – Diagnosis of EZK, LH with Tester9268

928 Air Flow Controlled Fuel Injection

Service Info Tech 1990 S4 GT (and others)

We would like to thank Barry and Jason for their review work and comments.

A special thank you goes out to Claus Schweiker who helped us a lot with the translation into German language.

Also, we would like to thank Peter from P&P parts, <http://www.porsche-parts.nl> for the help, advice, and support during the many times he let us use his workshop equipment to aid in our developments.

## 23. Disclaimer

We have taken considerable care in preparing information and materials for our product. However, 928-ecu-repair and its affiliates assume no responsibility or liability for any injury, loss or damage incurred as a result of any use or reliance upon the information and material contained within our products.