P5M

Automotive Training Courses
TRAINEE manual

MARINE IDC5 - Basic learning

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TEXA EDU

INDEX

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Legend:

Warning

Information/Notes

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1. INTRODUCTION

This manual aims at providing the most advanced information and knowledge of the TEXA diagnostic software to perform self-diagnosis on vehicles. It is suitable for personnel (technicians and mechanics) who are interested in knowing the basic principles of Self-diagnosis and basic electro-mechanical knowledge.
This manual also provides the most detailed technical information for advanced features that are now available with the new generations of electronic control units, equipped in the most modern vehicles.

1.1 Electronic Control Unit Operation

An Electronic Control Unit is basically a computer that is in charge of managing and verifying the operation of a system. To do this, it needs to obtain information through the SENSORS and change the operating parameters of the system through the ACTUATORS. For operation, a supply voltage is of course needed and, in the case of complex electronic board architectures, a data exchange line with other control units (CAN network).

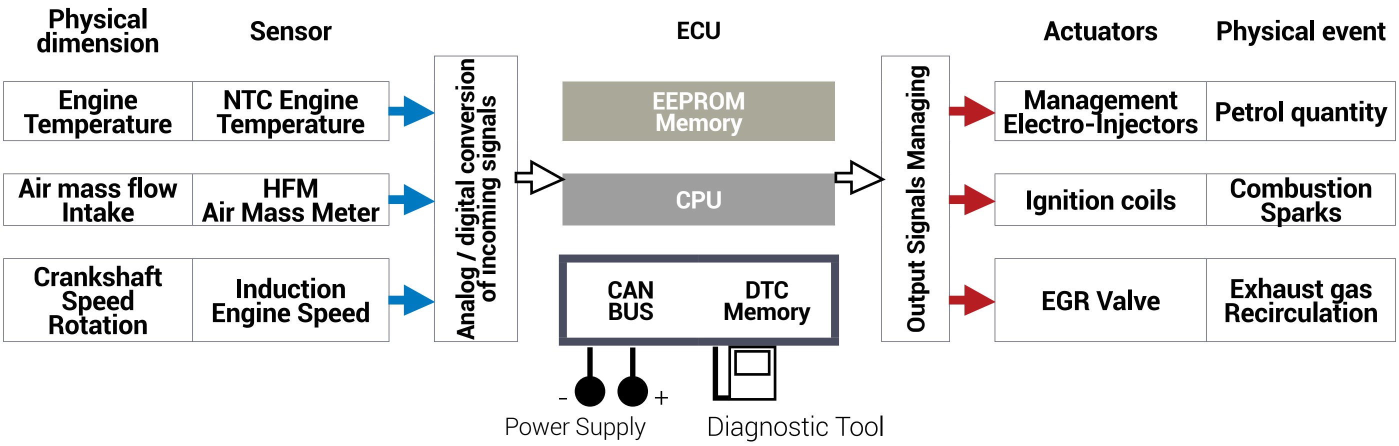

Figure 1

The ability of an ECU to monitor the operation of everything that it is connected to, as well as its own operation, takes the name of Self-Diagnosis.
Self-Diagnosis is the ability of the electronic control unit to control itself and to detect any failures that are stored in a "faulty memory" section.
In order to read and clear the "Fault Memory", you need to use a diagnostic tool that has the function of displaying the detected errors but does not implement any particular fault search.
The latest generation of controllers have an evolved software that can detect a wider range of errors, but the principle remains the same as the self-diagnosis tool reads the detected DTCs that an ECU has detected itself.
On the elements and devices of an electronic system, the control units are able to perform two different types of analysis and control:

1. Electrical analysis and control (short circuit - open circuit - out of range);
2. Analysis and functional control (plausibility of information - self-adaptability).

As a practical example, consider the following cases:

1. **Electrical Type Diagnosis**: It produces signals that cause the display of the "Engine Temperature Sensor" DTC caused by the damage or short circuit in the NTC (Negative Temperature Coefficient) sensor. The control unit identifies the current DTC by an evaluation of the intensity of the current circulating in the sensor or rather that the value of the latter does not fall again within a predetermined range (interval).
2. **Functional Diagnosis**: It is produced by a particular evaluation of the control unit and not by a single direct physical cause. The result of a functional diagnosis is, for example, the "Self-Adaptive Parameters" error that comes through the analysis of the oxygen sensor, which affects the modification of the mixture parameters.

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1.2 Ground and Power Supply

Although with some obvious limitations (if the power supply is completely missing, the control unit obviously does not work and is not able to communicate with the diagnostic tool), the control units generally control their power supply.
This is to verify and ensure their regular operation (some units do not work below minimum thresholds) and to handle more appropriately a low power supply situation (inhibition strategies for some non-vital activations and reduced operation of some systems).

Figure 2

It may happen that, due to oxidation or improper installation, not all of the ground points fit perfectly to the vehicle body, creating a partial contact that results in a smaller section of the conductor. This circumstance obviously makes the movement of the electrons harder by creating friction between them generating heat that causes an increase of the resistance, thus limiting the current flow to the connected circuits.
The device/system affected by a lower current flow will suffer an alteration of its operation. Therefore, it can be stated that in some cases a resistance check using only the ohmmeter can mislead the technician, causing a series of mistakes or imprecise diagnostic evaluations.
To carry out a resistive control in a dynamic form, using the voltmeter or better the oscilloscope, you have to get used to simple reasoning.
A fundamental principle of electric matter says "every resistance causes a drop in tension".
Taking note of the above, we can probably assert that if there is resistance in an electric current circuit, in the same circuit there is also a voltage drop between the terminals.

1.3 Sensors

This name defines a device that provides useful information to the electronic control unit. The main purpose of the sensors is to transform physical quantities of various types (e.g. temperatures, pressures, vacuum, rotations, displacements, etc. ...) into electrical signals that will be processed by the control unit.

Figure 3

A practical example is the crankshaft:
In this case, there is a specific magnetic induction sensor located in front of a toothed wheel (also known as the phonic wheel) which turns the rotation movement into an electric signal.
This signal is processed by the control unit to determine the speed of rotation of the crankshaft (revolutions) and to check if there are no ignition.

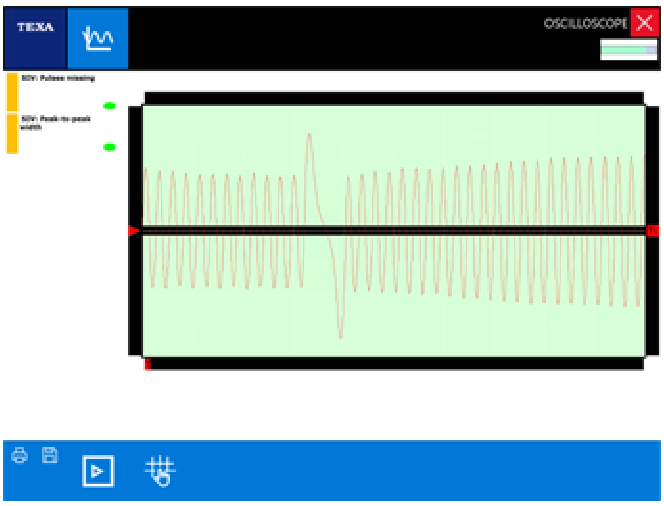

Figure 4: Crankshaft sensor oscilloscope acquisition via assisted "SIV" mode

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1.4 Actuators

Unlike the sensor, which is able to produce an input signal to the control unit (information for the computer), the actuator is a device able to control and carry out a command from an electronic control unit and transform an electrical signal into a physical event.
Some examples of actuators are: the stepper motor that changes the angular position of the throttle, the solenoid valves involved in the hydraulic or pneumatic circuits and the injectors.
In this case the control unit uses the information from the various sensors and commands the actuators according to a logic defined by a series of programs (mappings) stored and determined by the manufacturer.
One of the most important actuators in an engine is the injector: a solenoid valve controlled directly by the control unit to determine the amount of fuel to be fed into the cylinder through the injection times.

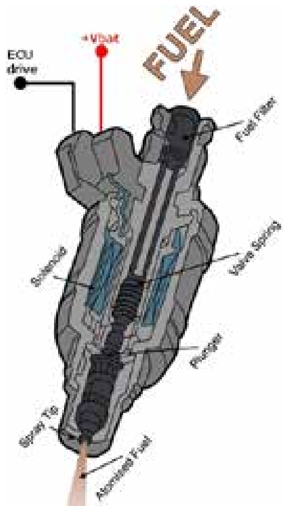

Figure 5: Injector Section

The injector is constantly powered at 12 V (A); at the time of the injection, the control unit puts an injector terminal to ground, allowing pin lifting and fuel leakage for the pre-set injection time (B). At the end of the injection, the closing of the mass command generates an extraterrestrial (C) useful for oscilloscope diagnosis on the operation of the injector.

Figure 6: Oscilloscope acquisition of the opening signal of an injector

1.5 CAN Bus: Characteristics and Advantages

CAN networks have been designed to reduce the complexity of traditional wiring by integrating a microcontroller/microprocessor-based control system that ensures flexibility configurability and improved information security as well as speed.

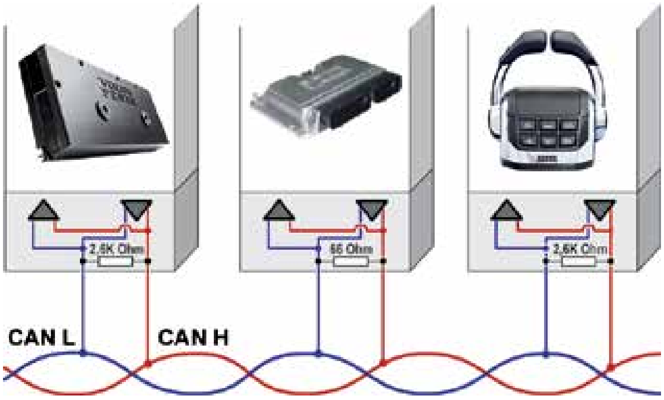

Figure 7: CAN Bus connection between ECU example

This interactivity suppose the exchange of information between the controllers that usually occurs through an interconnection network where computers communicate digital information using various protocols, most commonly the Controller Area Network or CAN BUS.
There are several CAN architecture solutions with two-wire communication networks with a different transmission speed. The SAE (Automotive Engineer Company) has classified the various transmission standards into three main categories, based on the transmission rates and the functions implemented:

- Bodywork network (**A class**) characterized by a low bit rates (up to 10 kb/s), few information and average response time: 100 ms;
- Intersystem multiplexing (**middle B**) medium bit rate (10 to 125 kb/s), average information and average response time: 10 ms;
- Medium/High bit rate (**C class**) high-bit rate (125 kb/s at 1 Mbps), much information and average response time: 5 ms.

Then it happens that the search for a failure should not be stopped at a single control unit, but involves the diagnosis of several control units:

- Each control unit may carry out checks actions through the information it receives from the other control units;
- The use of the CAN protocol makes it possible to simplify the electrical systems of the vehicles,

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making them even more reliable;
- Only a few sensors are required;
- Optional components can be installed without twisting the electrical system of the motor vehicle.

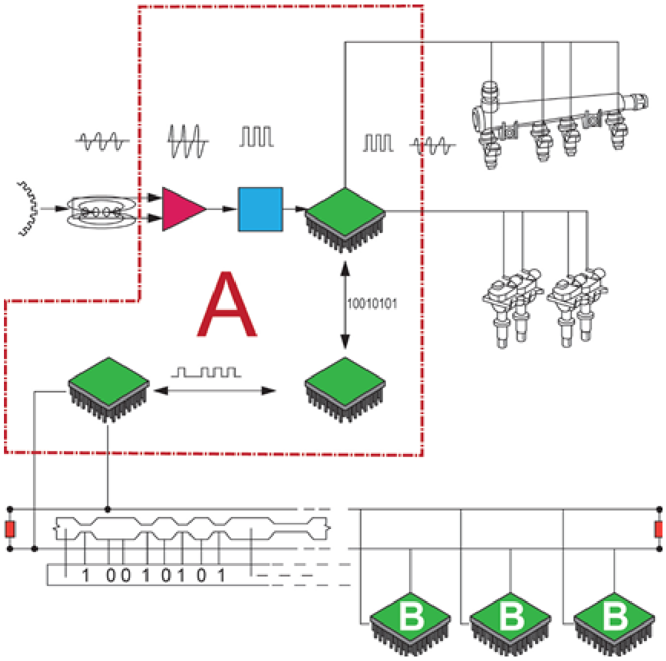

Figure 8

1.6 Self-Diagnosis Limit

It is important to emphasize and remember the limits of the self-diagnosis resources. In particular, it must be borne in mind that the main job of an electronic control unit is to manage the system it is connected to (engine control, lever management etc.) and, only later, to check and monitor the input signals and output for self-diagnosis functions
For example, a crankshaft or camshaft sensor malfunction can lead to engine malfunctions but without leaving any trace in self-diagnosis: this is because the sensor signal check for self-diagnosis is made at a lower frequency than the one used for the management of the direct injection.
This means that a signal interruption occurring between one check and the other does not lead to the engine failure or the activation of the engine failure, even though it causes an engine malfunction.
It is therefore clear that a system's diagnosis should not stop at the simple DTC reading, but it must be thoroughly analyzed by checking the parameters that the diagnostic tool provides.
It is therefore useful to take action only after a careful check of the engineering parameters and in the most complex cases to evaluate a road test with the "registration" function present in the TEXA self-diagnosis software.
The engineering parameters are the values coming from the sensors (engine temperature, air pressure, accelerator position, etc.) and those directed to the Actuators (injectors command, advances, etc.).
With the engineering parameters, the technician is able to make a critical analysis of the data managed by the control unit, but to do this the technician must have a good knowledge of the operation and the intervention strategies of the electronic system on which he must act.

1.7 Dynamic Self- Diagnosis

Electronic systems inside the boats have dramatically increased in the last few years: this can obviously cause the appearance of sporadic or intermittent failures that occur only under certain driving conditions (at low temperatures, along an uphill, accelerator partial load, etc.) and that during a workshop diagnosis are not correctly detected and the vehicle is working properly.
This could reproduce the conditions during which the vehicle is malfunctioning, while the "On-Board" diagnosis devices store the time sequence of all the signals handled by the control unit, including errors.
After collecting the data from the boat engine, it analyzes the detected values by connecting the "On-Board" devices. It starts the stage of interpretation and investigation of the causes that generate the fault. The new solutions for dynamic diagnosis not only improve and innovate the equipment for the workshops, but they also create a new and different work approach to the automotive technology.

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Figure 9: NAVIGATOR TXB Evolution allows the recording of the diagnostic session in "Dynamic Testing" mode

1.8 The Measurement Tools

According to what has been explained so far, it is clear that the diagnosis of a system should not stop at reading errors, but it must be thoroughly analyzed by checking the parameters with the diagnostic tool. However, in certain cases in which malfunctions are out of the ECU's control, it is imperative to use the oscilloscope to analyze the signals from the individual sensors and to check the controls implemented by the control unit towards the actuators.

Figure 10

The exhaust valve that manages the throttle position, the throttle body opening command, the OCV control for engine timing management, just to give some examples, are managed by PWM (Pulse Width Modulation) commands and for their correct evaluation of functionality an oscilloscope is required.

Figure 11: PWM signal

Another example may be an interruption on the signal of the throttle position sensor that creates a malfunction on the output engine's power management from the ECU.
The ECU uses a fine control of the voltage parameter of the throttle valve potentiometer for operation, while Self-diagnosis and parameter display checks the signal within a certain range of time.
In addition, for the evaluation of an efficient air mass flow, we recommend using the oscilloscope, which allows a dynamic measurement of the engine running.

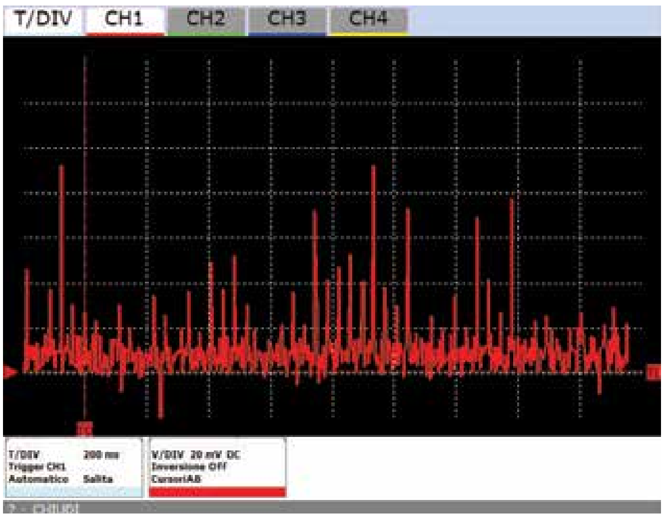

Figure 12: Example of a ground point analysis with electrical disturbances due to a bad connection

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1.9 The devices calibration using the Self-Diagnosis tool

It is clear that the Self-diagnosis tool is now increasingly used just to perform all the adaptation and calibration operations required to restore the system after an ordinary or extraordinary maintenance on the vehicle.

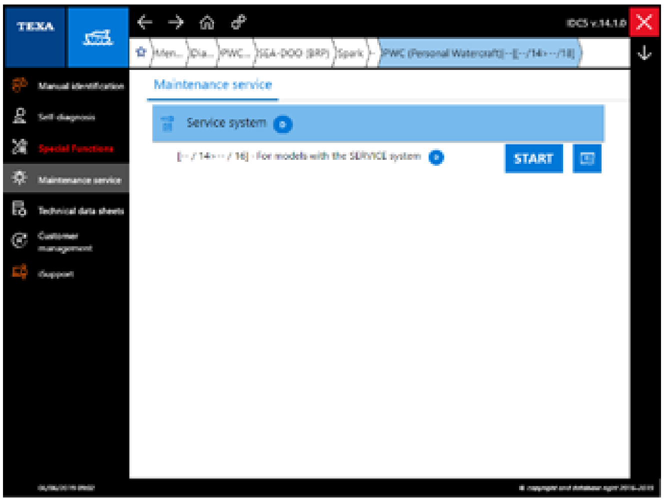

Figure 13: List of features for vehicle maintenance

For example, the technician, using the specific functions of the tool, is able to configure an ECU, set the winterization, etc ...
Furthermore, all the initializations can be performed, when some components/electronic devices are replaced or disassembled and repaired, and then reinstalled, such as the EXUP valve, an accelerator potentiometer or an accelerometer sensor, for which the control unit must learn the specific positions.
Without neglecting the function of resetting the lights after replacing, for example, of the engine oil during maintenance operations.

1.10 Diagnosis procedures and fault finding

As already mentioned, the self-diagnosis function performed by a vehicle's control unit does not always allow accurately locating the source of the failure that has caused the vehicle malfunction.
If the control unit indicates a DTC related to a passive sensor "Circuit open or circuit shorted to battery", it cannot define if the problem is the sensor itself, if there are interruptions on the wiring, oxidation in the pins or interruptions within the ECU.
In order to avoid falling into a false diagnosis, it is best to follow a precise procedure to find out the correct nature of the failure:

1. Check the stored DTCs;
2. Create a logical group of parameters associated with the detected errors;
3. If necessary, check the actuator control by means of the "active diagnosis" function (this way you can check both the component operation and the goodness of the circuit connected to it);
4. Analysis of the wiring diagram to highlight the connections between different components, powers and grounds;
5. The possible use of the oscilloscope to verify the congruity of the electrical signal generated by the sensor and also the circuit associated with it;
6. Verification of the continuity of the electrical wiring.

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2. TEXA SELF-DIAGNOSIS

The TEXA self-diagnosis is composed with two devices:
- The display tool;
- The remote connection device (interface).

The first is where the diagnostic software is installed and where the user can view the information, while the second is the device that is physically connected to the vehicle to be diagnosed.
The two devices are connected to each other via a Bluetooth® wireless connection or via a common USB cable.

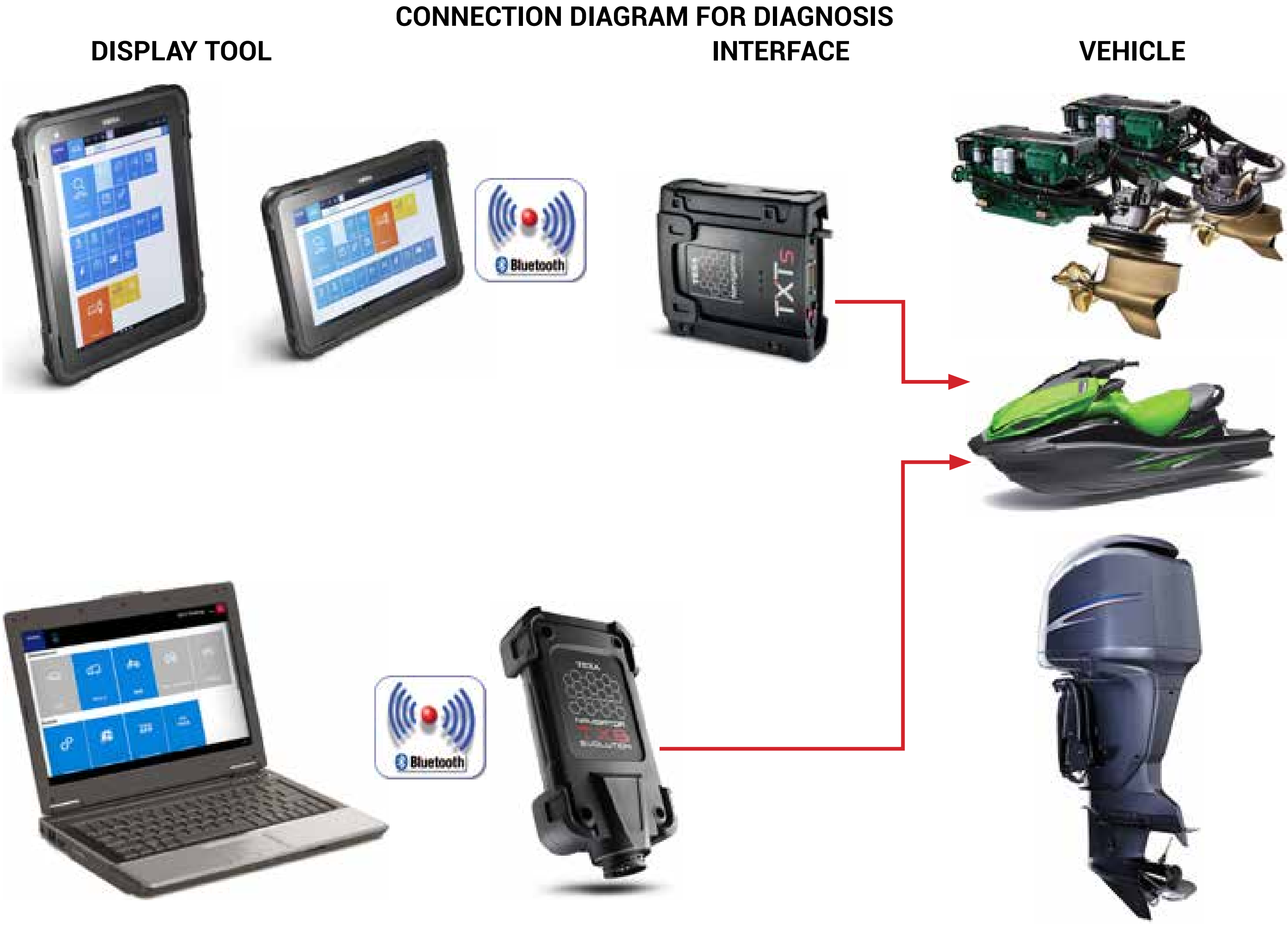

Figure 14

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2.1 AXONE Nemo

The new AXONE Nemo Diagnostic Device is the TEXA home flagship among the diagnostic tools.
To create AXONE Nemo, we started from our great experience as a trusted partner of tens of thousands of mechanical workshops, and we imagined what would be the evolution of their work over the next five years.
From this philosophy the first "SMART" diagnostic device was born, which is able to guarantee the technician a total flexibility of use thanks to its interchangeable modules, capable of making it suitable for multiple uses and situations.
Built according to military standards, it resists to violent falls and is designed to cope with all the disadvantages of heavy work. Unique in the world, it has the extraordinary peculiarity of being not only waterproof but also floating: a patented international innovation by TEXA.
Other features include:

- ISO TS 16949 certification, the standard required for first-class automotive suppliers.
- Magnesium shell for ruggedness, rigidity and lightness.
- 12 inch ultra-wide screen, robust thanks to Gorilla Glass specifications.
- Display either vertical or horizontal.
- Magnetic hooks for additional modules capable of extending the potential and resources to keep it ready for the needs of checking any car, even in the future.
- Conforms to military standards.
- Resolution of 216x1440 pixels.
- Quad-Core Processor.
- Wi-Fi communication systems and Bluetooth® 4.0 Low Energy.

Figure 15

2.2 Personal Computer

For maximum reliability and versatility, you can install the self-diagnosis software on a very common PC with a Windows™ operating system.

Figure 16

The advantage of the PC solution is that it can integrate TEXA's self-diagnosis software into your personal network of applications and access the new IT technologies by unlocking the software from the hardware.

2.3 Navigator TXBe Evolution

TXBe Evolution is the interface of complete self-diagnosis, which allows operation on motor vehicles (motorcycles, quads, watercraft, snowmobiles and marine engines).
It connects to all TEXA display interfaces thanks to Bluetooth® technology and to any commercial PC equipped with TEXA's IDC operating software.

Figure 17

Thanks to Bluetooth® wireless technology, it is possible to work freely around the vehicle or comfortably seated inside it.

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2.4 Navigator TXTs

The NAVIGATOR TXTs is the latest multibrand diagnostic interface by TEXA; NAVIGATOR TXTs is a powerful multibrand diagnostics and autodiagnostics tool that connects directly to the vehicle's diagnostic socket.
It connects to all TEXA display interfaces thanks to Bluetooth® technology, and to any commercial PC equipped with TEXA IDC operating software.

Figure 18

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3. IDC5 INFO DATA CENTER 5

The information below is available in the self-diagnosis software at the time of the publication of this manual and may therefore not be up-to-date.
TEXA reserves the right to make any corrections and changes it deems necessary during the development of its software.

IDC5 (Info Data Center 5) is the new evolution of the TEXA Diagnostics Program, constantly updated and developed, integrating not only diagnosis and self-diagnosis capabilities, but the entire schema database and support documentation that the modern workshops and technicians need.
The IDC5 MARINE software is complete, practical and intuitive, very fast when communicating with engines and rapid through all the phases of diagnosis, from the identification of the error to its resolution
IDC5 MARINE is designed to accompany the mechanic from the identification of the error to its complete solution, guided, practical and safe.
Nominal values associated with the error, technical sheets, interactive wiring diagrams contain 26 years of experience and thousands of cases successfully solved

Figure 19

Figure 20

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3.1 IDC5 Self-Diagnosis software

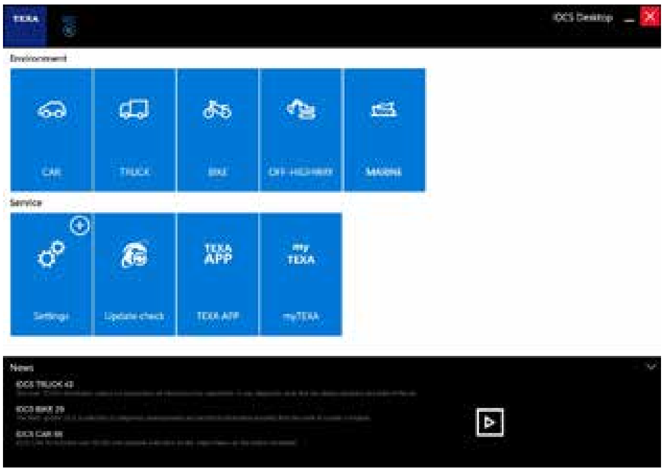

Figure 21: IDC5 Desktop

TEXA IDC5 is the operating environment that combines the capabilities of the individual tools to a media support perfectly integrated in the diagnostic software.

In fact, IDC5 provides technical data and detailed information when it is needed and is constantly updated via Internet.

The self-diagnosis features have been structured and divided to facilitate the reading and the management of the maintenance operations for the vehicle being tested.

The information provided by the self-diagnosis is divided into six different working environments divided into pages:

- **FAULTS**
- **PARAMETERS**
- **STATUS**
- **ECU INFO**
- **ACTIVATIONS**
- **SETTINGS**

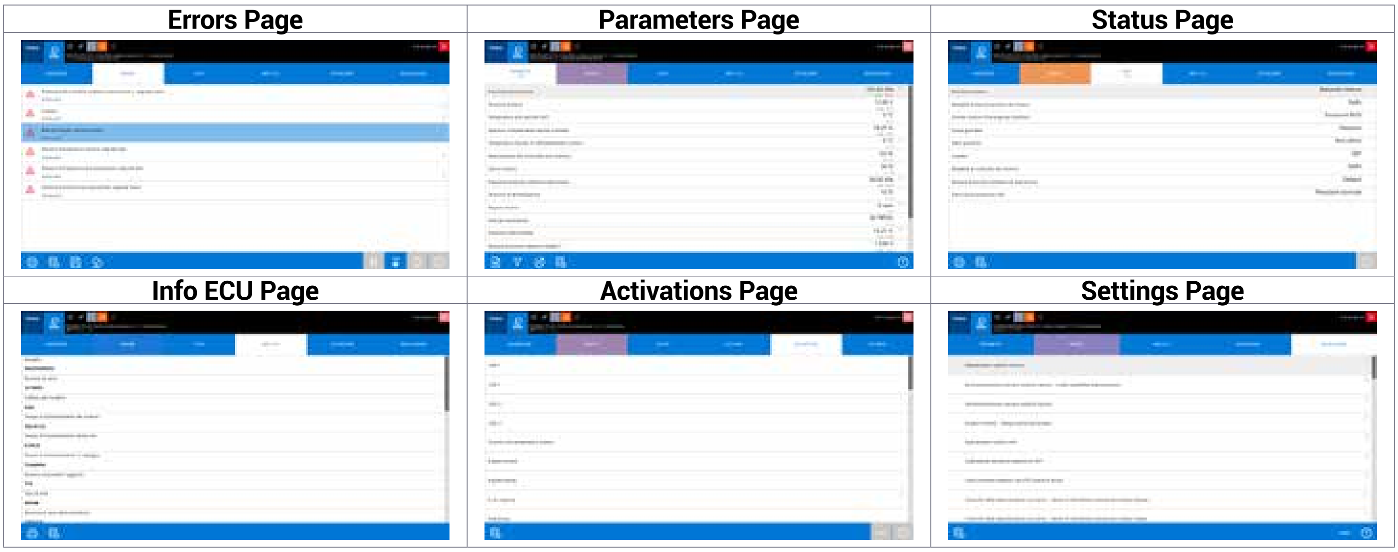

Figure 22

3.1.1 Activation of the diagnostic software

When the IDC5 software is started for the first time, the new installation environment must be unlocked using an activation code provided by the local dealer.

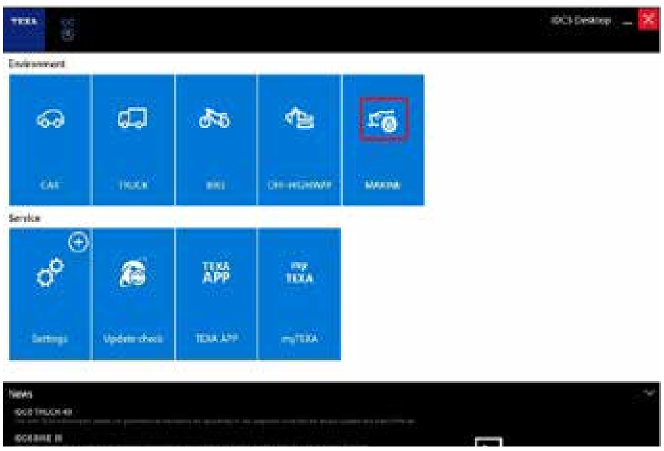

Figure 23

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During the first initialization of the software, the license agreement is displayed before allowing the input of the counter code.

Figure 24: Before activating the software, the license terms must be accepted

Your local TEXA dealer will provide a code of 30 alphanumeric characters that must be input in the appropriate filed as indicated below.

Figure 25: First activation license screen

By inserting the counter code and pressing the "Manual activation" button, the software will then be activated in all its functions.

3.1.2 Navigator TXB: firmware update

The firmware update of the TXBe tool takes place automatically, just before communicating with the control unit.
If TEXA releases new updates available for the tool, the procedure will be as follows:
After connecting the TXBe tool to the diagnostic socket of the engine's boat by means of a special cable (indicated in the appropriate window, based on the selection made), press the CONFIRM button.

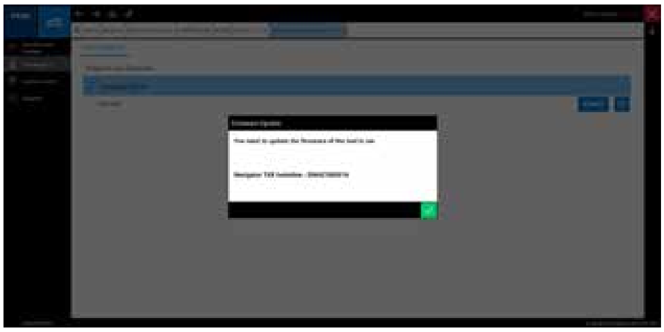

Figure 26: Warning screen when the Navigator interface's firmware needs to be updated

A pop-up related to the new update will be displayed automatically, and then by following the simple indications on the screen you can complete the operation:

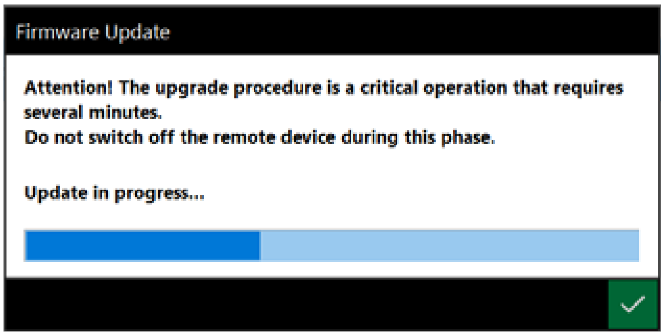

Figure 27: Warning: the firmware update is a critical operation: at this stage the Navigator must have a stable power supply (> 12.5 V)

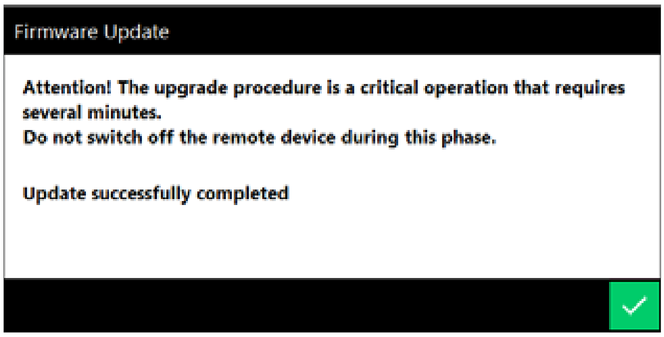

Figure 28: Update successfully completed

At this point, press OK. The updated tool will restart automatically and be ready for use.

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3.2 The evolution of diagnostic systems

The evolution of electronic management systems has led to a consequent evolution of the diagnostic methods.
The first diagnostic mode implemented in the control units was the process called **BLINK-CODE** in which, through a flashing code emitted by the control unit and typically visualized by the engine failure indicator, the technician could have a first diagnosis feedback.

3.2.1 Blink-Code diagnosis

TEXA's self-diagnostic resources make it possible to transmit this code to the control unit by means of a specific diagnostic socket and, once issued, to interpret it. Below this type of approach is explained in detail: let us analyze the specific case of a Steyr Motors MO114K33 110Hp.

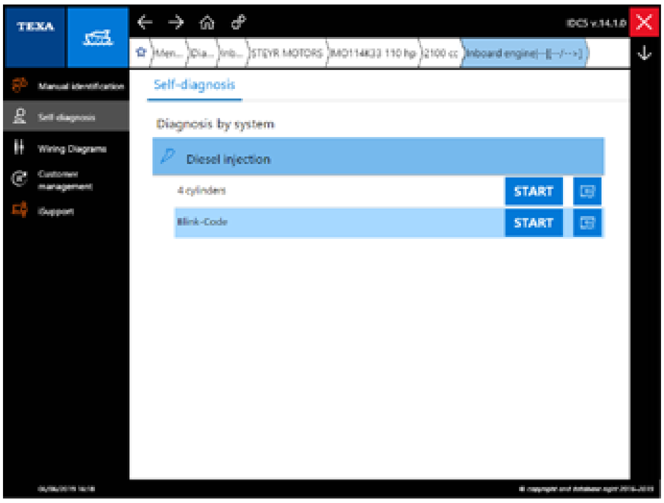

Figure 29: List of diagnostic variants, in our case we choose "Blink-Code"

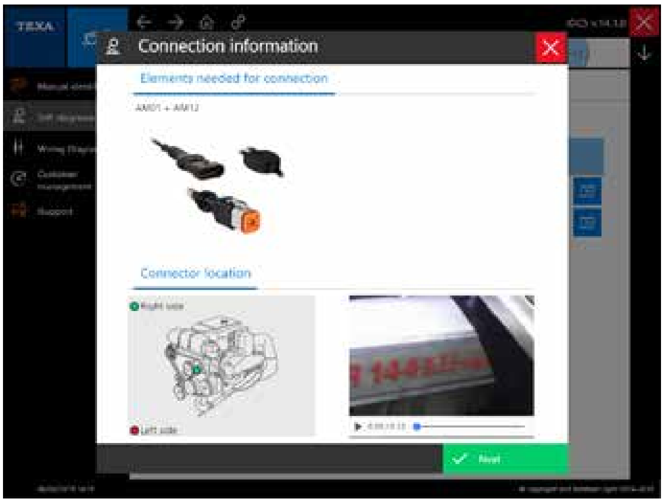

Figure 30: Description of the connection cable

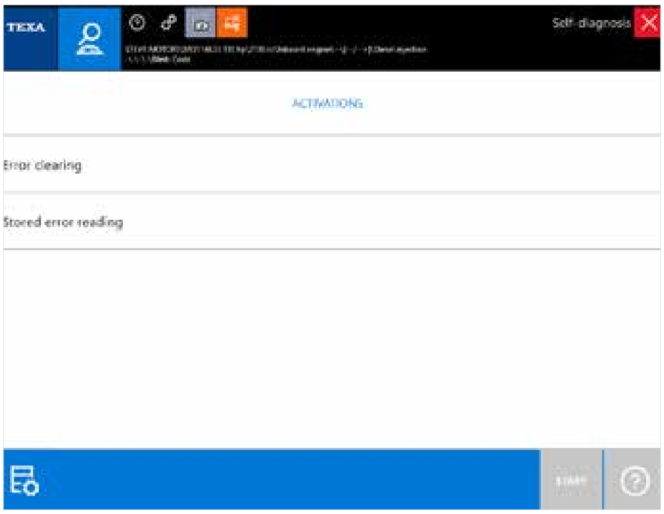

Figure 31: List of available operations

After selecting the vehicle and the diagnostic mode, the tool guides the technician though the various stages of diagnosis with messages:

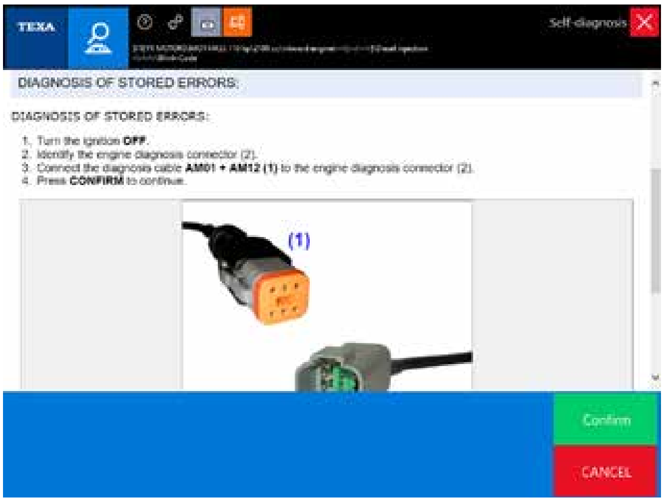

Figure 32: FI light for reading procedure

The first message states the methods for detecting and signaling the presence of an error by the self-diagnosis of the control unit.

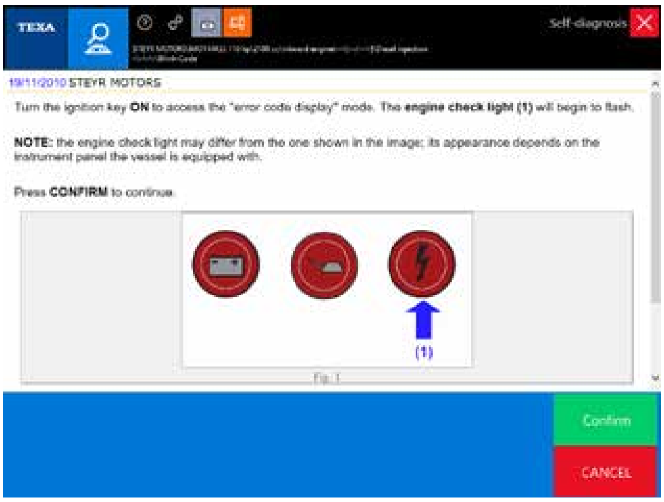

Figure 33: Indications on the connection of the tool

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The second message gives information on which cable to use and how to connect the diagnostic tool.

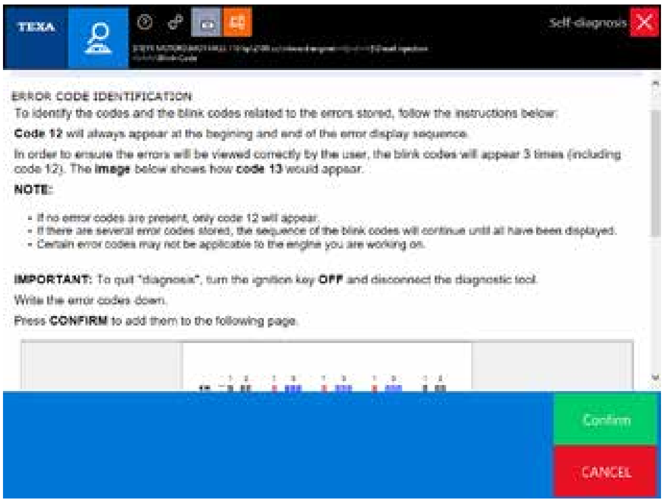

Figure 34: Help message on how to read errors

Once the fault code has been detected, it is possible to know its meaning by typing it in the diagnostic tool.

Figure 35: Information on the detected code

The tool then asks if you want to clear the related DTC.

3.3 Vehicle selection

This function allows selecting the vehicle on which you need to operate and access all the diagnostic functions.

The selection is made by choosing among the items proposed in the drop-down menus of the fields:

- **Category**
- **Make**
- **Model/Engine/Engine Code**
- **Year of validity**

These fields are different selection levels.
In order to move from one selection level to the next, you need to have completed the selection level in which you are located.
The selection is complete when an item has been selected for each of the proposed levels.
At the end of the selection, the software shows a specific menu for the selected vehicle.
This menu shows the tests that can be performed on the vehicle.
The Vehicle Selection screen is the first that the software displays at startup.
Alternatively, you can start it from the Home screen.

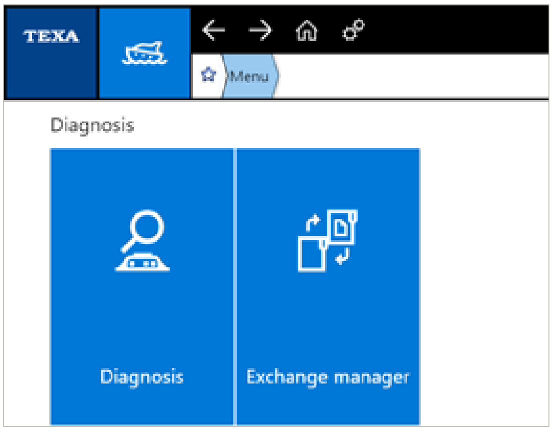

Figure 36: The IDC5 home screen is located by pressing the top home button

Proceed as follows:

1. Press 
2. Select the Category;

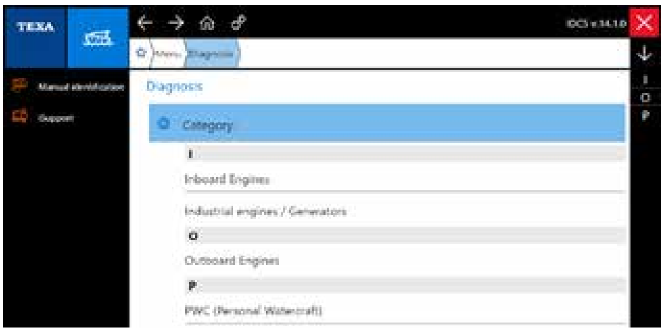

Figure 37: Category Selection

3. Select the Manufacturer
   The makers, the models and the engines code are in alphanumerical order;

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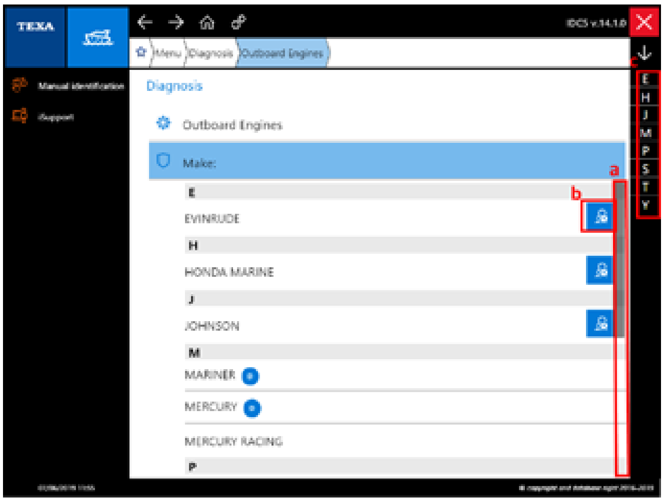

Figure 38: Manufacturer Selection

To quickly access the selection items level you can:

a. Use the vertical scroll bar.

b. From the Make selection level it is also possible to start the Quick Diagnosis function (only for compatible makes)

c. Press directly on your keyboard the letter corresponding to the initial of the desired make/model/engine.

4. Select the **model/engine/vehicle code**

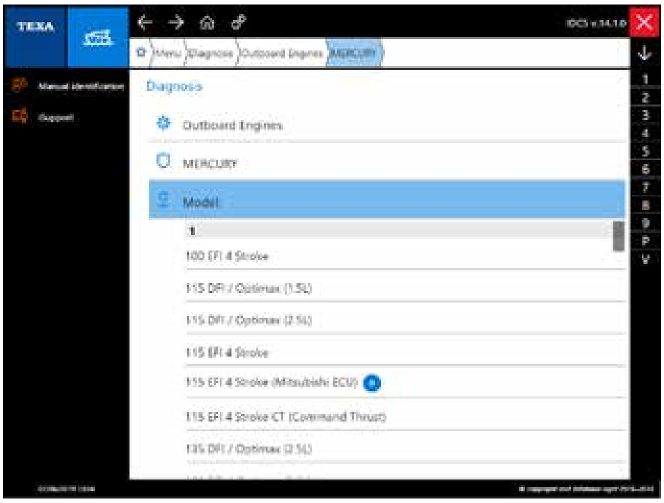

Figure 39: Engine selection

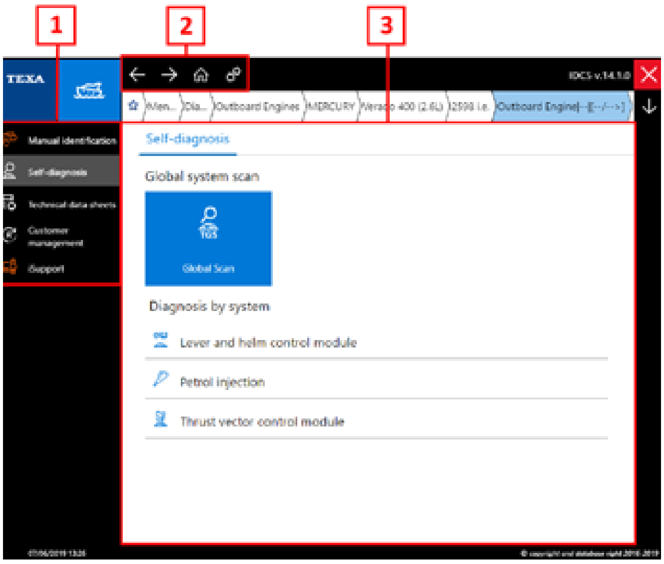

Figure 40: Vehicle selected MENU

The screen of the selected vehicle is divided into three sections:

1. Side Menu: here you can select all the functions available for this vehicle;
2. Summary Bar, useful to return to the previous MENU;
3. Selection of the specific diagnostic system.

The functions available in this screen depend on the selection made.

3.3.1 Manual Vehicle Identification

It is the technician's duty to correctly identify the model and the system version that needs to be checked, starting from the vehicle documentation (registration certificate, user and guide manual, etc.). Often the vehicles that require a Self-diagnosis check are already known, but sometimes they are "uncommon".

For this reason, TEXA has increased the vehicle search possibilities through a special function called: **Manual Identification**.

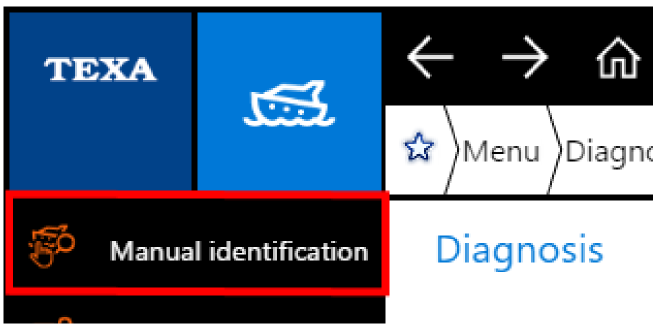

Figure 41: Manual Identification Button

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This function allows to perform a vehicle search based on the Registration Number search (this must be previously saved in the

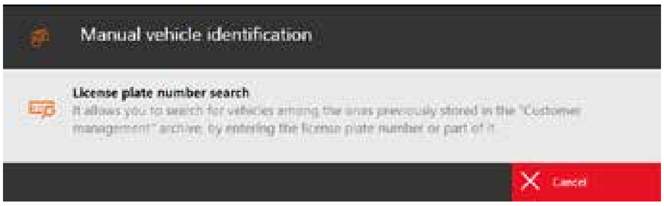

Figure 42: The 2 available selection options


The vehicle license plate number search, on the other hand, allows searching for the vehicle only among those registered in the customer management database

Table 1

3.3.2 Automatic vehicle selection

To make simple the correct selection of the vehicle from the "Make" selection level of IDC5 it is possible to start
"QUICK DIAGNOSIS" function that allows the specific and correct diagnosis selection getting at the interested vehicle in a few clicks.
Simply click on the function button located near the make and connect the diagnostic tool to the vehicle. The software will directly access the injection system or perform a scan reporting the systems available, with the possibility of specific diagnosis.

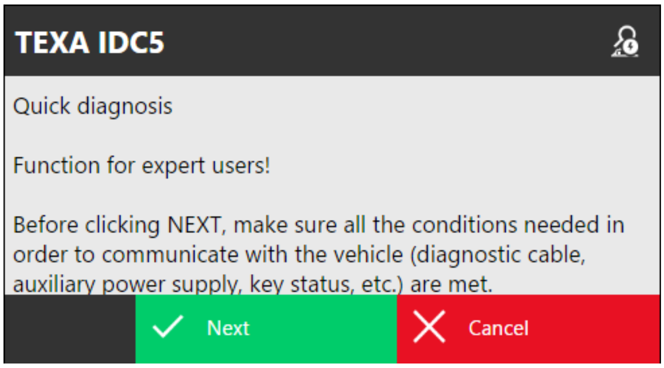

Figure 43: Displayed message before to perform the Scan VIN

3.4 The Global Scan function

The Global Scan function is the evolution of TEXA's system scanning functionality and allows obtaining a list of the systems available on the motorbike, selecting the desired systems and performing a scan to obtain the status (detected errors, etc.) of the control units.

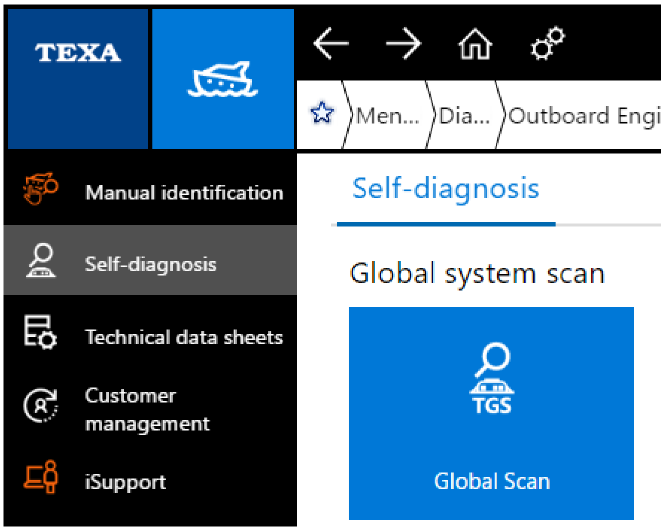

Figure 44

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After selecting the system to be diagnosed, the function can be accessed.

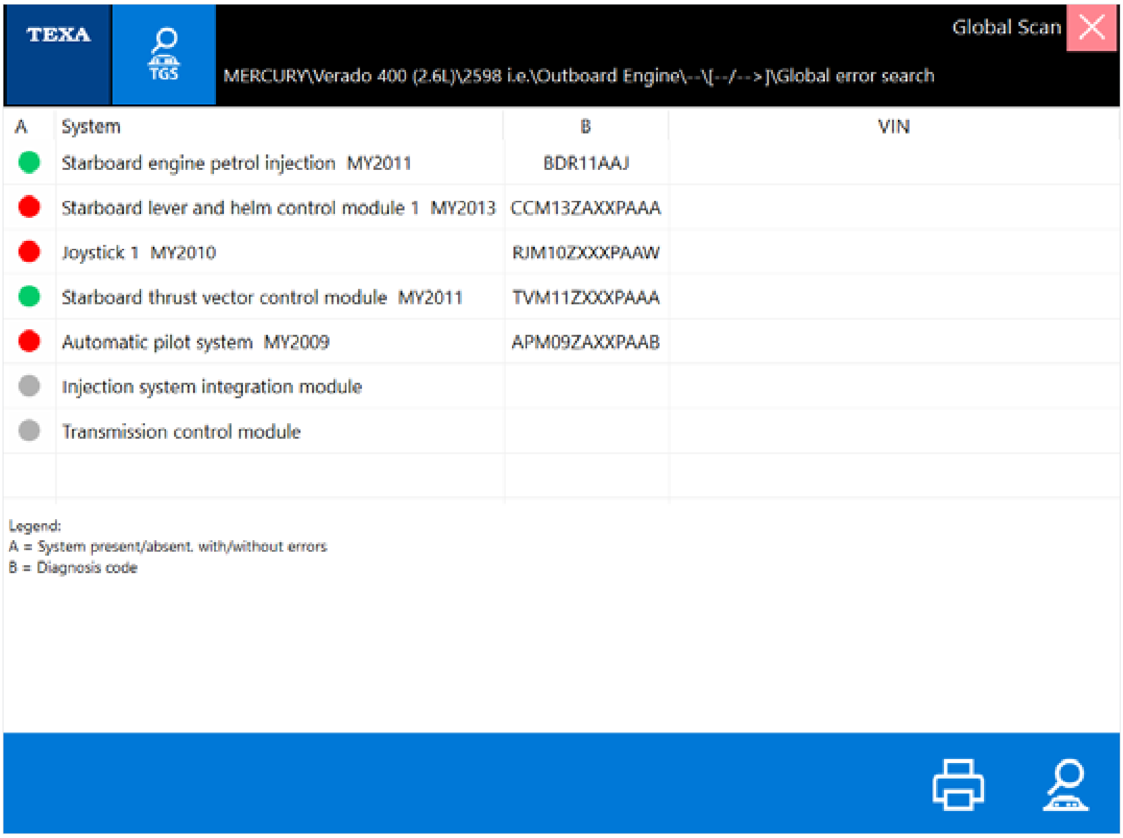

Figure 45: Global Scan on Mercury Verado

After a few seconds (the time is determined by the quantity of ECUs present), you can view a report that presents a list of the control units present, which of these have errors in the memory and in what condition they are: present or stored.
At the end of the operation, the operator can also print the result of the scan to deliver it to the customer with all the errors detected.

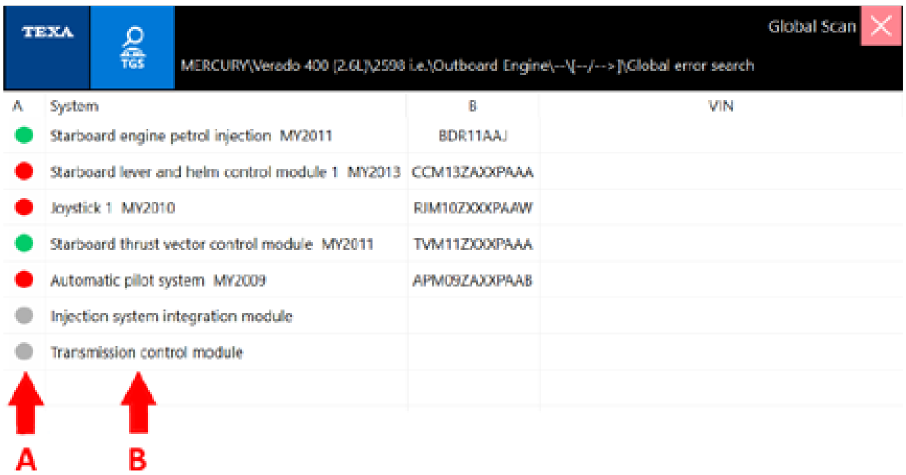

Figure 46: When scanning the Mercury control units, you can also view other data such as diagnosis code

In this page it is possible to see the complete list of the control units (B) available and in correspondence of each one the presence of a dot (A) that remembers the response of the control unit and the status of the errors in memory. The example shows us the scan with Mercury engine where there are several other columns that complete the information of the system. Please note that this information may vary and depend on the manufacturer, the model and the preparation of the boat.

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3.5 ⚠ Faults Page

Each diagnosis should begin with the acquisition and identification of errors stored in the electronic control unit of the vehicle.

> *In IDC5 the flashing "Tab" is informing the user that the ECU has one or more DTCs stored.*
>
> FAULTS

The DTCs displayed by the self-diagnosis can be divided into 3 types:

- ⚠ **ATT (Active)**: This type of DTC it is currently present into the system, detected and saved by the ECU;
- ⚠ **MEM (Stored)**: The DTC has been detected by the ECU but currently it is not present, however the DTC is still stored in the ECU DTCs memory;
- ⚠ **STO (Historic)**: The DTC is no longer present in the memory of the electronic control unit, but is stored as a historical error in the memory of the diagnostic tool (this type of DTC automatically disappears at the end of the diagnostic connection).

> *__Stored DTCs__*
>
> *While active or historical errors do not require additional explanation, a special note is necessary for the stored failures. In fact, an error can assume the stored state for 3 distinct reasons:*
>
> *1. It is a failure that occurred long ago, so the failure was repaired, but the ECU memory was not deleted. The system keeps the error stored only as a past reference.*
>
> *1. Some types of errors cannot be deleted for legal reasons (e.g. issues regarding the emission of pollutants from Euro4 or higher vehicles). If the failure has been solved, this error may remain in the memory to make law enforcement control of the "history" possible. The clearing in this case only comes after a series of trips (from 1 to 3 trips) where the control unit recognizes the deletion of the failure.*
>
> *3. The vehicle has a failure, but this only occurs in special conditions of use. In this case the error switches to the active state (ATT) only when the conditions are met, for example only when the vehicle is in motion and the engine is hot.*
>
> *It is easy to understand that the 3rd case is the most interesting one for technicians.*
>
> *In fact, there is a whole series of failures that can occur only in particular conditions of use of the boat.*

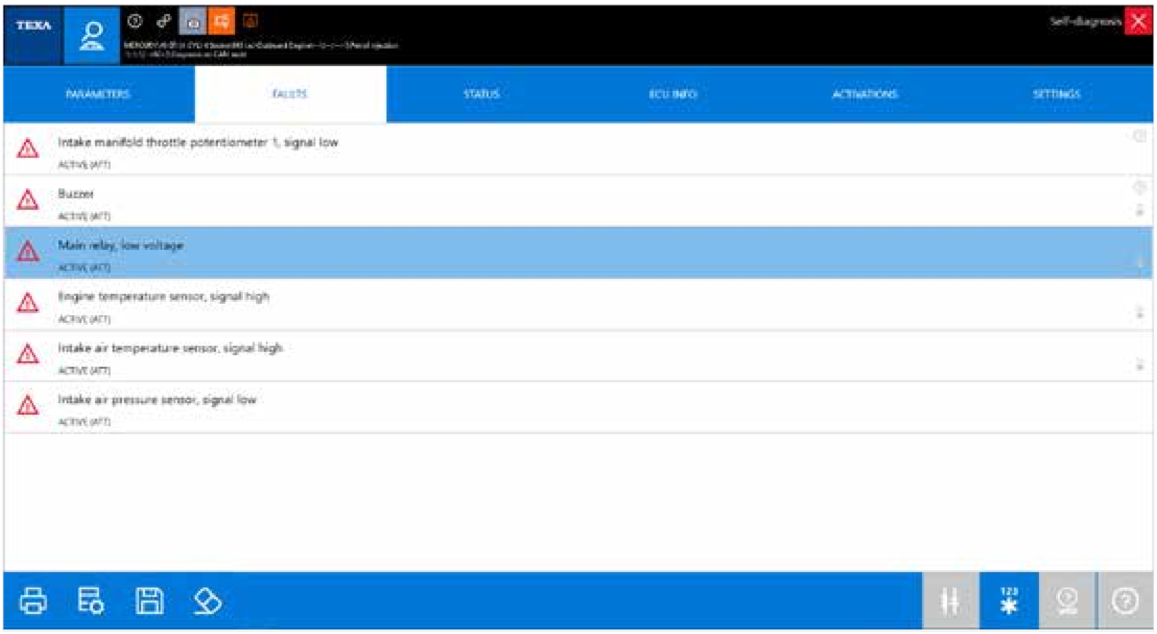

Figure 47: Available DTC in the ECU

> *The meanings of the above abbreviations must be considered only as a general rule; In fact, there may be exceptions.*
>
> *For example, in some electronic systems, the storage of DTCs is not classified between the ATT and MEM status.*

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By selecting a specific error, you can get information about the displayed error.
Clicking twice on the error will give you more detailed information about the recorded error.
The errors can be cleared by clicking on the "FAULT DELETE" icon.

Figure 48: Identification Icon related to the DTC clearing

3.5.1 DTC Detail and Code

By double-clicking on the description of a DTC, you will see a detail of the fault itself. The level of detail depends on the programming of the electronic control unit and may include an error specification and the manufacturer's original error code.

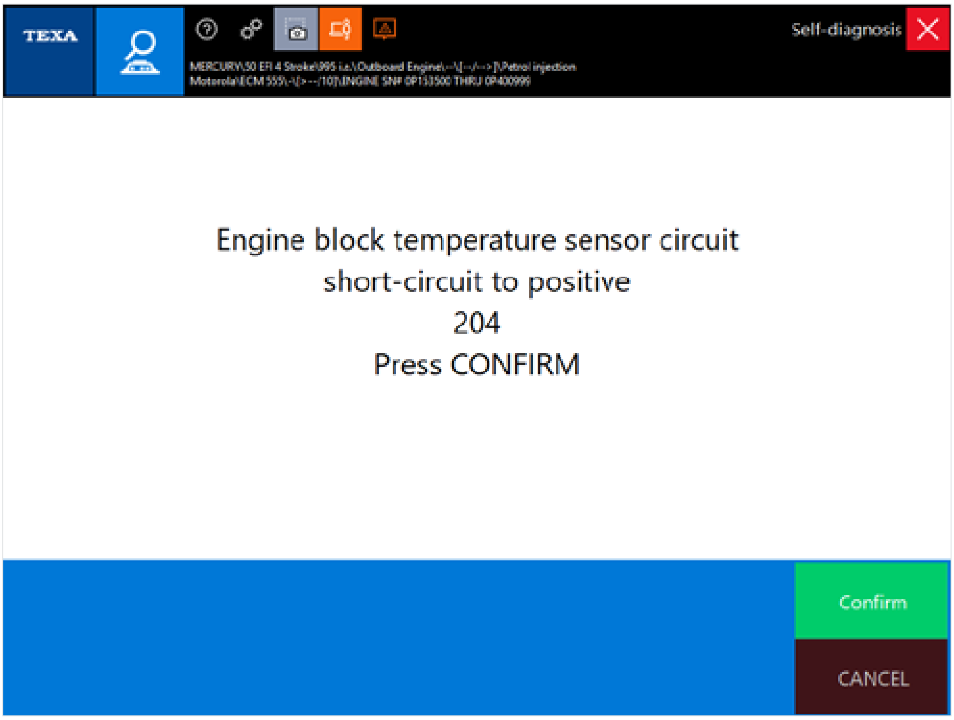

Figure 49: The DTC detail is always available by double click. In this case the error code 204 indicates that the a short circuit is present for the engine temperature sensor

> *The DTCs displayed belongs ALWAYS to the Manufacturer or the owner of the system/Supplier. TEXA never uses own codes.*

3.5.2 Fault Page, further Information

The triangle icon next to the description of the DTC indicates the state of the error itself, while the availability of additional information may be inferred from the presence of some symbols on the right of the error that enable their command buttons.

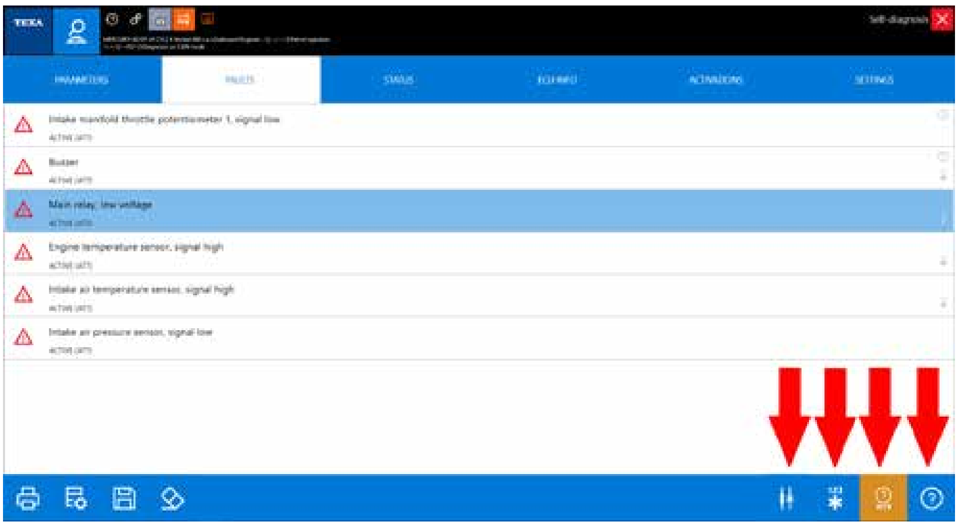

Figure 50

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ICON	NAME	DESCRIPTION
	Help DTC	Explanation of the error with the possibility of troubleshooting
123	Freeze Frame	Operation Parameters saved when the fault occurred.
	Component location	Location of the co Location of the component on the wiring diagram. mponent on the wiring diagram.
WEB	Fault Solved Database	Fault Finding through the TEXA workshops customers database.

Table 2

3.5.3 DTCs Help

Each fault message, when possible, is accompanied by an error "Help" that includes a series of information and explanations of the DTC itself. When available, by selecting the error, the button is enabled.
The help contents can offer a series of useful information to better understand the meaning of the error message and, possibly, a first set of checks to be performed.

3.5.4 Freeze Frame

The continuous technological development brings new features and new possibilities in the field of self-diagnosis also.
The Freeze Frame function is like a "screenshot" of a number of engine parameters taken when a fault occurs, especially for random issues.
This way it is possible to learn the causes of the issue in detail.

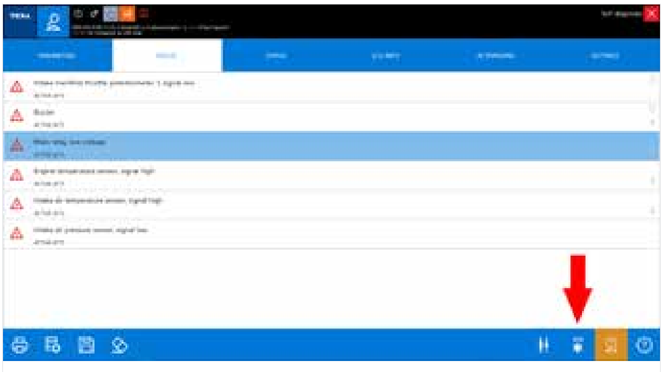

Figure 51: Freeze frame function button location

The detail of the information contained in the Freeze Frame depends on the manufacturer and can vary greatly depending on the type of diagnosed system. It is not TEXA that has developed this kind of technology, but it is a feature of the new generation of electronic control units.

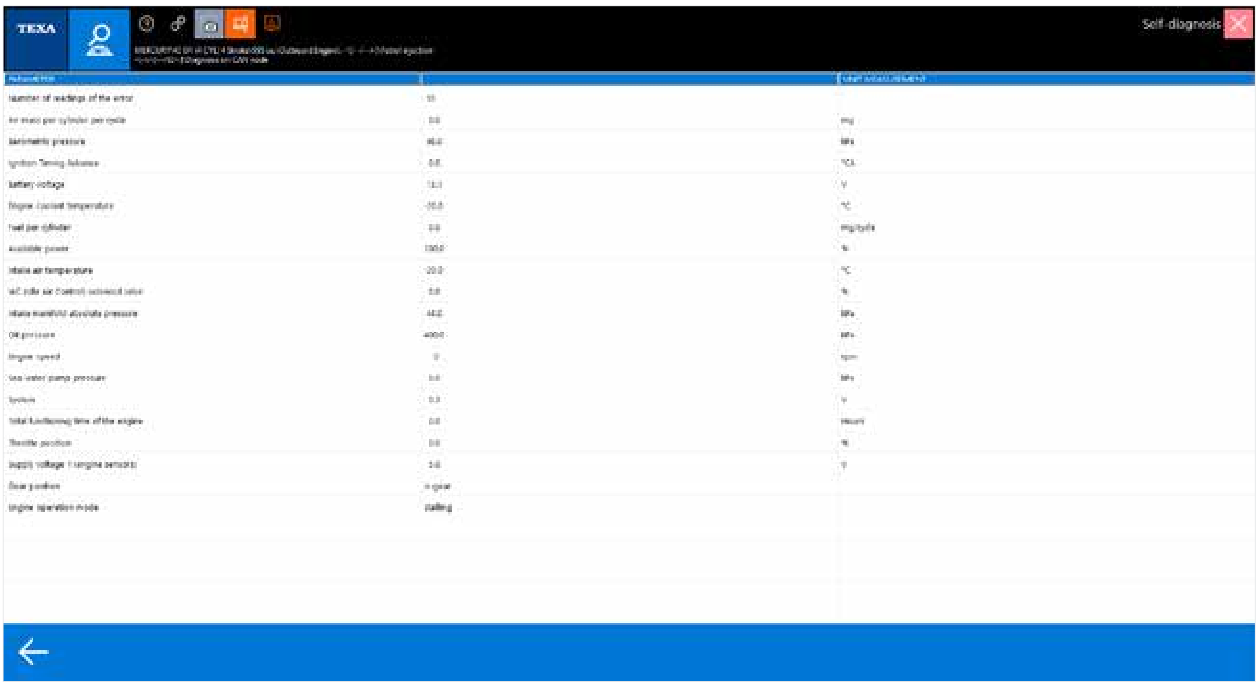

Figure 52: Table of parameters recorded when the error occurred

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3.5.5 Component Location on TEXA Schematics

Many DTCs that can be found in the control unit are related to specific components (faulty pressure sensor, temperature probe shut off, solenoid valve or short-acting actuator, etc.).
When you already know the vehicle or system to be diagnosed, the location and type of connection of the failed component are already known. However, in many other cases, it is useful to know which is the device listed and where it is.
In fact, manufacturers often use different denominations to identify the same component (e.g. the block of motors that handle the air passage in the air conditioning system can be called "Flap Motor" or "Stepper motor" depending on the manufacturer of the vehicle).
Therefore, for those installations where a wiring diagram is available and for those errors associated with a specific component, the "Component Location" button will display the associated device on the circuit diagram.

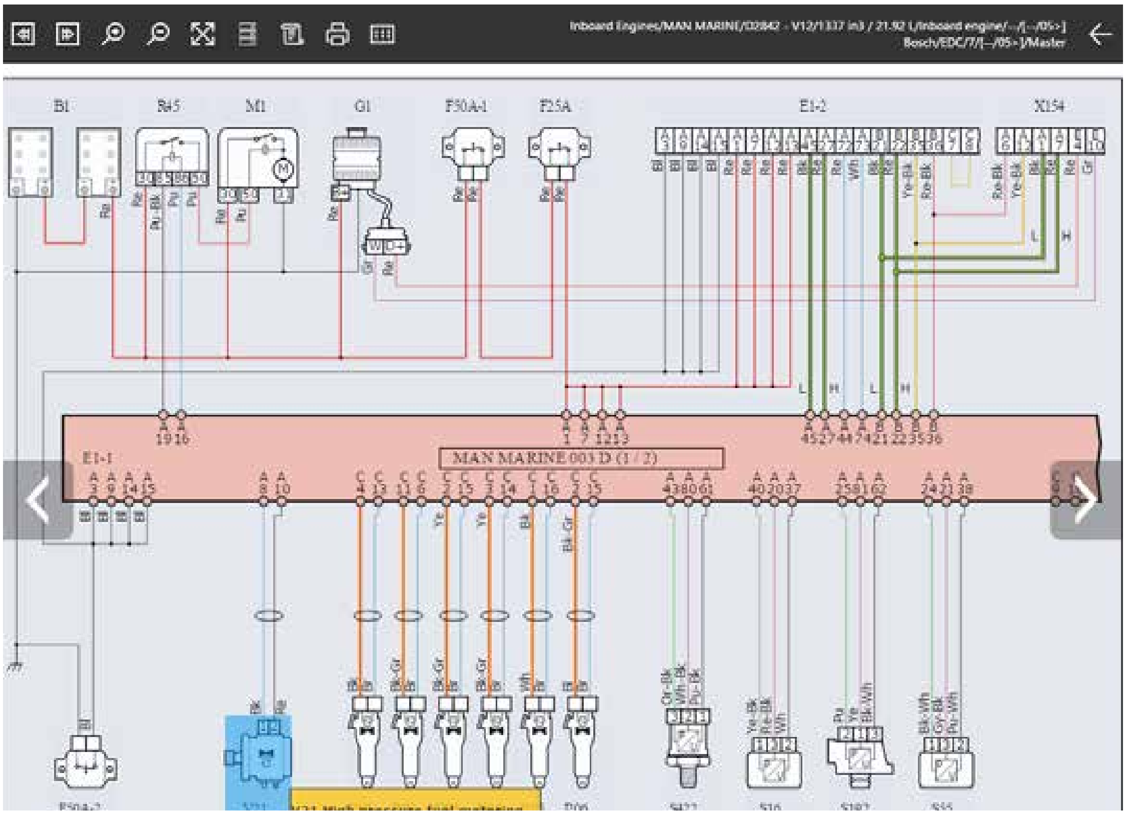

Figure 53: In the wiring diagram, the component linked to the selected DTC will be highlighted

3.6 Parameters Page

Another important feature of the self-diagnosis is to display the system parameters, such as sensors and actuators, ensuring that the car-repairer understands if the test component is working properly.
The TEXA diagnosis allows reading the parameters through the dedicated function.
The displayed parameters are proposed almost in real time with a delay due to the speed of the serial line and the calculation power of the control unit.
Remember that the control units have the priority to manage the system and, just as a secondary activity to communicate this information to the diagnostic tool.
The parameter reading depends on the type of electronic control unit being tested: older power supplies have a longer data upgrade delay. The user can activate or deactivate the initial parameters by selecting the most interesting ones for the diagnosis that is being performed up to a maximum of 8 at the same time. We recommend verifying that the update of the various parameters matches the actual change in the working condition of the observed component.

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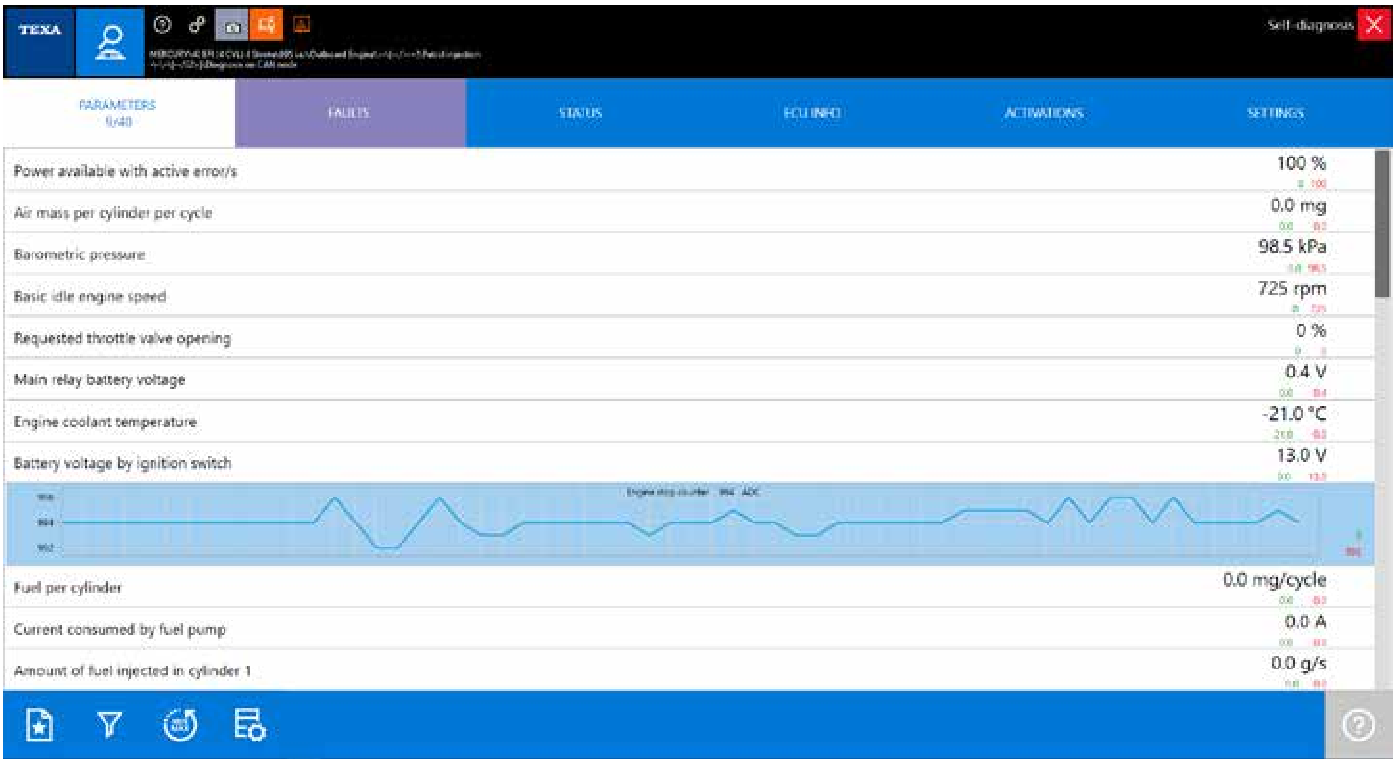

Figure 54: The number of parameters that can be displayed on the page depends exclusively on the manufacturer and on the control unit selected

The most recent versions of control units allow a very thorough diagnosis with a considerable number of parameters available during the diagnosis, which however can make the parameters search difficult and not fast. To overcome this problem, TEXA has created a new parameter search feature that makes the parameters search easier and faster.

This function is selectable by the following button: 

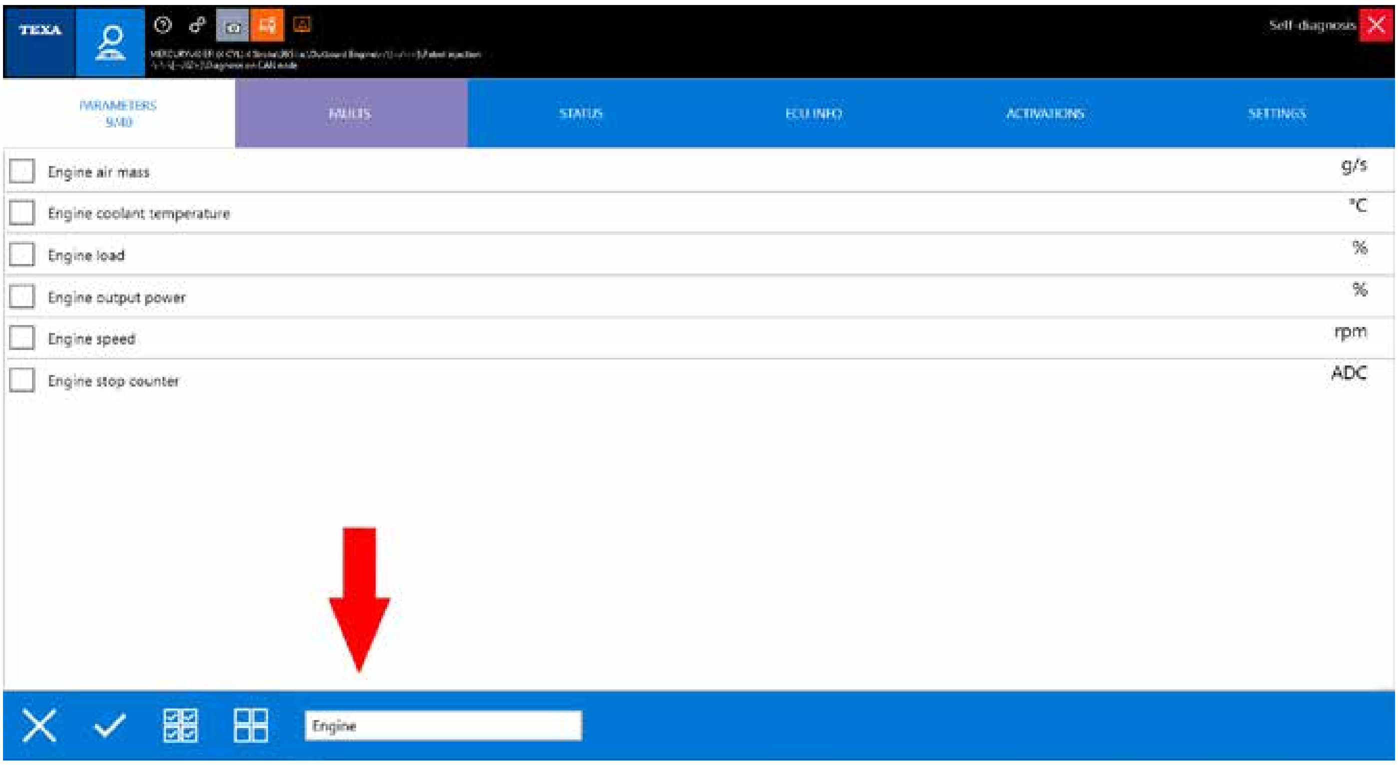

Figure 55: By typing in the highlighted line the keyword of the parameter to search for automatically, the list of parameters matched to that term will be displayed

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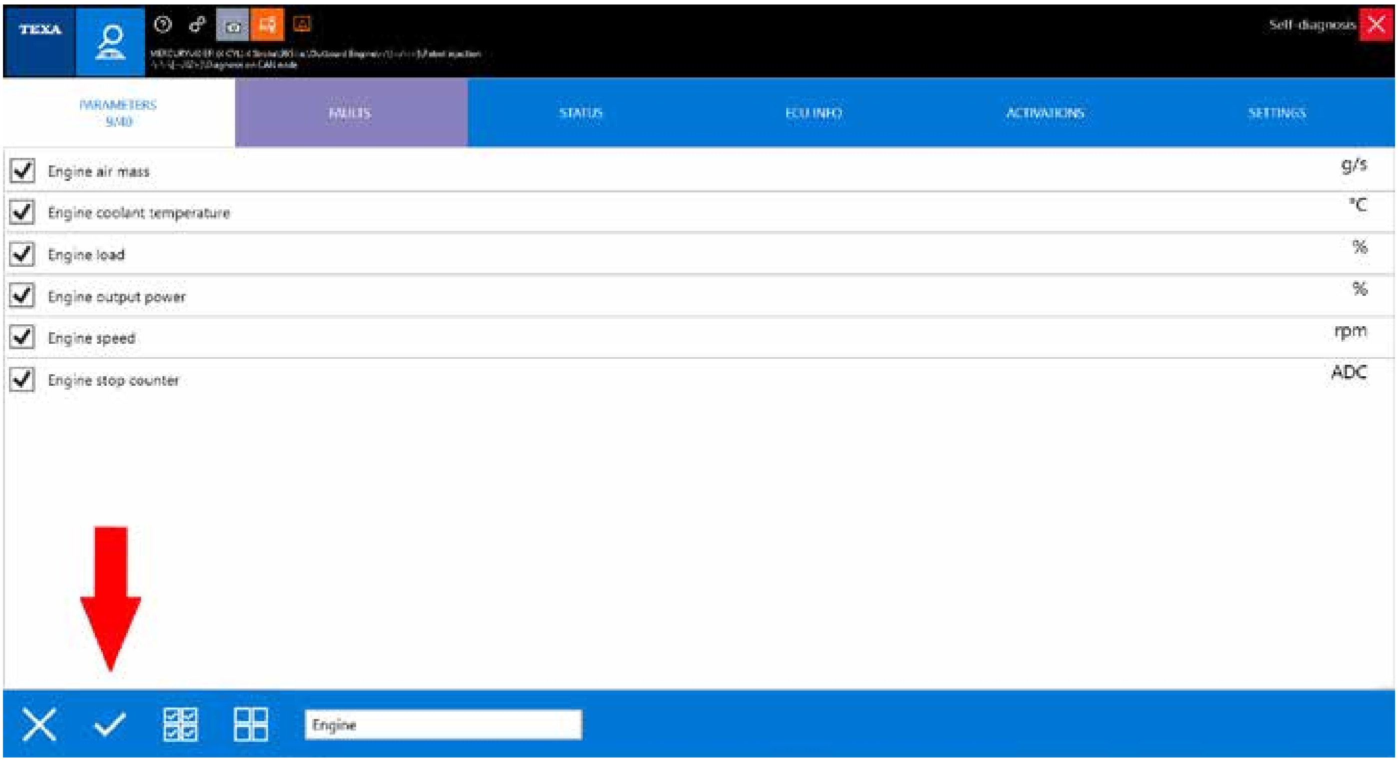

Figure 56: Once the parameters have been selected, the selection can be checked using the highlighted button

3.6.1 Logical Group, Parameters

Making a list of parameters according to a logical group means to let the Self-diagnosis tool display a number of selected parameters that are only relevant for the check on a specific system.
For the logical group to make sense:

- the operator must know the system which requires a check;
- all the selected parameters must relate to the component or part of the system that must be checked;
- the operator must not select too many parameters at the same time to avoid slowing down the update of the selected data (Refresh): the ideal number is 4 at a time.

3.6.2 Favourite Group

This function allows viewing and managing the favorite parameter groups created through the Parameters function.

Favorites are organized in pages as diagnosis functions. Each new favorite group will be displayed on a new page, which can be selected simply by pressing the related label.

Proceed as follows:

1. Press 

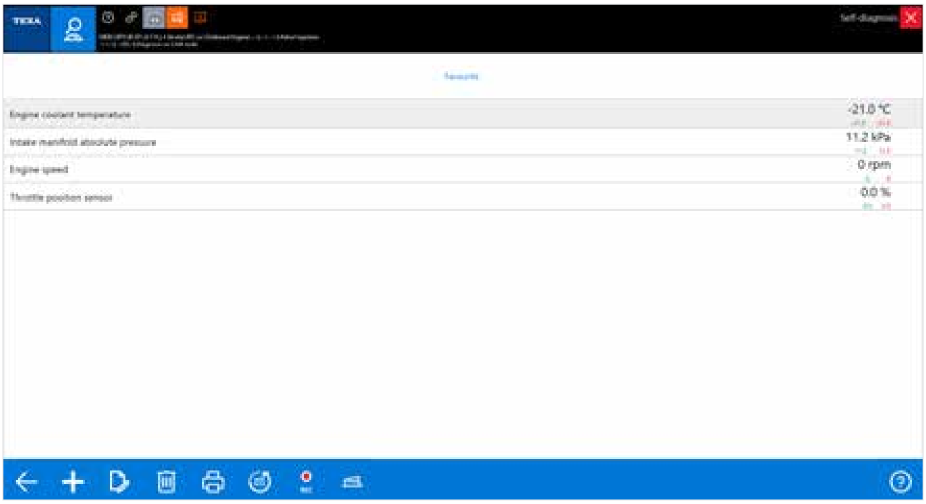
Figure 57

ICON	NAME	DESCRIPTION
	Create a Group	Allows creating a new Favorite Parameters Group
	Edit a Group	Allows editing the Favorite Parameters Group by adding or deleting some of them
	Delete a Group	Allows to delete a Favourite Parameters Group
	Printing	Allow printing a report in which the parameter values are saved
MIN MAX	Reset Min Max	Allows resetting the max and min values of the displayed parameters
REC	Recording	Allows recording the parameter values of the selected favorite ones. The Recording is saved in the Customer Management Database.
	On the raod test/ Dinamic Test	Allows to configure the Self- Diagnosis Tool for the recording function of the parameters and the DTCs detected by the ECUs with boat at sea.
	Information	Allows viewing a Help screen related to the selected parameter

Table 3

A. Group creation

Proceed as follows

a. Press +

b. Select the desired parameters

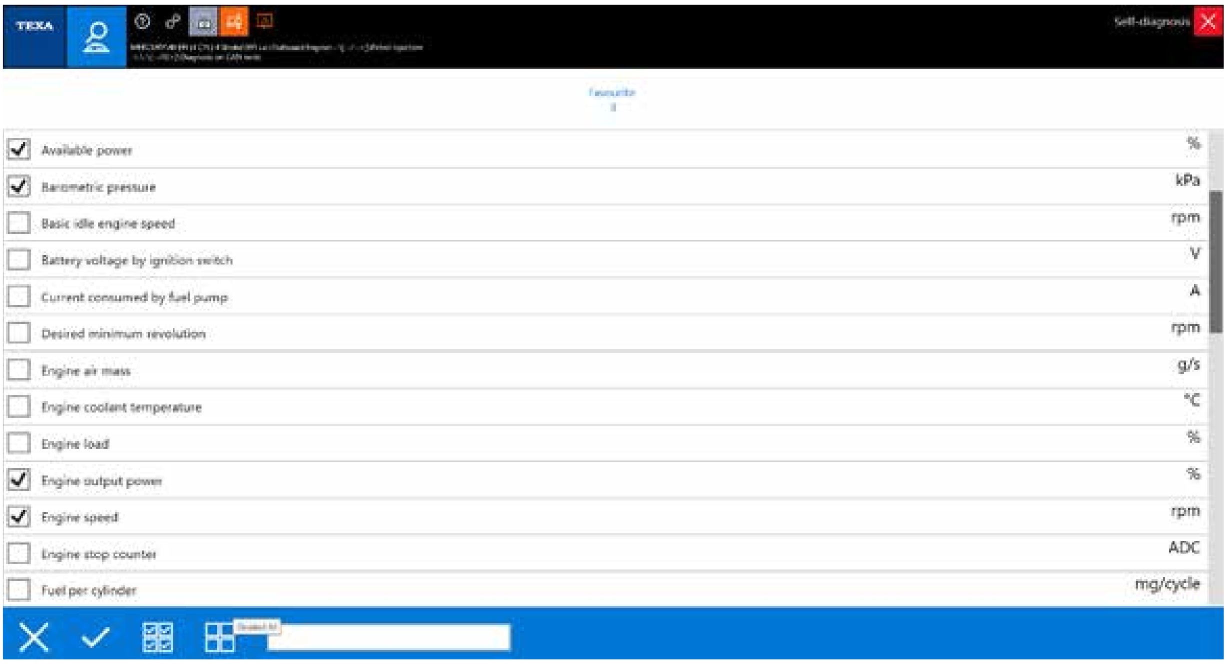

Figure 58: From the complete list of parameters you can select only those to create the logical group

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c. Please write the name of the group in the specific space

d. Press ✓ the group is now done.

3.6.3 "Dynamic tests" function

Thanks to the new high-performance hardware installed on Navigator TXB Evolution it is possible to record the diagnostic session in "Dynamic Testing" mode, i.e. with a the vehicle moving, in order to identify specific problems that would otherwise not be found in the workshop.

The best advantage is the recording of parameter without the need for a connection between the TXTs and the display unit (computers or TEXA tools).

Once the interface has been programmed, it records a complete overview of the conditions in which the fault occurred, providing important analysis elements to identify the causes of the fault and carry out the repair after the vehicle is back in the workshop.

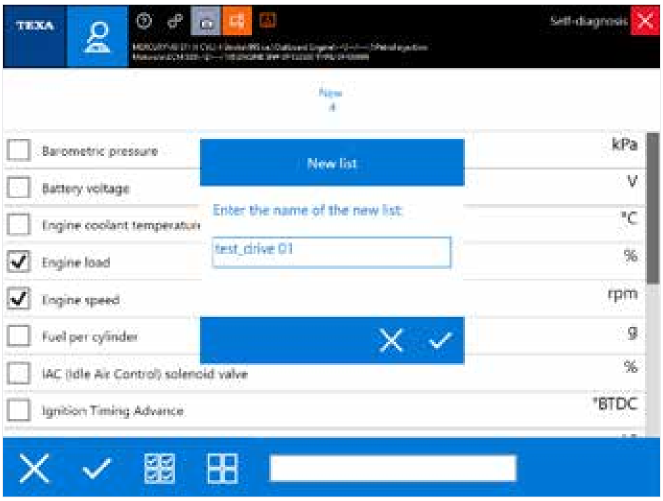

Figure 59: To perform a recording it must starts from the preferred parameters choice

In order to have a good recording we recommend selecting a logical group not above 20 parameters to maintain a sampling time of the sampled data very close to the real time of the engine parameters.

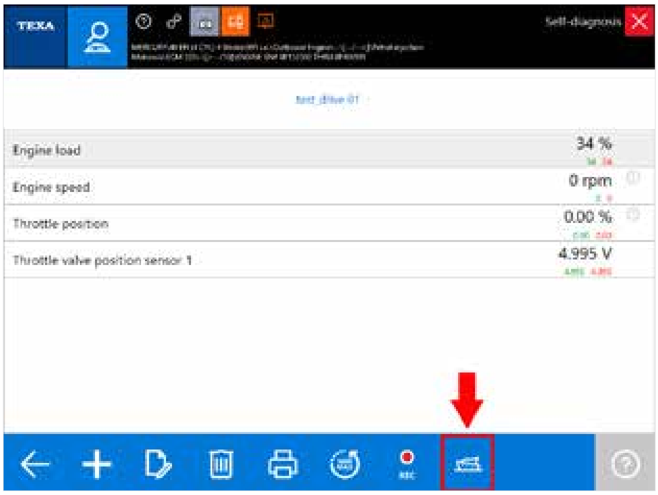

Figure 60: By selecting the highlighted button, the procedure for dynamic diagnosis will be launched

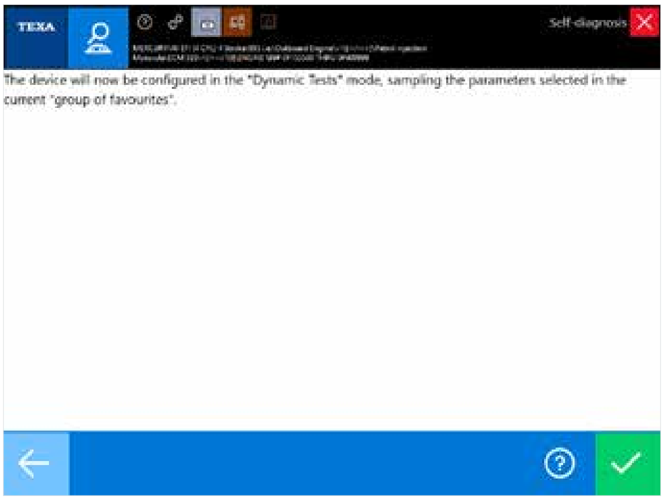

Figure 61: By confirming with the button on the bottom right, the diagnosis of the chosen group of favorites will be installed in the TXBe

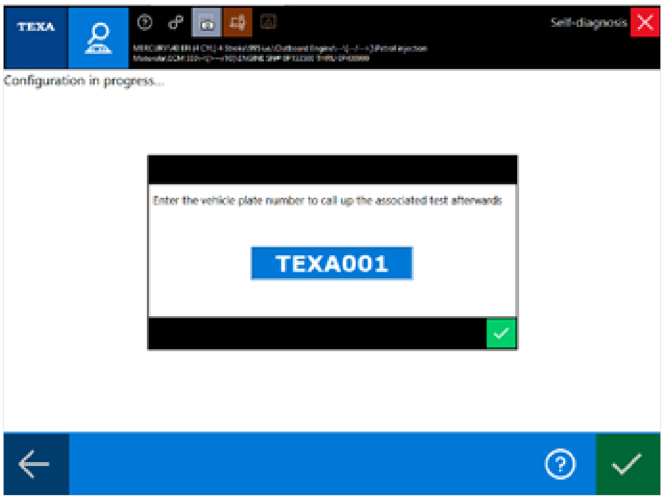

Figure 62: The data recording will be linked to the vehicle's license plate number entered in the box during the final programming phase of the TXBe

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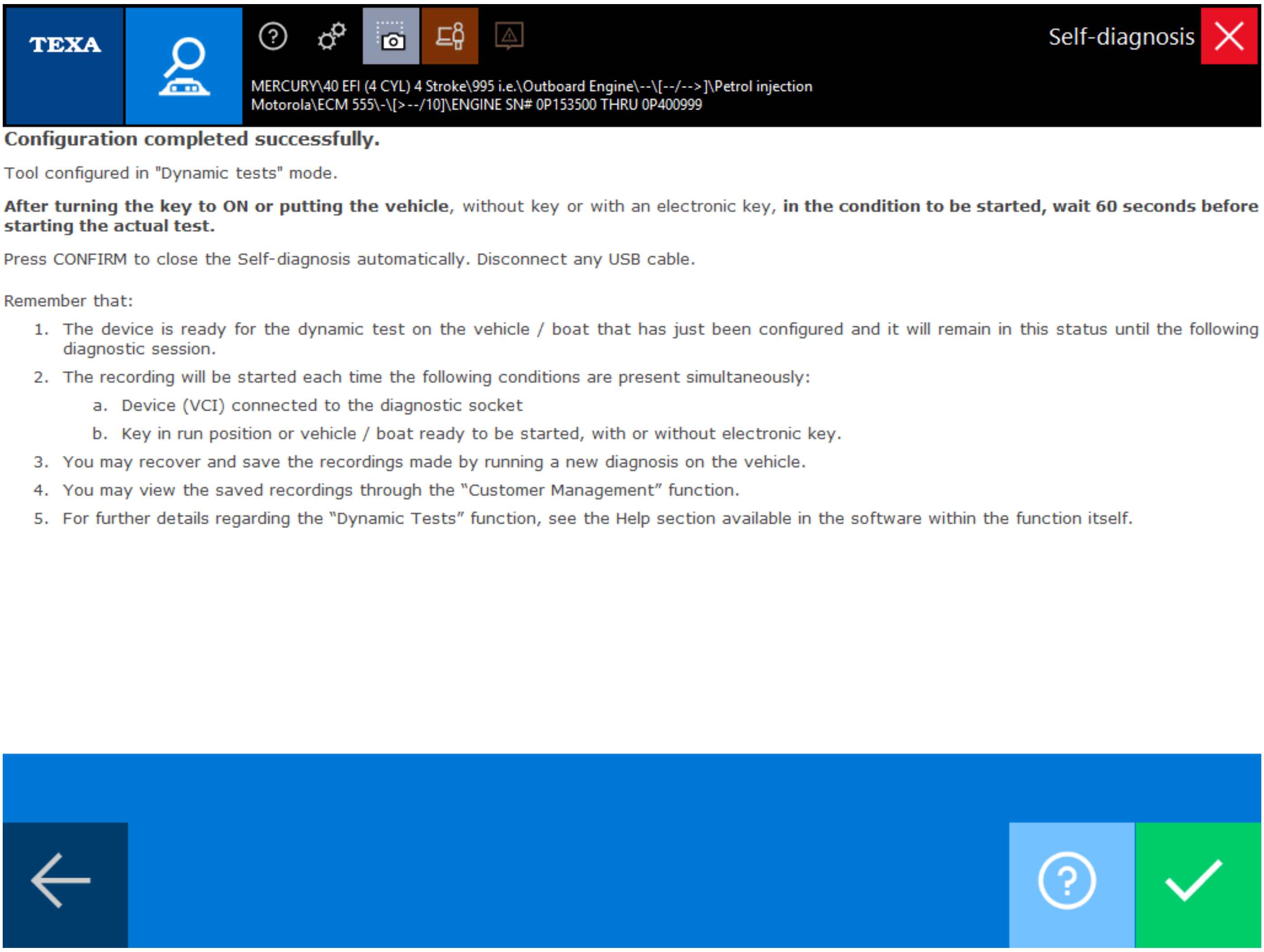

Figure 63: The TXB Evolution configuration has successfully completed

Once the interface has been configured, it will emit a beep at regular intervals: this means that it is in acquisition mode and each time the key is on ON, it will start saving the selected diagnostic data autonomously.

At the first diagnostic connection between the IDC5 software and the interface, you will be asked to download the data recorded up to that point.

The downloaded data can be easily found in the "Customer management" section, which can be reached from the main menu and from the vehicle selection menu (see figure below).

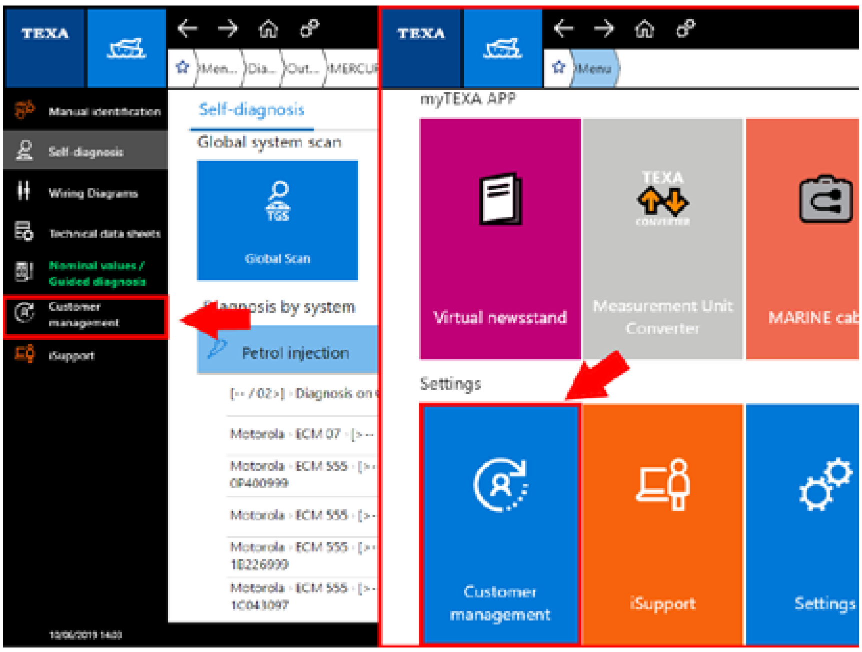

Figure 64: The customer management menu is located in the left-hand bar in the vehicle selection (left figure), or in the main menu of the MARINE home (figure on the right)

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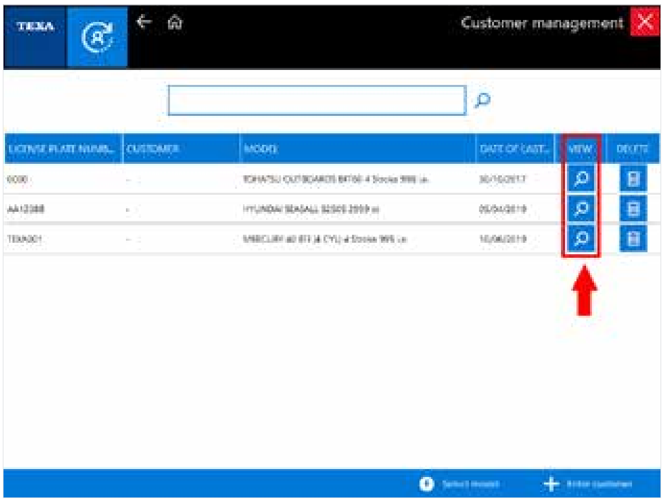

Figure 65: The main screen of the customer management allows selection the reg. number

Using the view button (red arrow in the previous figure) you can select the desired plate and then the trips divided according to date and time.

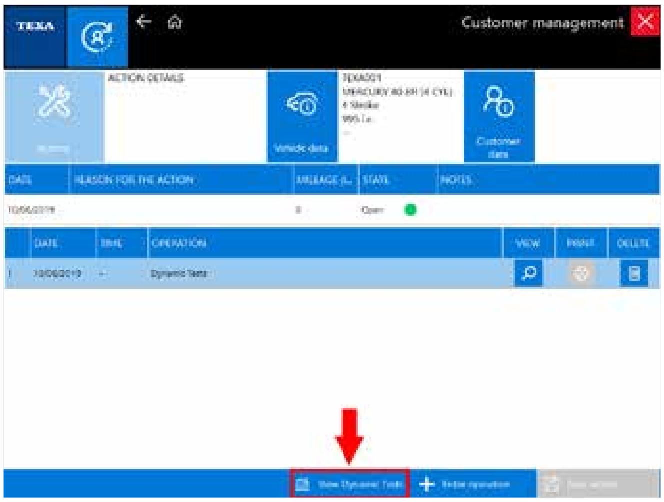

Figure 66: The acquired data can be displayed by selecting the dynamic test button

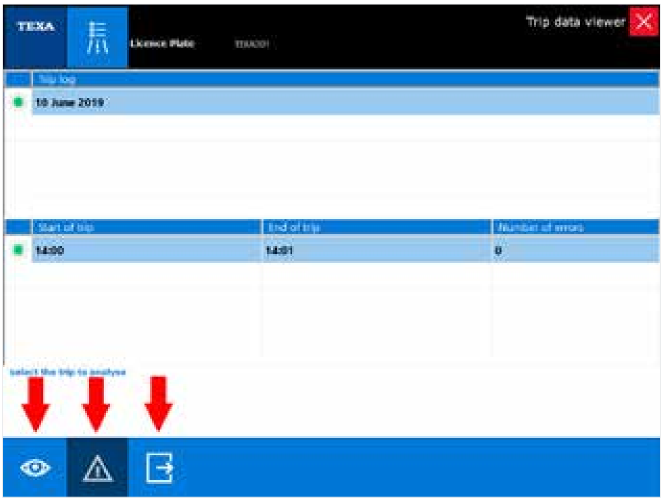

Figure 67: Recorded Trip list

ICON	NAME	DESCRIPTION
	View	It allows viewing the selected trip graphically
	DTC	It allows viewing the list of DTCs detected during the trip
	Export	It opens a Windows folder allowing to save the selected trip data in a file in .csv format for further processing (e.g. with Excel) or sending it to TEXA technical assistance

Table 4

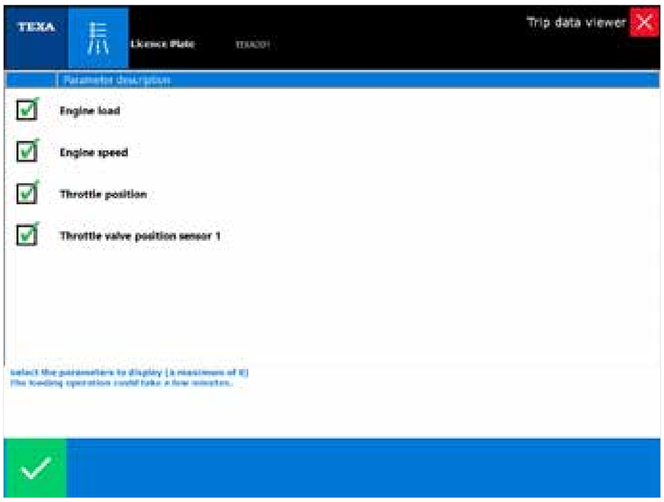

Figure 68: It is also possible to select which parameters to view from the recording group created

Figure 69: Parameters graphical page

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3.6.4 Graphic Display

When the parameters page is displayed, the software proposes the display of the instantaneous value by default.
Sometimes it may be practical to have the possibility to view the values in a graphical form according to time that is to see the trend. This mode can be activated simply by double-clicking on the parameter you want to display graphically.

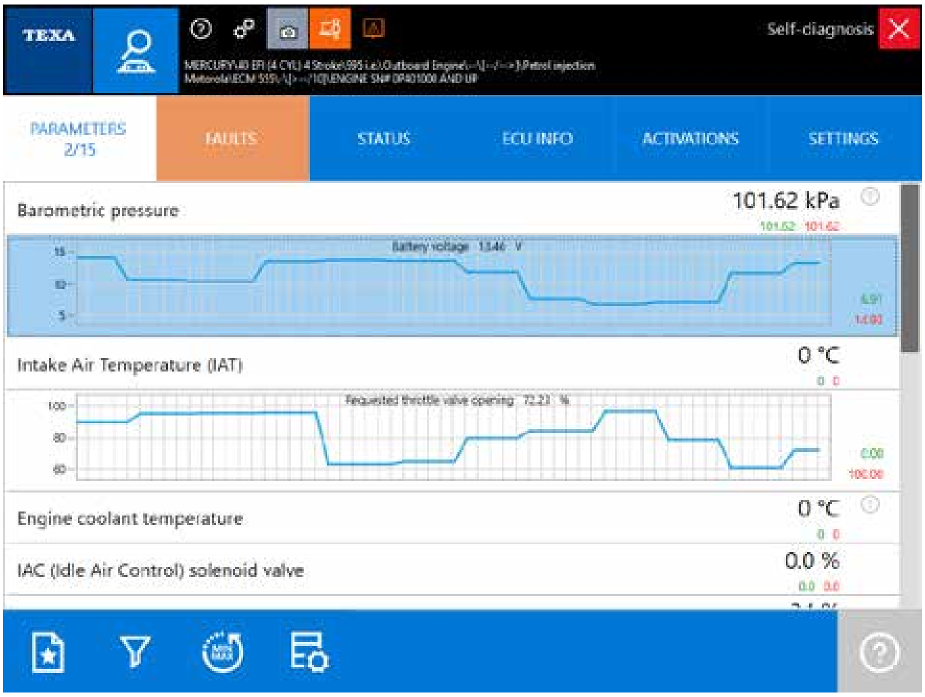

Figure 70: Graphic Parameter Display

The convenience of this graphic display is to be able to monitor not only the numeric value, but also the behavior of multiple values over a certain period of time.

3.6.5 Actual and Minimum and Maximum values

There are three values for each item on the parameters page. The large one is the current value of the parameter, while the two smaller numbers are the maximum and minimum values reached during the self-diagnosis session (a kind of reminder of the maximum and minimum values reached by the parameter during the diagnosis).

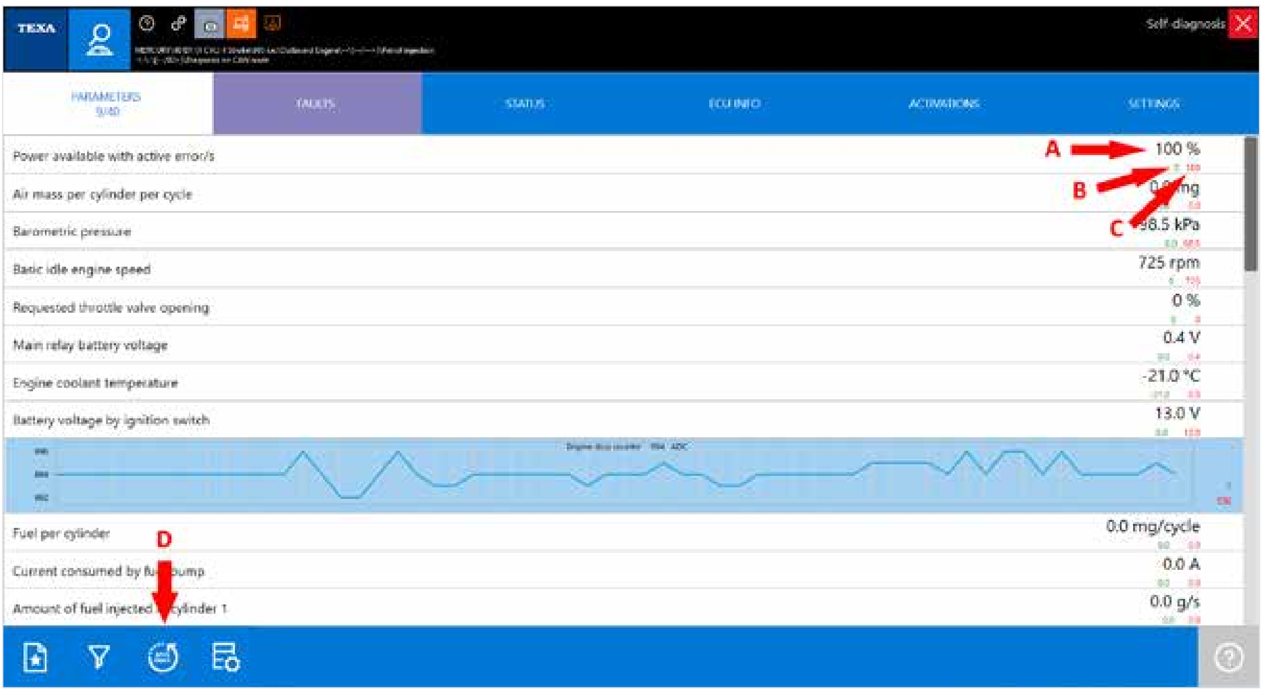

Figure 71

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Legend:
A. Current Value
B. Minimum value
C. Maximum value
D. Reset MIN / MAX values

In Figure 71 it is possible to see that the value of the parameter "Power available with active error" is currently at 100 (%), but in the self-diagnosis session a minimum value of 0 % and a maximum of 100 % (B and C) were also recorded.
You can reset maximum and minimum values at any time using the " " (D).

3.6.6 Logical and Physical Values

Many electronic control units allow displaying a parameter in its two possible forms:
- Physical value (rough value);
- Logical value (decoded value).

The first is the display of the signal value, analyzed in relation to its electrical components: voltage (Volt), frequency (Hertz), resistance (Ohm), etc.
The second is the interpretation of the information contents of the signal processed by the control unit: pressure expressed in bar, in ° C, sec, etc.

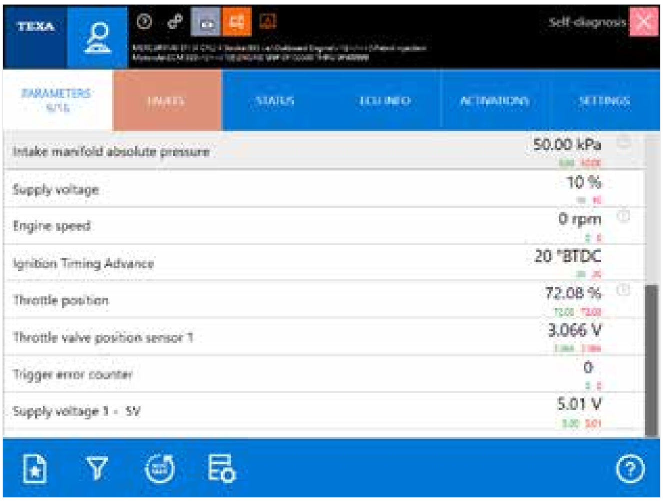

Figure 72

3.6.7 Parameter Value Update Speed

The update speed of a parameter depends on two essential factors:
1) Communication speed of the electronic control unit;
2) The number of parameters displayed.

For the first case nothing can be done.
The communication speed merely depends on the type of hardware used by the manufacturer of the electronic control unit (if the control unit is programmed to send the new value every 0.5 seconds for a particular parameter, the value will be updated every 0.5 sec.).
For the second case, however, you can try to reduce the number of selected parameters to get a quicker display.

3.6.8 Nominal Values

The Nominal Values sheets offer the technician detailed information, useful for the resolution of any error identified during self-diagnosis.
The nominal value sheets provide a step-by-step guided procedure developed to identify the possible cause of the error and the possible solution to it. They also contain the nominal values of the electrical components concerning the stored error.
You can access the sheets only within the self-diagnosis session, in the "Documentation" section: they are divided by system and specific device or fault code, in order to make the search simple and intuitive.

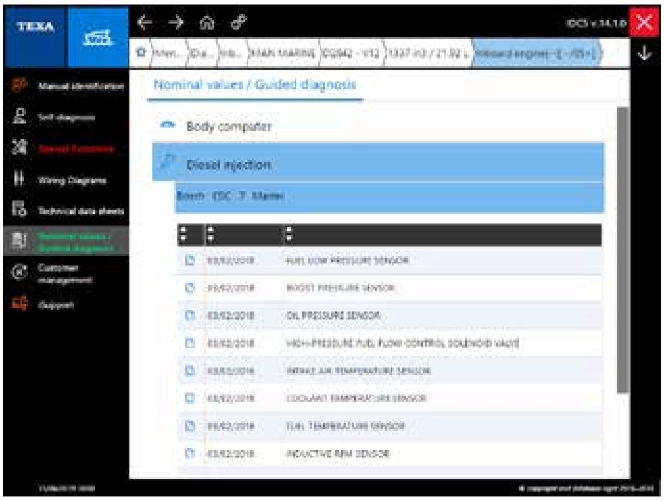

Figure 73: Nominal values sheets list

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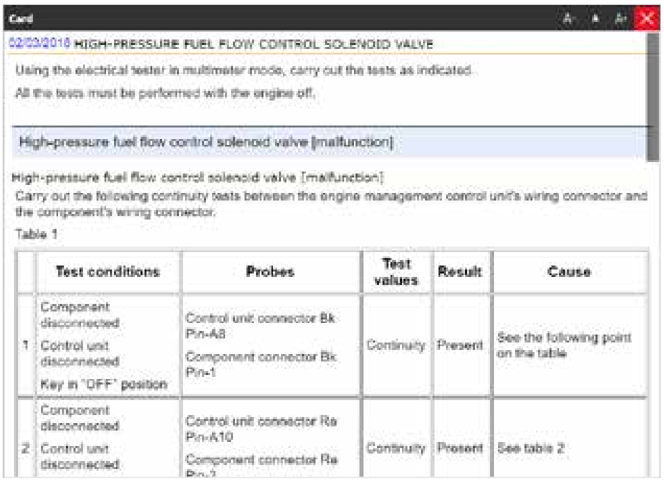

02/03/2018 HIGH-PRESSURE FUEL FLOW CONTROL SOLENOID VALVE

Using the electrical tester in multimeter mode, carry out the tests as indicated.

All the tests must be performed with the engine off.

High-pressure fuel flow control solenoid valve [malfunction]

High-pressure fuel flow control solenoid valve [malfunction]

Carry out the following continuity tests between the engine management control unit's wiring connector and the component's wiring connector.

Table 1

	Test conditions	Probes	Test values	Result	Cause
1	Component disconnected Control unit disconnected Key in "OFF" position	Control unit connector Bk Pin-A8 Component connector Bk Pin-1	Continuity	Present	See the following point on the table
2	Component disconnected Control unit disconnected	Control unit connector Ra Pin-A10 Component connector Ra Pin-2	Continuity	Present	See table 2

Figure 74: Nominal value sheet

3.7 Status Page

Normally, the information from the sensors is an ANALOG signal, such as the crankshaft sensor that provides the electronic control unit with the information about the speed of the crankshaft, or as in the case of the temperature sensors that provide information to the electronic control unit on the water temperature, air, etc. through a variable voltage continuously within a precise range of values.

Electronic control units also need other information that can be calculated according to the position of actuators, switches, relays, system configurations, etc.

This information is precisely given by another type of sensor installed in the vehicle that provides the digital signal controller with information such as: OPEN / CLOSED, ON / OFF.

This information indicates the status of the component.

The TEXA tool allows reading the specific status through a dedicated page called **STATUS**.

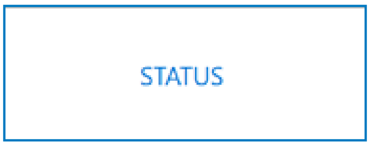

Figure 75: Status Page

In addition to provide an easy and immediate check of some components such as the clutch switch rather than the trunk opening button, this feature sometimes allows accessing essential information. In some systems, for example, in order to code the new ECU, it is necessary to read in the related Status page which components are fitted to that specific system; the precious "camshaft / engine synchronization" information that can be read on some marine's engine is relevant to identify possible causes if the engine does not start.

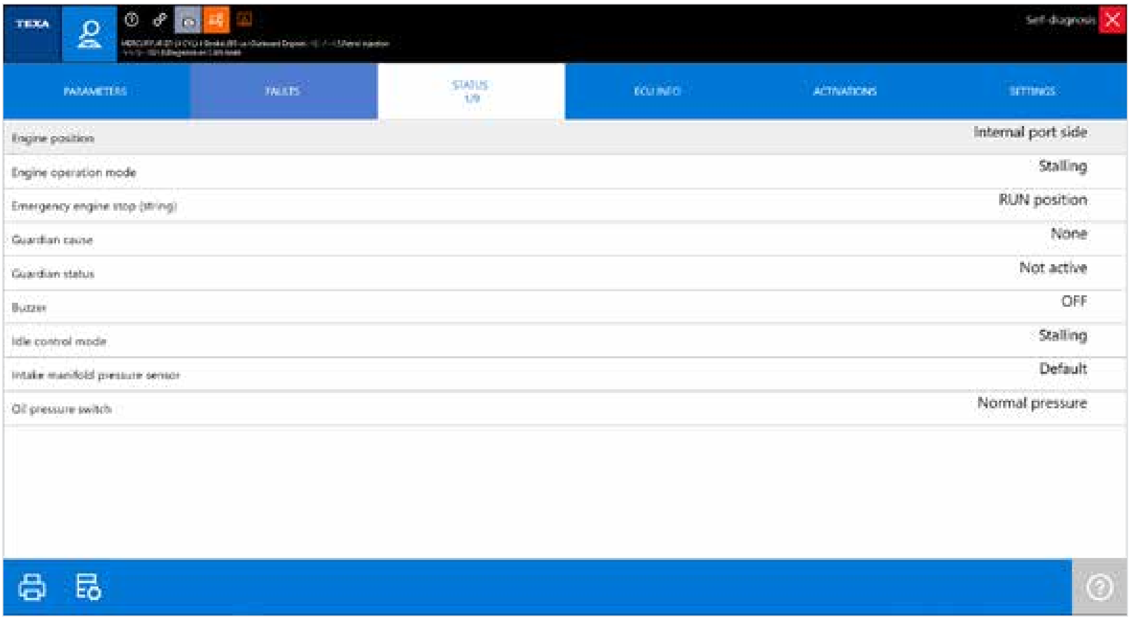

Figure 76: Status Page of the suspension ECU on BMW

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With the "Emergency engine stop" status it is possible to understand if the control unit receives the electrical signal of the component itself. By pressing and releasing the Emergency stop switch, the technician can detect the change from the RUN / STOP condition by the diagnosis. This action will be interpreted by the control unit as the driver's intention to stop the engine and will accordingly apply the appropriate strategies.

3.8 Info ECU Page

With this function it is possible to identify the Manufacturer's features of the tested control unit, both on a hardware level and on a software level.
Depending on the diagnostic system, you can obtain information such as the replacement code, date of production, and version of the software.

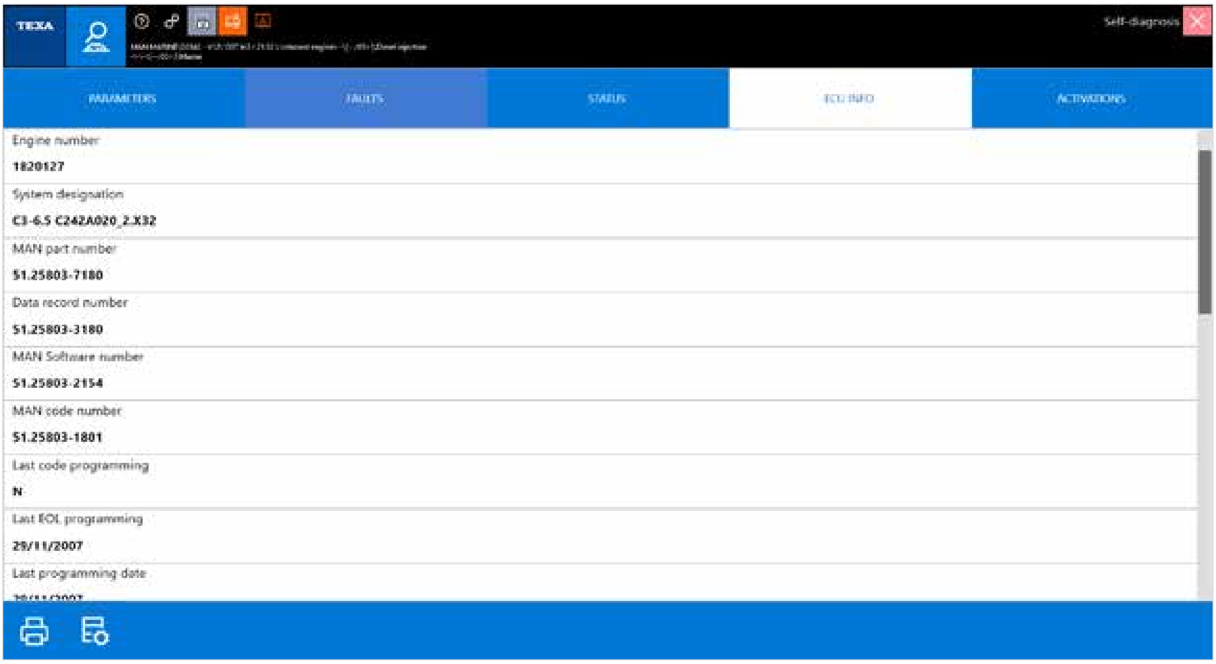

Figure 77

In addition, this page contains useful information for programming or coding when replacing the old control unit with a new one.

3.9 Activations Page

The electronic control unit is a computer that, based on the information received from the sensors and communication lines (Bus-CAN), monitors the actuators by applying the operating strategy for managing the system. These transactions are called ACTIVATIONS.
ACTIVATIONS, in the self-diagnosis feature, give the possibility to control the various actuators connected to the specific electronic control unit directly from the diagnostic tools.
This type of test is performed by the controller itself based on a command given by the diagnostic tool.
The component activation overcomes the normal operating logic of the control unit.
From the activations page you can directly actuate warning lights, solenoid valves, injectors, etc.
This function should be used primarily to test the operation of components the control of which would otherwise result in a loss of time.
It can also be used to understand the many components the diagnosis refers to.
For example, if there are two solenoid valves selected that are the same, such as the EGR command and turbine geometry, and you do not know which of the two commands the EGR, you can select one of them to detect which one activates.

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In some cases, activations do not only have diagnostic capabilities but are required to perform maintenance procedures.
For example, in some engine systems in which the injection or ignition time can be changed.

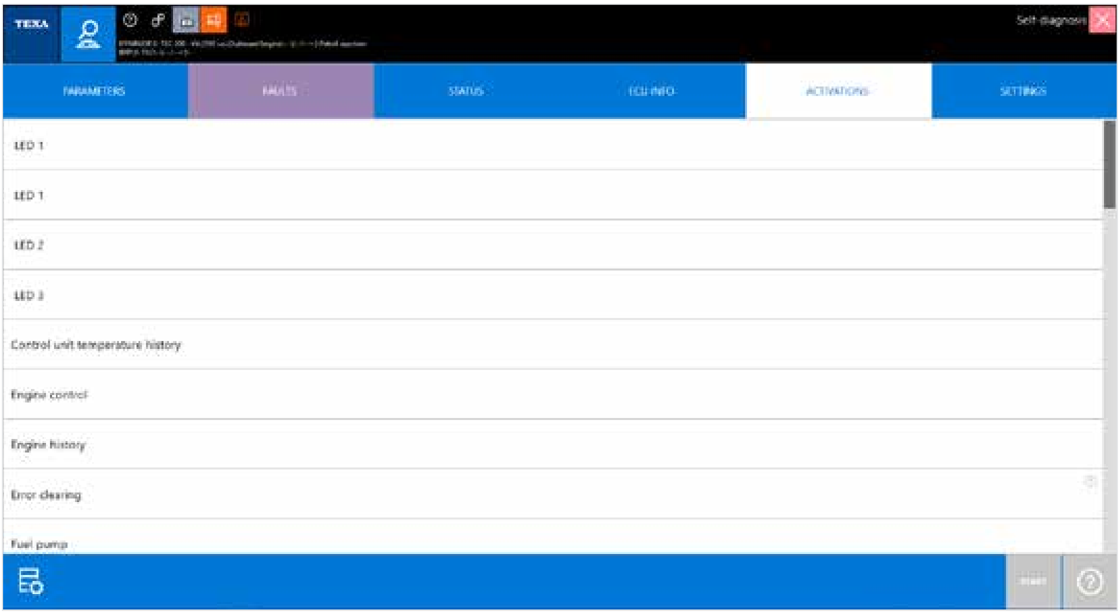

Figure 78: The ACTIVATION list available in the specific ECU is related to the Manufacturer

- The ACTIVATIONS function has differences that depend on the manufacturer, the model and the electronic system.
- The number of devices to be activated and the test execution mode depend strictly on how the controller software is designed and not on the capabilities of the diagnostic tool.
- Some control units enable activation tests with the vehicle moving. This possibility of diagnosis could be very dangerous when it comes to diagnosing safety systems. In fact, the direct activation of a security system actuator will force the electronic control unit, causing improper behavior of the vehicle.
- Activating some components may not have a preset activation time; in this case it will be up to the operator to disable the component after a few seconds to avoid overheating and possible failure.

3.10 Settings Page

The majority of the latest ECUs produced, regardless of the type of system they control, have the option of being configured without operating directly on the hardware part. This is possible because they adopt a flash rewritable EEPROM memory.
Using this technology and external power connections to the control unit, it is often possible to quickly change the software settings programmed by the manufacturer. In fact, the reprogramming has the purpose of modifying the controller's behavior in the system's management.
External programming, carried out with appropriate tools, is now widely used by all manufacturers, light commercial vehicles and industrial vehicles.
This type of solution allows using a single type of control unit to handle different systems: the control unit is adapted to the various models in which it is used. The possibility of adapting the control unit to the various solutions required is called **CONFIGURATION**.

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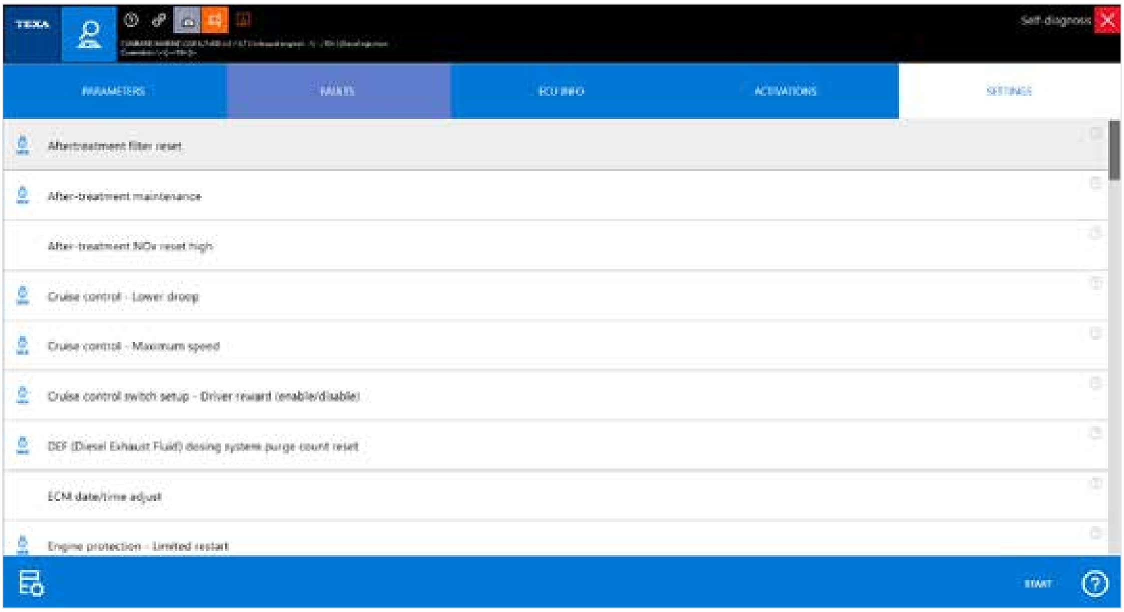

Figure 79: SETTINGS page & settings available

The "Settings" procedures are not only related to the possibility of coding the control unit, but often are very important to perform just common maintenance operations such as replacing brake pads or clearing the expired maintenance notice. With self-diagnosis tools, various types of encoding can be performed depending on the type of control unit, the manufacturer and the vehicle on which it is being used. In the following chapters, we will discuss some of the most common encoding procedures, analyze some differences between the various manufacturers, and explain how the coding procedures can be performed from the Settings page.

> *Starting from chapter 5 there will be examples of Settings according to the electronic systems, how to use the page with a detailed explanation of the procedures to carry out.*

3.11 The Vehicle Maintenance menu

Until a few years ago, the traditional self-diagnosis method was to connect to the control unit, see the stored DTCs, and perform the repairs accordingly. This is just one of the possibilities. It often happens that the technician's operations on an engine require using fast functions, such as resetting the parameters, performing an encoding, or just testing a single component. This is why TEXA has developed a series of fast functions that are quickly accessible.

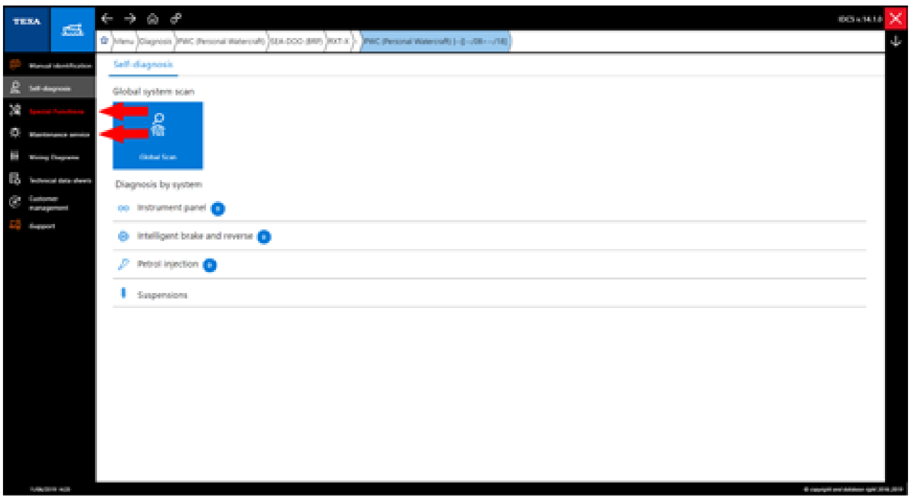

Figure 80: Vehicle Maintenance Menu

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After selecting the vehicle to be diagnosed, there are two buttons that give the possibility to quickly access a series of features, without having to connect to the electronic control unit first.

ICON	DESCRIPTION
Maintenance service	Allows accessing the adjustment functions to reset the deadlines in the maintenance systems
Special Functions	Allows accessing the special functions of settings and/or activations of the systems/ components related to the selection of the vehicle made

Table 5: Motorbike Maintenance menu

Each single function thus allows quick access to the Activations and/or Adjustments without having to connect to the specific control unit that manages the specific function the technician would like to test.

3.11.1 The Maintenance Service menu

The "Maintenance Service" menu contains all the Settings needed to reset the maintenance lights.

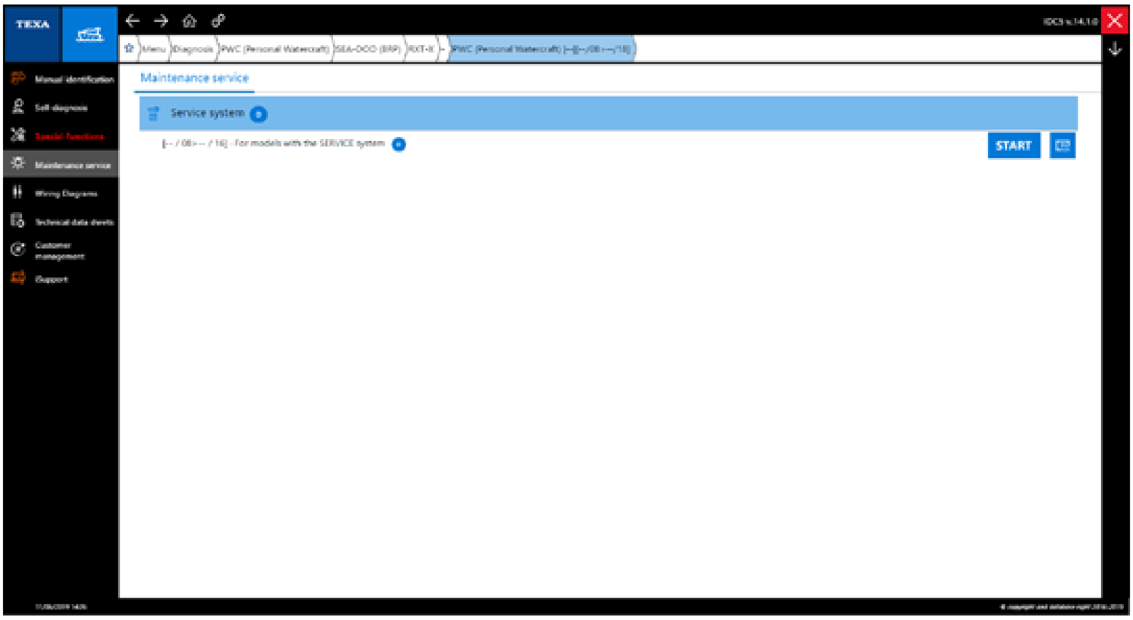

Figure 81: Maintenance menu on Sea-Doo RXT-X

For example, in the figure above, in order to check the parameters of the maintenance system on a Sea-Doo RXT-X is necessary to perform a reset of the service.

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3.11.2 The Special Function menu

The "Special Functions" menu contains the all Settings that are important in the maintenance process of the engine but which are not considered common operations, such as the CAN Line alignment.

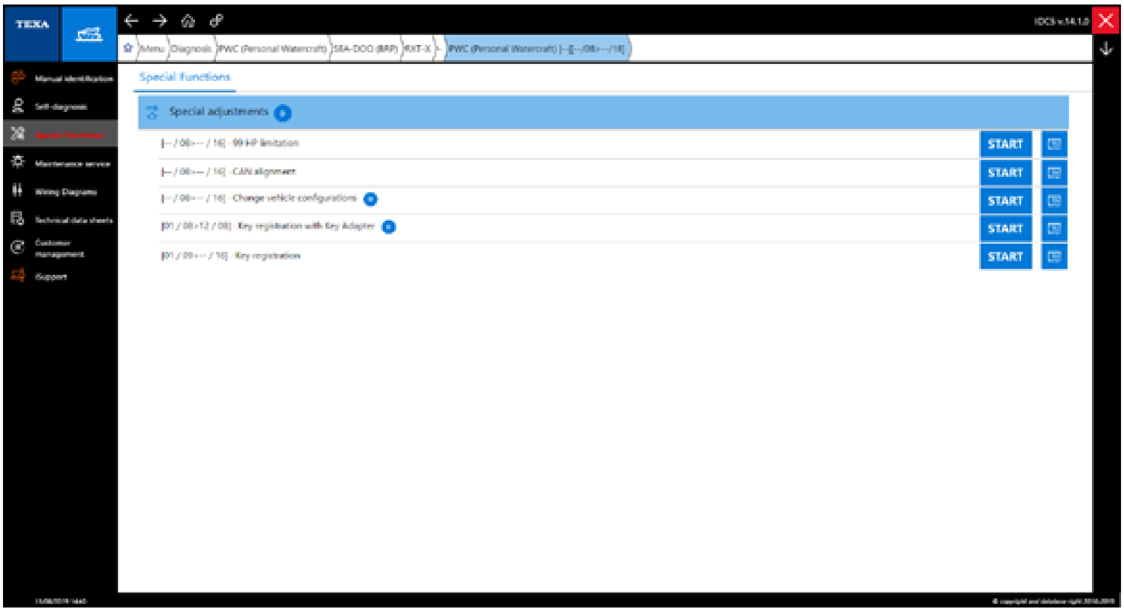

Figure 82: List of Special function on Sea-Doo RXT-X

3.12 The IDC5 Technical Documentation

Not only Self-Diagnosis is required for modern mechanics, but often all the additional information that allows understanding the functioning of a system and provide Control and verification data is also needed.
In fact, reading the “Intake air low deviation” only helps defining the problem area, but if you are not familiar with the vehicle and the system being tested, it is partial information.
To compensate this, in the TEXA diagnostic environment you can find various types of technical information:

- Wiring diagrams, with the related component data sheets
- Bulletins and technical sheets
- System description sheets

3.12.1 Wiring Diagram

The wiring diagrams are very important for the technician and workshop in general. In fact, many vehicle issues require checking the wiring and/or specification checks by the electrical signals on the cables.

It is possible to access the wiring diagrams both in free consultation mode and within the Self-diagnosis.
Selecting "Wiring Diagrams" menu, a list of the all wiring diagrams available for the selected vehicle, grouped by system type, will be displayed.

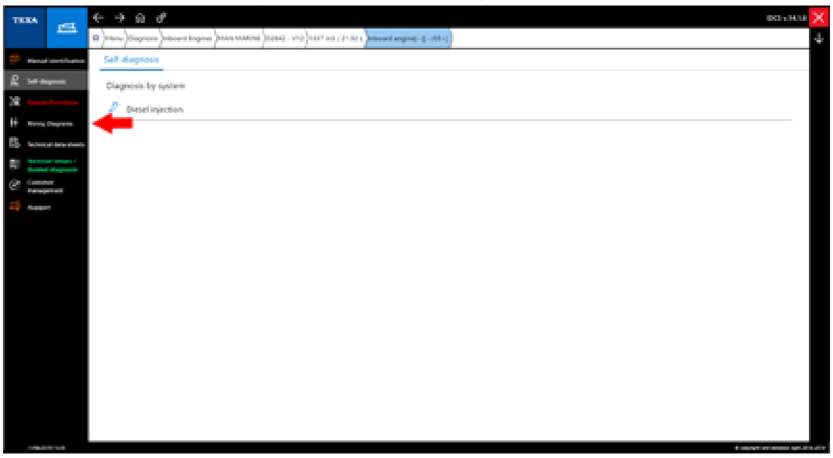

Figure 83: The Wiring Diagram appears when the engine has been selected

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The wiring diagram can be displayed on several pages and a series of specific commands and functions are available with all the information related to it.

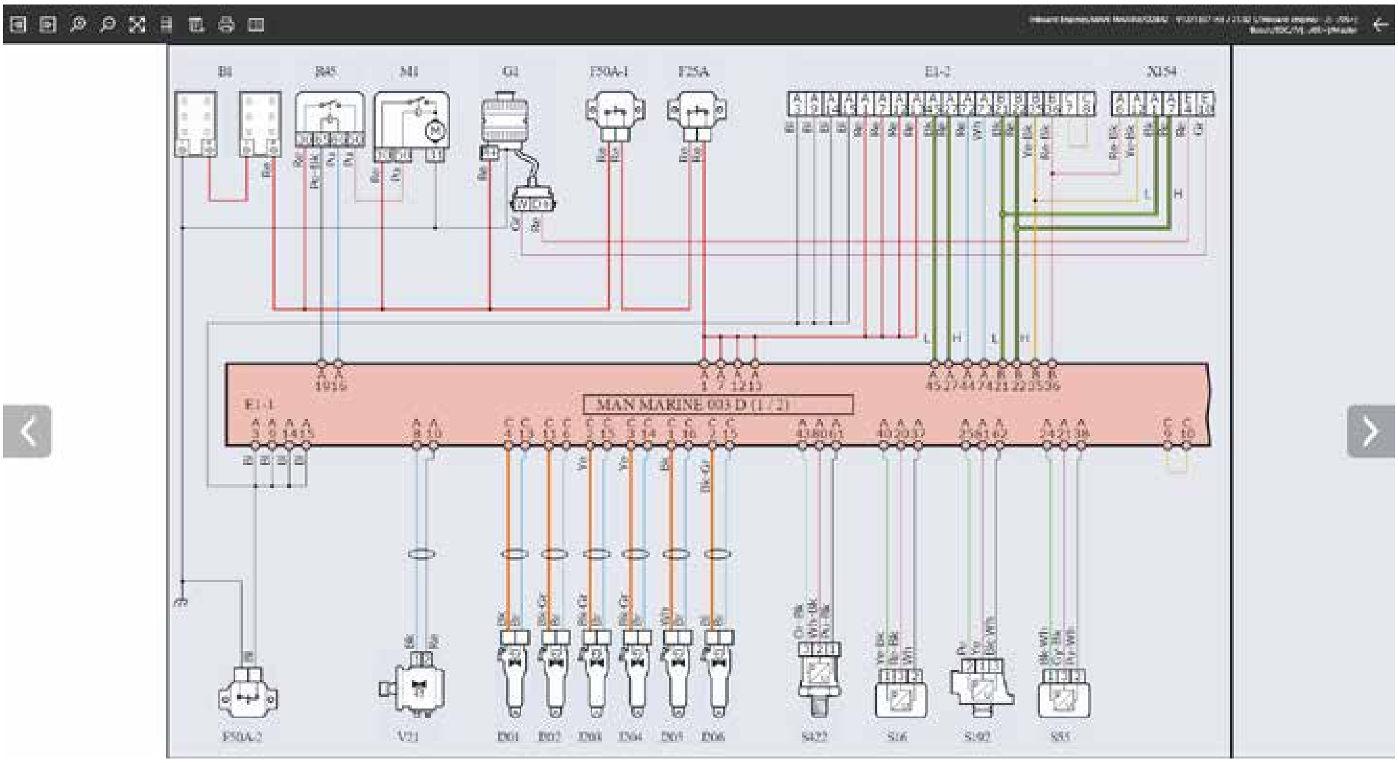
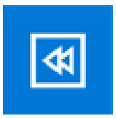
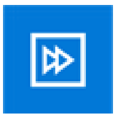
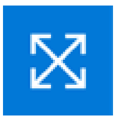
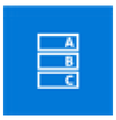


Figure 84: Engine management MAN Marine D2842 – V12 pag 1/2

Another feature introduced is the interactive display mode that helps technicians investigate the path of the cables within the wiring diagram. Simply move the cursor over the single cable to see the complete path within the diagram.

For an easier understanding of the system diagram, the display is standardized for every manufacturer based on a univocal logic.

Icon	Name	Description
 	Previous Page / Next	Allows moving between different pages of the same wiring diagram (only for multi-page diagrams).
 	Zoom In/ Out	Allows zooming in the desired wiring area.
	Full Screen	Allows returning to the Full Screen display of the wiring diagram.
	Device Legend	Allows viewing the list of components in the wiring diagram.

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	Device Location	Allows viewing the location of the desired component
	Schematics Legend	Allows viewing the color code used in the links.
	Print	Allows printing the Wiring Diagram and the Legend
	Interactive Wiring Diagram	Allows viewing the details of all the cable connections selected

Table 6: Wiring Diagram tools

Moving the pointer over the symbols in the Diagram shows a label identifying the component and indicating its location.

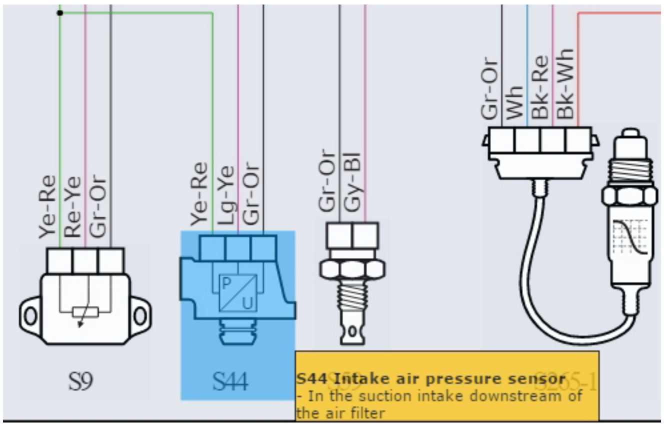

Figure 85: Intake air pressure sensor identification with location description

By clicking on the symbol of a component, the menu of the available functions is displayed.

Icon	Name	Description
	Technical Sheet	Displays a technical datasheet of the selected component.
	Image	Displays a photo of the component.
	Manual Mode	Allows executing the oscilloscope command interface.
	Connector	Display a pinout image of the connector.

Table 7: Controls and functions of the electrical diagram component

Not all commands are available for all components.

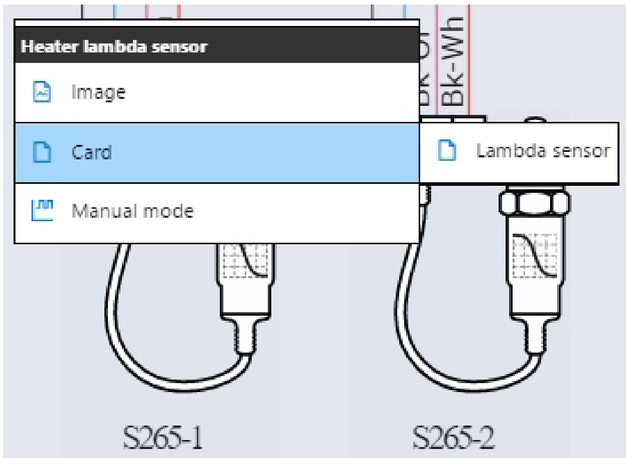

Figure 86: Under the menu the technical sheet connected to the oxygen sensor is displayed

For example, the technical sheets of a component can explain the operating principle, the technical characteristics and the control values, the operating aid in Self-Diagnosis: depending on the type of component, it is possible to find several sheets for a specific topic.
Figure 86 shows the data sheet of one of the two oxygen sensors, in which you can see the operation and the characteristic waveform that this component must have..

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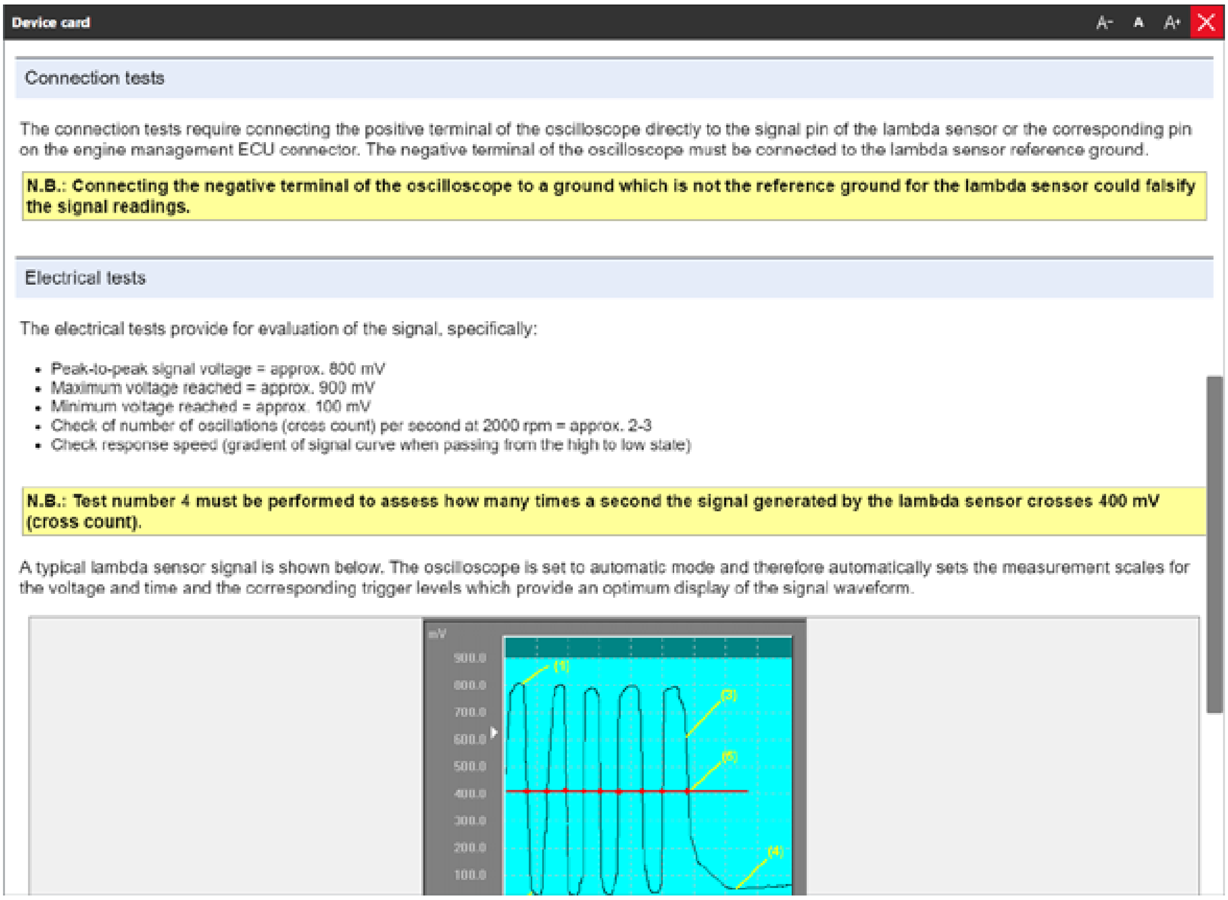

Figure 87

It is often necessary to be able to consult wiring diagrams during a self-diagnosis session.
On the various screens there is a "" button (Parameters, Activation, Adjustments page, etc.) that allows accessing all the documentation that supports self-diagnosis.

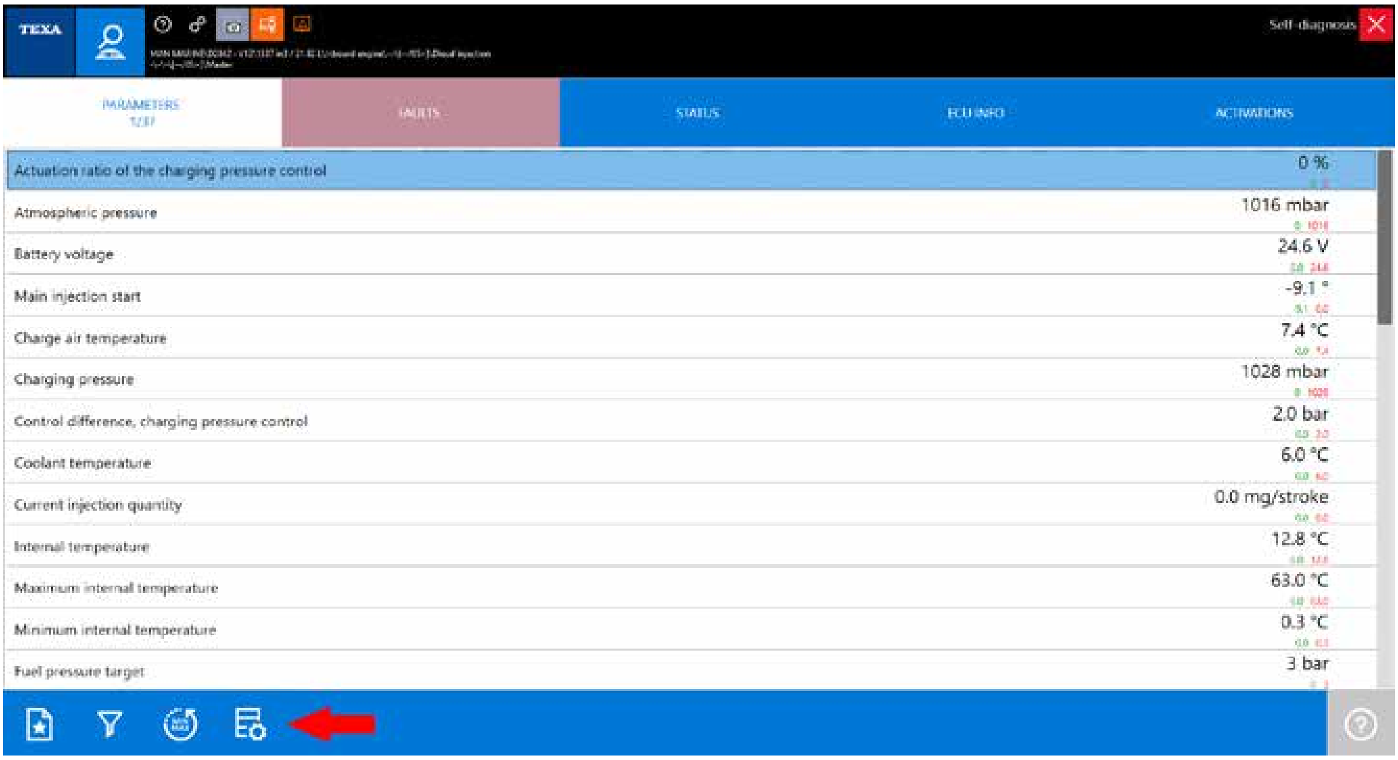

Figure 88: Location

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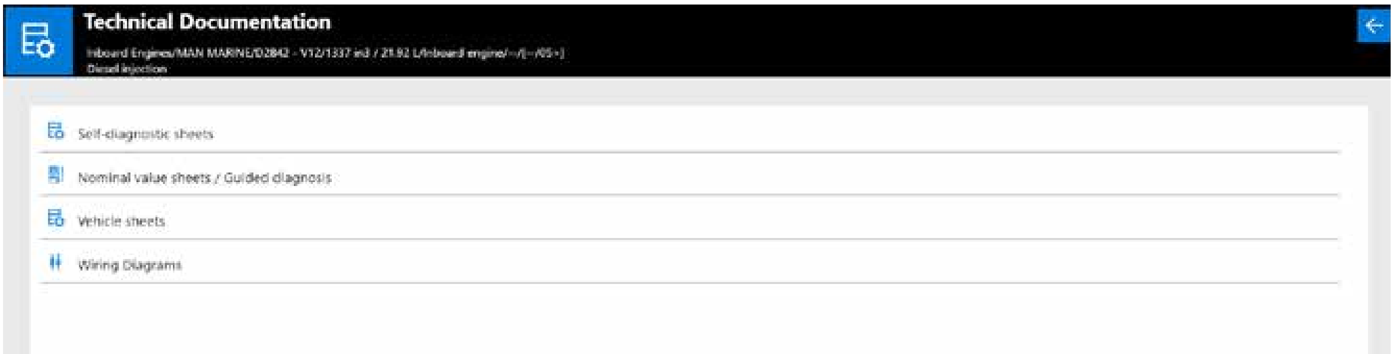

Figure 89: List of the Technical documentation available

3.12.2 Bullettins and Technical Sheets

Nowadays, the technician of a multi-brand workshop has to face a great variety of systems from different manufacturers, each with its own peculiarities.
This, of course, is not always possible. The huge number of manufacturers and variants makes an in-depth knowledge of each system practically impossible.
For this reason, TEXA provides a range of technical sheets and information for the diagnostic systems.
This information is available, sorted by system and/or vehicle, by clicking the " " button.

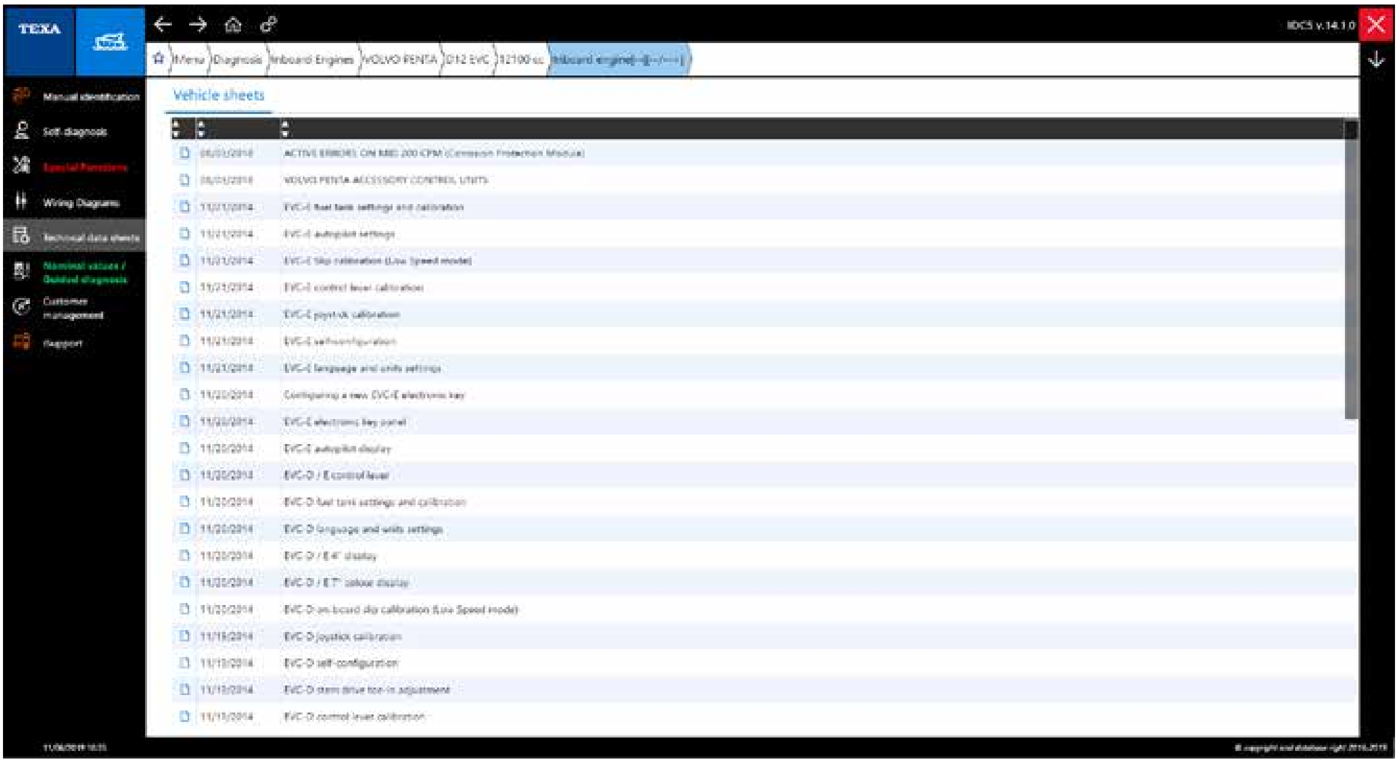

Figure 90: Sheet and Technical Bullettin

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There are two types of technical information: Sheets and Bulletins.

Icon	Name	Description
	Sheet	Displays a descriptive data sheet for the selected system.
	Bullettin	Displays a document that shows a specific problem and/or solution.

Table 8

Each of these two types can be found under two different categories:
- System sheets;
- Vehicle sheets.

The System Sheets contain information related to a specific system, while the second contains valid information for the entire vehicle.
Due to the nature of the information and the explanation of "practical" problems, technical bulletins are constantly updated and made available to the public (subject to a subscription).
This way you are constantly updated with the latest information available.

3.12.3 Self-diagnosis cable list

The diagnostic interfaces produced by TEXA to connect to the electronic systems available in the motorbikes require using a specific diagnostic connector for each manufacturer.
Considering the large number of motorcycles in IDC5 and therefore of diagnostic cables present in the TEXA catalog, in order to simplify the search for the correct cable, a free APP has been introduced with information on the availability of diagnostic cables for which a standard cable is not yet available.
It consists of four sections, from which you can access the complete list of cables used by the software, those used by each make, the list and descriptions of the cable cases available and the information on the adapters to use with compatible tools in other environments.

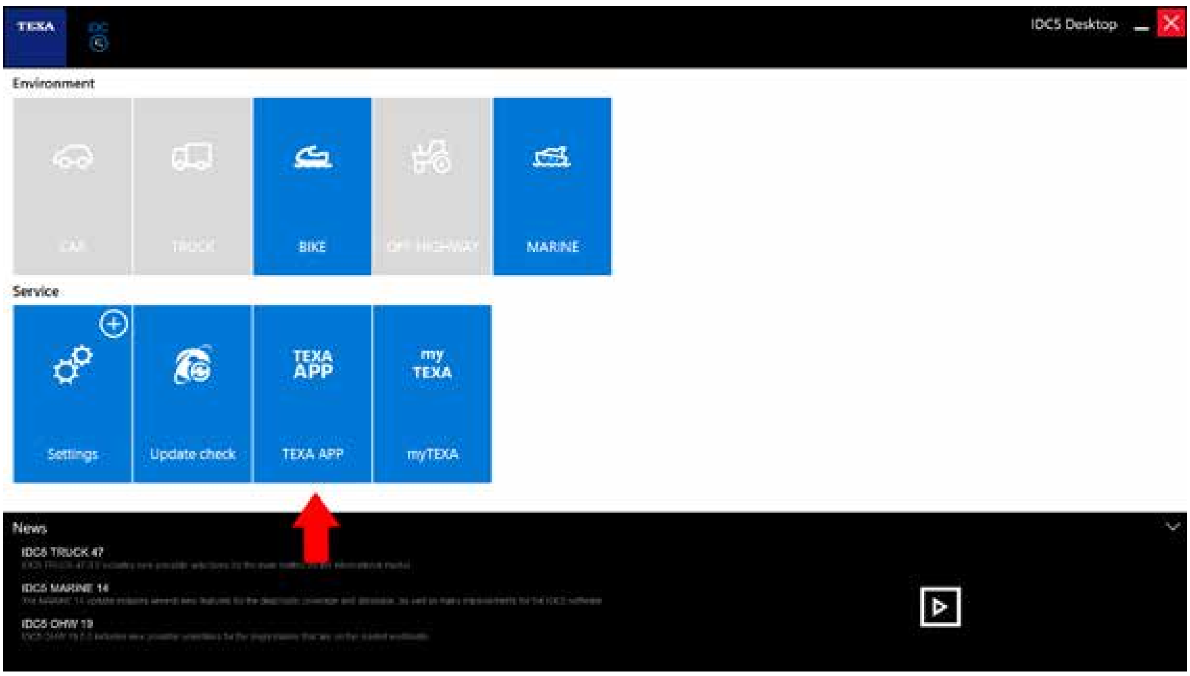

Figure 91: The search for the bike cables app starts with the installation from the TEXA APP menu

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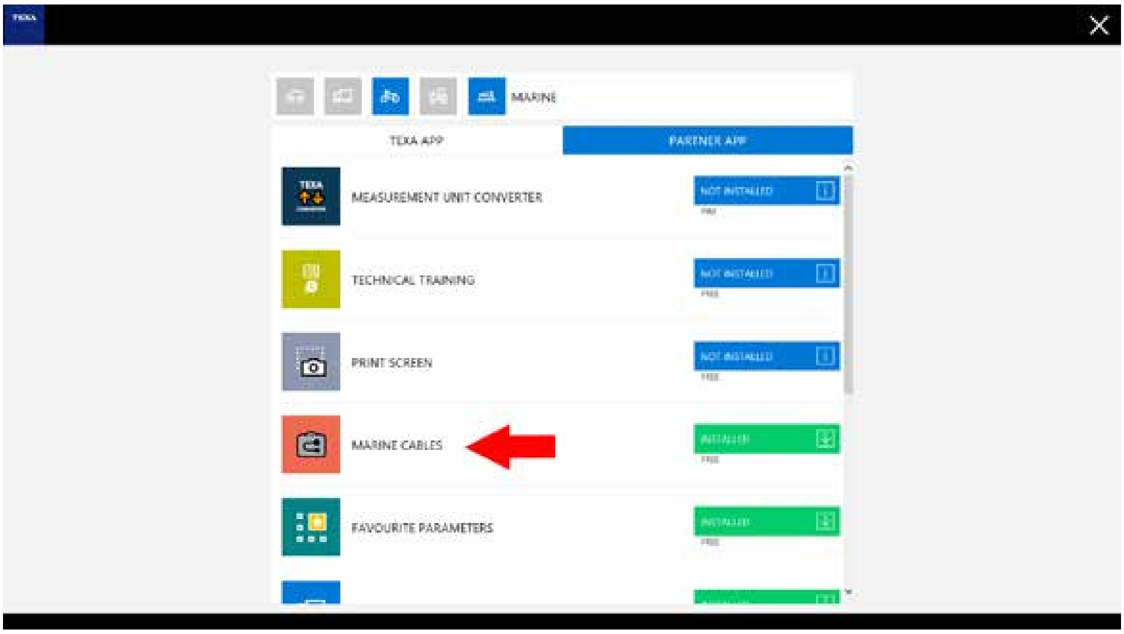

Figure 92: The Cable app is in the list of apps available for the bike environment

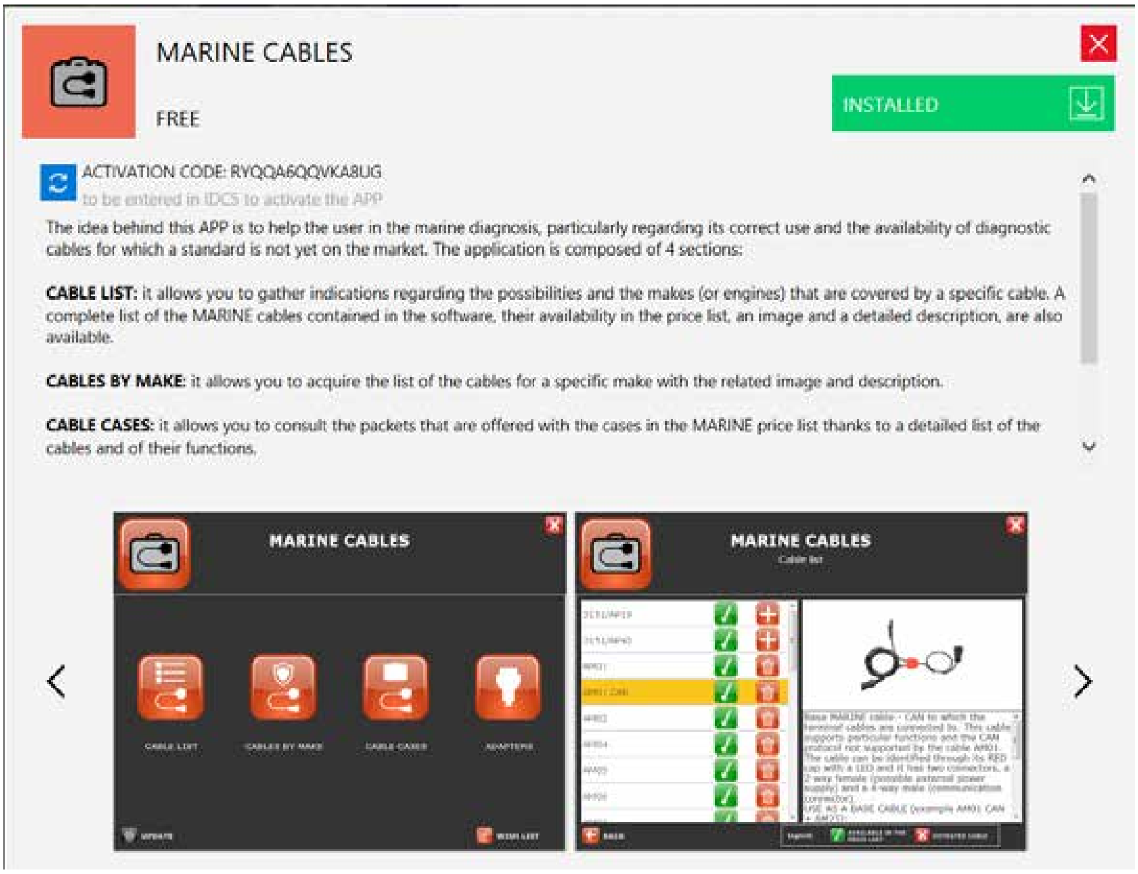

Figure 93: Once selected, the App can be installed using the button at the top right

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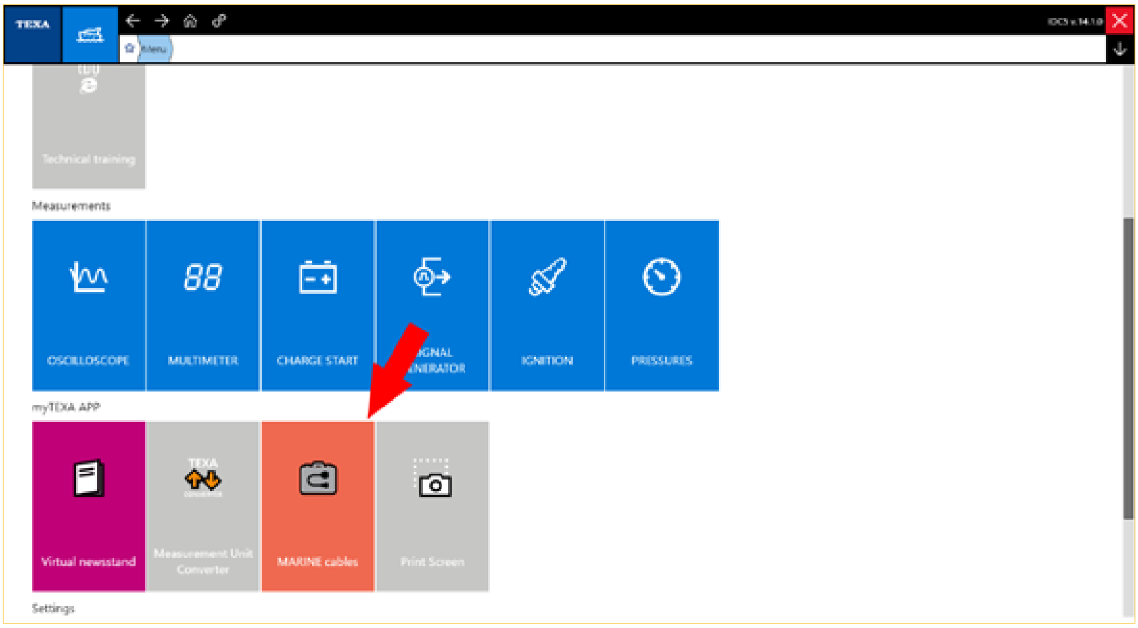

Figure 94: Once installed, the App will be enabled in the myTEXA APP section

Figure 95: The cable search is divided by cable code, by make and by case kit. Furthermore, the adapters needed for the connection to the various Texa self-diagnosis interfaces are indicated

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4. REGULATIONS FOR THE POLLUTANTS CONTROL AND EOBD SYSTEM

Pollution is a phenomenon that is not limited to the emission of toxic gases from power plants, heavy industries and vehicles.
In fact, it often also involves a series of very complex chemical reactions the repercussions of which have not yet been clearly defined, despite the exhausting discussions by experts around the world.
All the newly manufactured outboard engines have the American EPA certification in compliance with the air pollution control regulations. This certification is based on the setting of certain values in compliance with the factory-established standards. For this reason, the product's maintenance procedure must be followed thoroughly and the original design intent must be respected whenever possible.
Maintenance, replacement and repairs on emission control devices and systems can be carried out by any technical center qualified for repairs on spark-ignition marine engines.

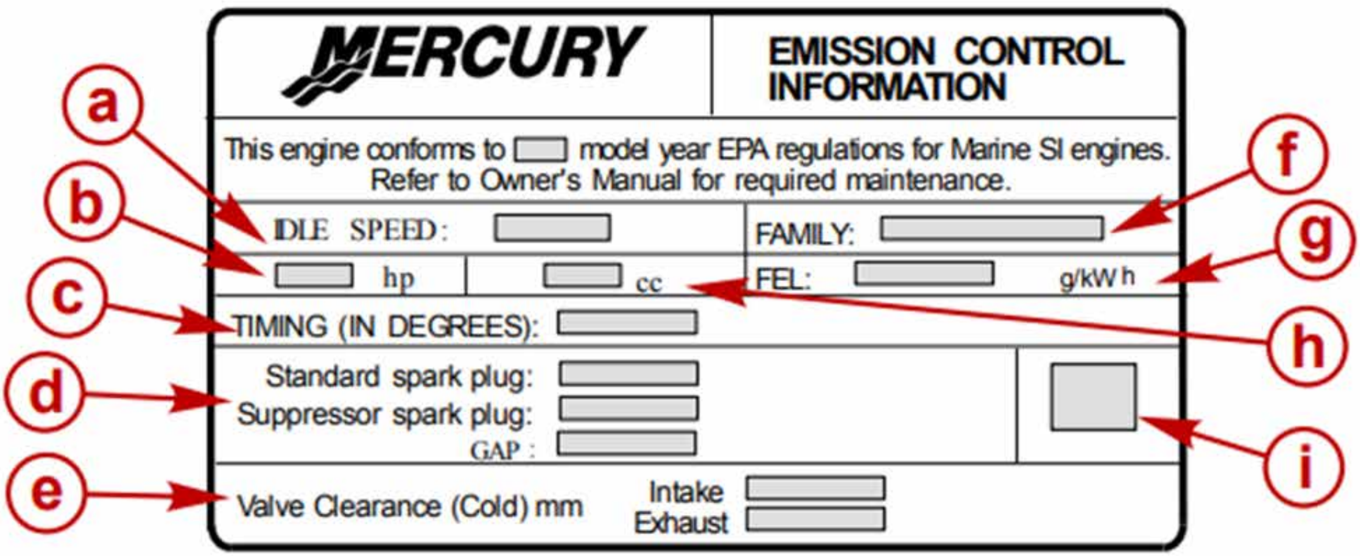

Figure 96: While the engine production is complete, a label is installed in order to certificate the emission level and the related engine specification.

Legend:
A. Idle speed
B. Engine power
C. Timing specifications
D. Spark plug and recommended distance between the electrodes
E. Valve clearance (if applicable)
F. Product line number
G. Maximum emissions for the line of engines
H. Engine displacement
I. Date of production

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5. RESET AND CODING

The "settings" available are many and differ from make to make and model to model.
However, we will explain as much as possible the procedures that will be useful also to understand better all the tests developed in the tool.

Be aware that some of the operations we are going to explain can be very important and relevant for the normal functionalities of the marine engines, therefore some knowledge is required in order to perform them according to the manufacturer's instructions

5.1 Adjustment of the Mercury levers

The adjustment of the Levers is a procedure during which some parameters of the injection control unit are modified within limits established by the manufacturer.

This function is necessary to let the new engine learn the type of lever that you want to use or when this one is replaced.

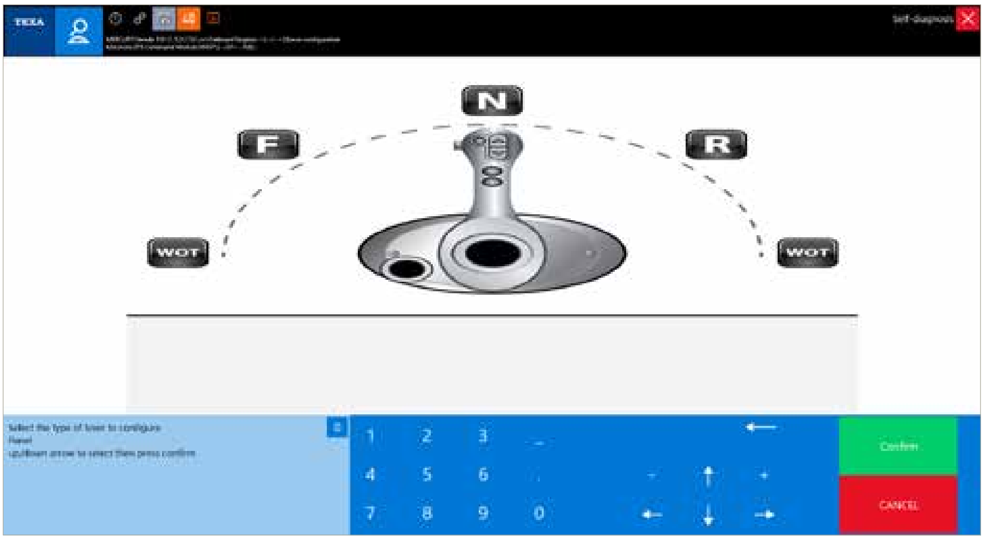

Figure 97: Mercury lever adjustment

5.2 Reset of the HONDA control unit

This adjustment is essential to let the control unit (ECU) learn when a component is replaced, for instance, the lambda probe, TPS, temperature sensors, etc...

Figure 98

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The proper procedure to perform this adjustment is the following:
- Replace de damaged component
- Perform the control unit reset through the Adjustments of the IDC5 Marine software page
- Switch on the cold engine and maintain it at idle up to the reaching the operating temperature while paying attention not to accelerate or use additional services
- Once operated the engine, switch it off and wait at least 2 minutes before restart it

At this point the procedure is completed and the engine can be normally used.

When this operation is performed, all the errors present in the control units are removed.

5.3 Reset Service SEA-DOO

This adjustment is performed to record in the control unit the date on which the service has been performed, the instrument that has performed it and the time that the engine had in that precise moment and, at the same time, the SERVICE warning light is switched off. Actually, a new writing is performed in the control unit.

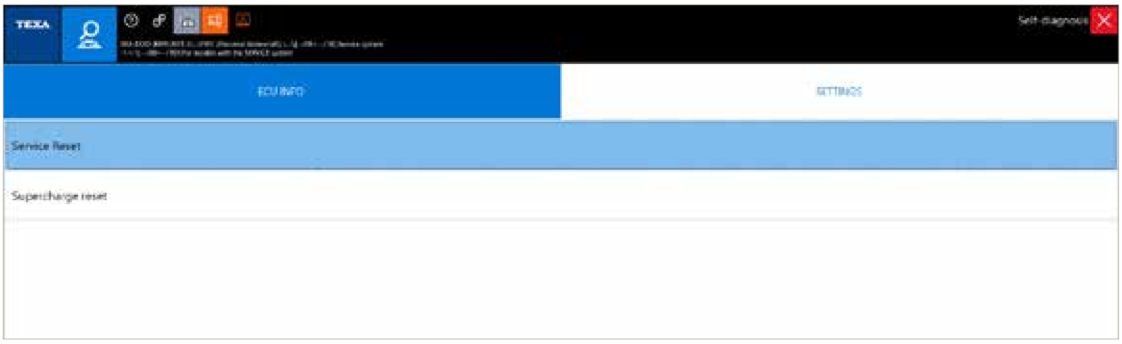

Figure 99: Sea Doo adjustment page

5.4 Key coding Sea Doo

The software indicates the number of the keys that are currently stored in the control unit and allows the user to enter new ones.

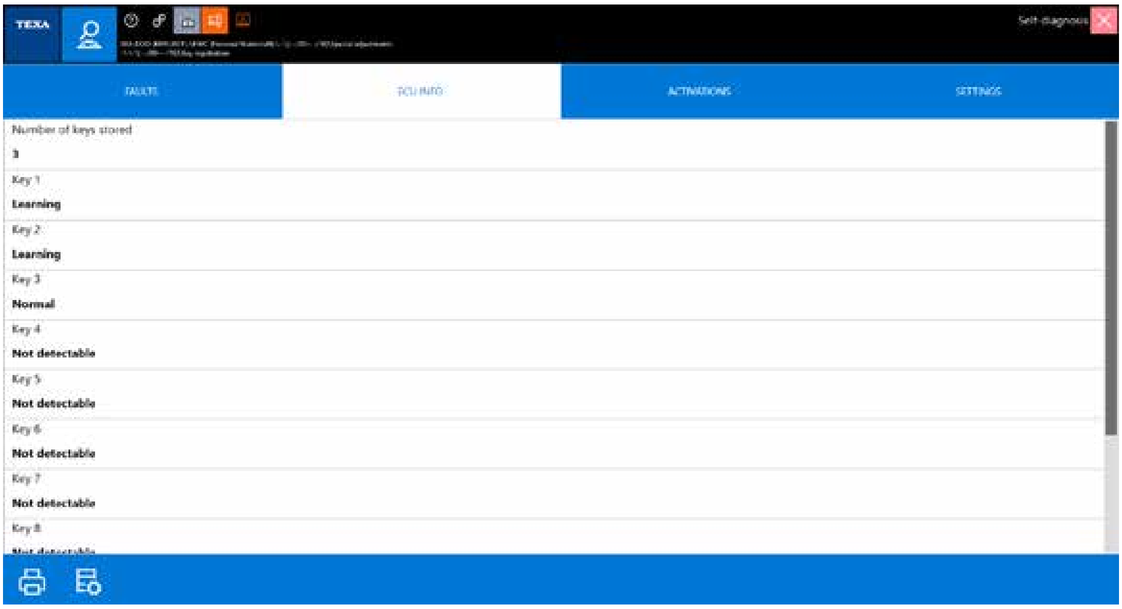

Figure 100: In the Info ECU page, the software shows the number of stored key

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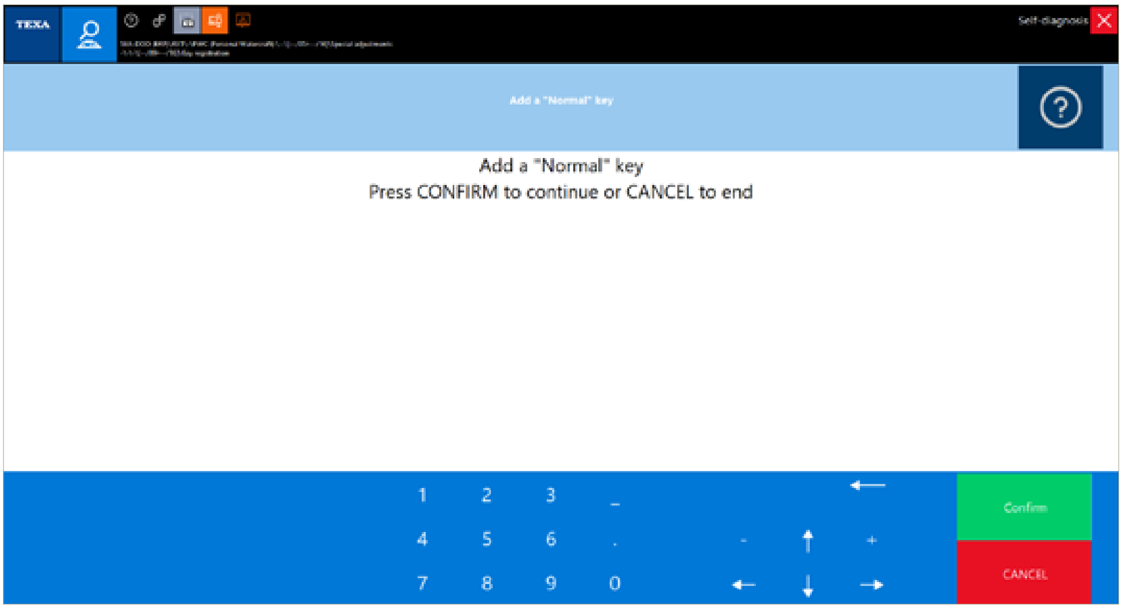

Figure 101: Key coding function for Sea-Doo PWC

It is essential to specify that every adjustment that brings the engine to operate in a different way with respect to the factory settings, it is performed as a sole responsibility of the repairer that performs it. Indeed, the possibility to operate adjustments passes through the agreement on the responsibility terms that is requested at every new updating.

5.5 Oil type setting procedure for Evinrude engines

This procedure allows you to set the type of oil to use. The types of oils that can be used are: XD100 or TC-W3/ XD30/XD50. We recommend using the XD100 oil for high performance engines and to always follow the indications given by the manu facturer of the engine.
This function is available in the "Special Functions" tab.

This function its available only on specific engine.

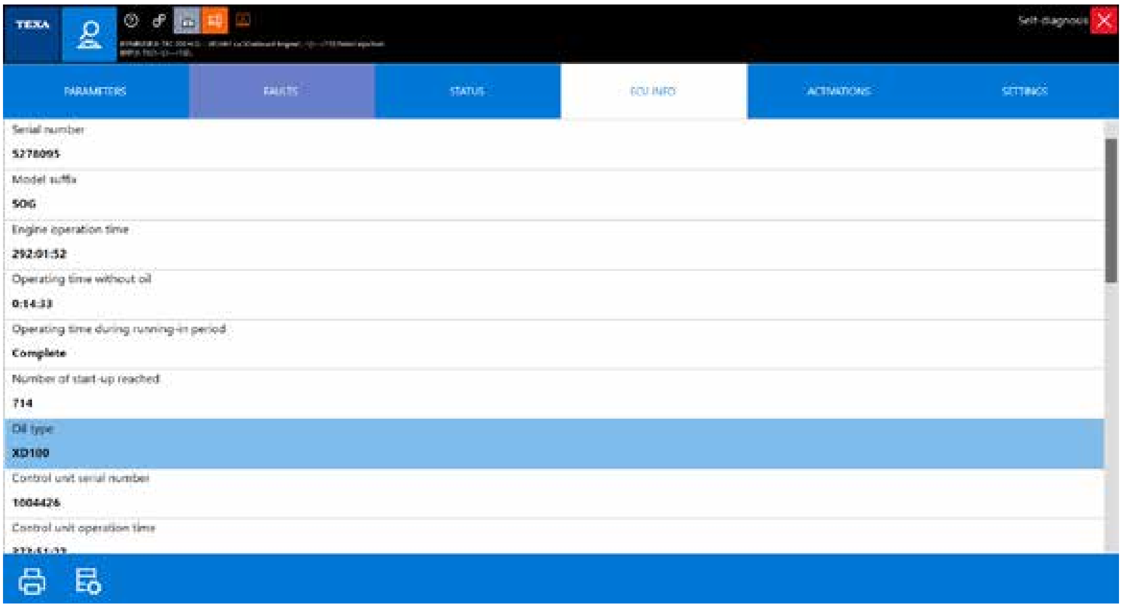

Figure 102

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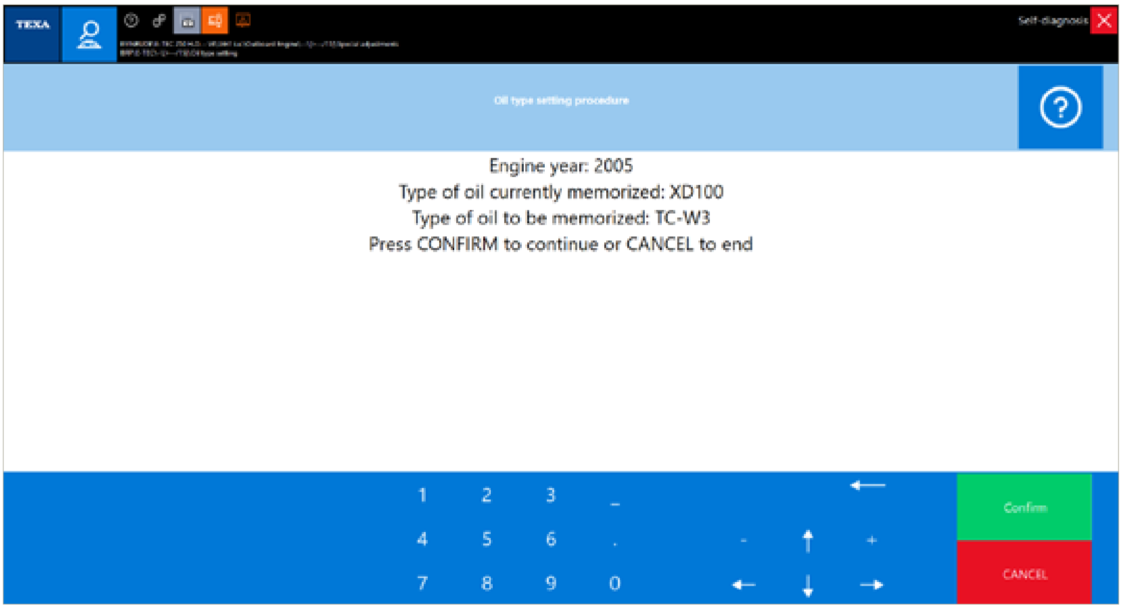

Figure 103: Oil Type setting procedure

5.6 Web Special codes (Cummins)

Cummins adjustments include specific functions that, to be used, require additional conditions. The PC must be connected to the Internet and the user must have undersigned the Web special code form to use these adjustments.

If the Web special code is not active, the IDC5 software will display the following message:

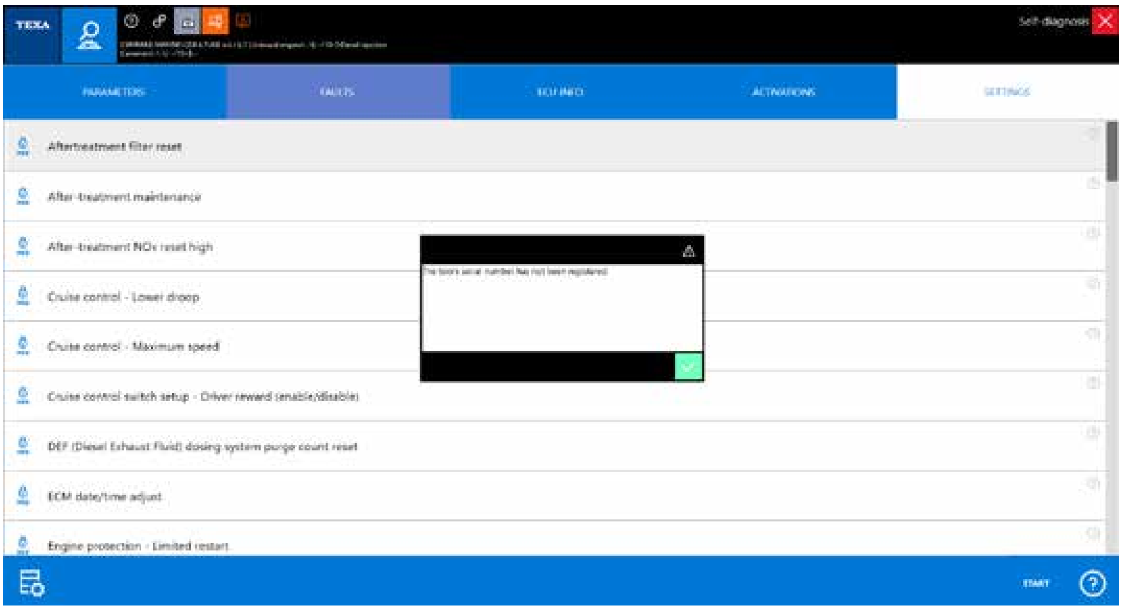

Figure 104

To enable these special functions that will be monitored via Internet, you must contact your retailer who will enable your tool for their use.

Once the Web special code functions are enabled, the software will display the following message at the beginning of the first adjustment performed during a single diagnostic session.

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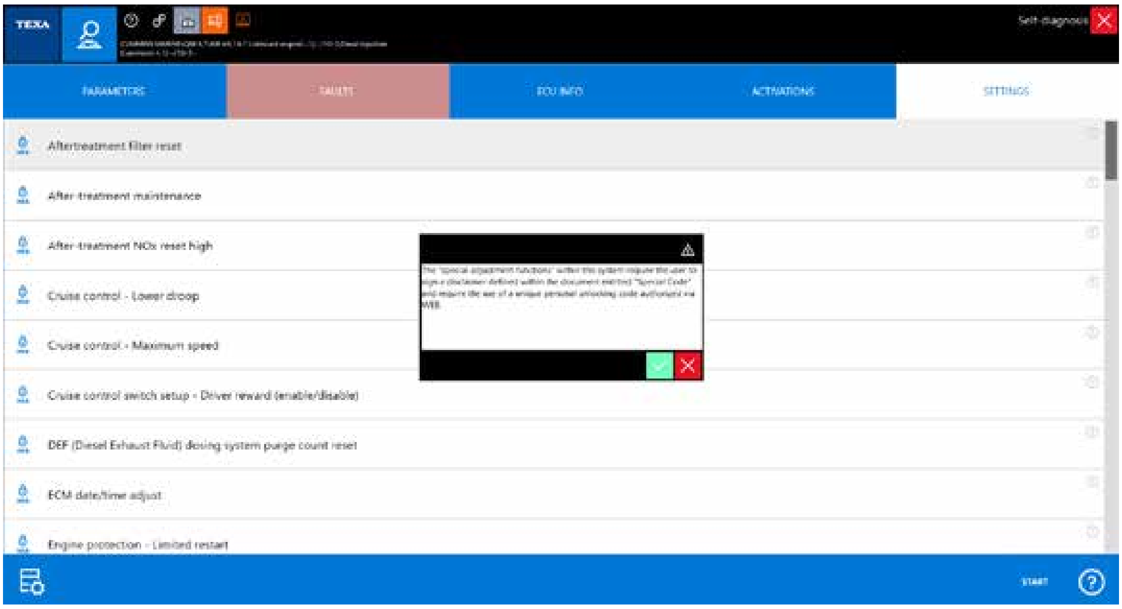

Figure 105

The SETTINGS functions have differences that depend on the manufacturers, the model and the electronic system.

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6. VOLVO MARINE DATA TRANSMISSION LINES

6.1 Introduction

The CAN, acronym for Controller Area Network, is a wiring specifically created to connect the control units with one another. The CAN allows exchanging large quantities of data at high speed, efficiently and securely. In order to increase immunity to interference, the cables are twisted around each other and the data is sent according to a differential transmission.

6.2 Main data transmission lines

6.2.1 Data transmission line: EVC CAN bus

The EVC is a proprietary, differential data transmission bus, which consists of 2 wires twisted around each other that connect all the ECUs of the EVC system through the wire labelled X2. The data transmission speed is 125 kbit/s and, in the event of an error, the bus can work with a single wire. The bus is powered when the ignition is turned on. The EVC bus CAN H and CAN L signals mirror each other. The EVC CAN H signal has a typical operating range of 0.1-4.1 V whereas the EVC CAN L signals have a typical operating range of 1-5 V.

6.2.2 Data transmission line: AUX bus

The AUX bus is a proprietary differential bus consisting of 2 wires twisted around each other. The transmission speed is 250 kbit/s.
The bus can have two different power sources:

1. External power supply
2. Power supply from the PCU

In case of power supply from the PCU, the bus will be powered only with the ignition ON.
The AUX bus is used by the multisensor, the CPM, the ICM and the other units inside the engine compartment. Based on the connected unit, a Y-shaped joint must be installed between the unit and the AUX bus.

The aux bus must always be terminated appropriately. No aux bus connector must be left open.

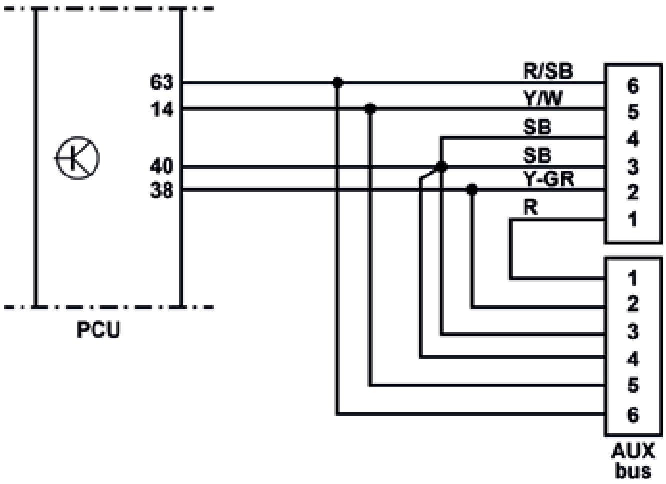

Figure 106

Legend:
1. Positive
2. CAN L
3. Negative
4. Negative
5. CAN H
6. Positive from PCU

The image above shows the AUX bus signal measured on a PCU. The AUX bus CAN H and CAN L signals mirror each other. The AUX CAN H signal has a typical operating range of 2.5-3.5 V whereas the AUX CAN L signals have a typical operating range of 1.5-2.5 V.

6.2.3 Data transmission line: Multilink bus

The multilink bus is a proprietary differential bus consisting of 2 wires twisted around each other. The transmission speed is 250 kbit/s and the bus is powered with the ignition ON.
The multilink bus is mainly used for the HMI (Human Machine Interface) as display and controls. It is also used to connect several gateways (NMEA 0183, NMEA 2000, Autopilot, DPS). The bus is powered when the ignition is turned on.
The image above shows the multilink bus signal measured on an HCU. The multilink CAN H and CAN L signals mirror each other. The CAN H signal has a typical operating range of 2.5-3.5 V whereas the CAN L signals have a typical operating range of 1.5-2.5 V.

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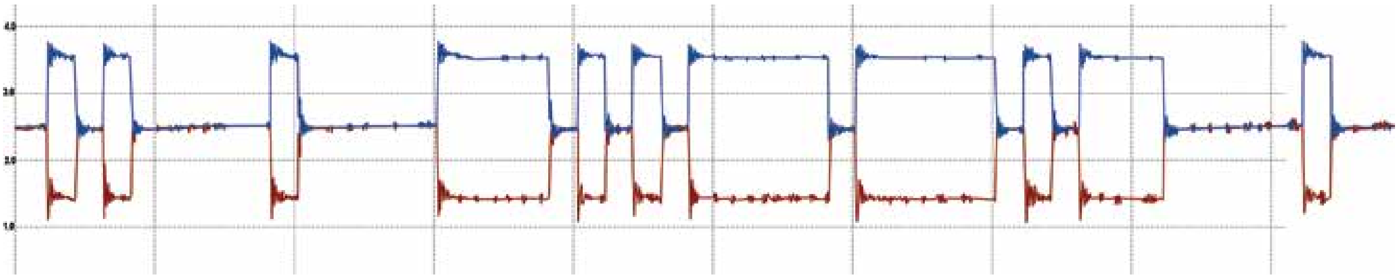

Figure 107

6.2.4 Multilink hub

The multilink hub is used to split the multilink signals to various multilink devices. This means that all pins in multilink hub 1 are connected with one another, all pins in multilink hub 2 are connected with one another, and so on.

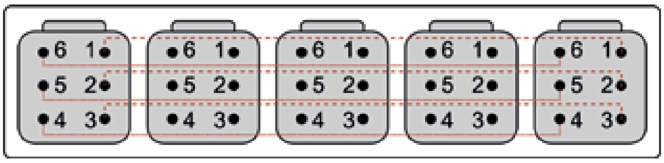

Figure 108: Multilink hub electrical detail

Figure 109: Multilink hub

6.2.5 Data transmission line: Steering control bus

The steering control bus is a proprietary differential bus consisting of 2 wires twisted around each other. The transmission speed is 125 kbit/s. The bus is powered with the ignition ON.
This bus is used to connect the HCU and the steering wheel/joystick.
The steering control bus L is on pin X8:2 and the steering control bus H is on pin X8:5. The steering wheel/joystick is powered through pins X8:1 and X8:3. A reserve power supply for the steering wheel/joystick is available on pins X8:4 and X8:6. The steering control bus is powered when the ignition is turned on.

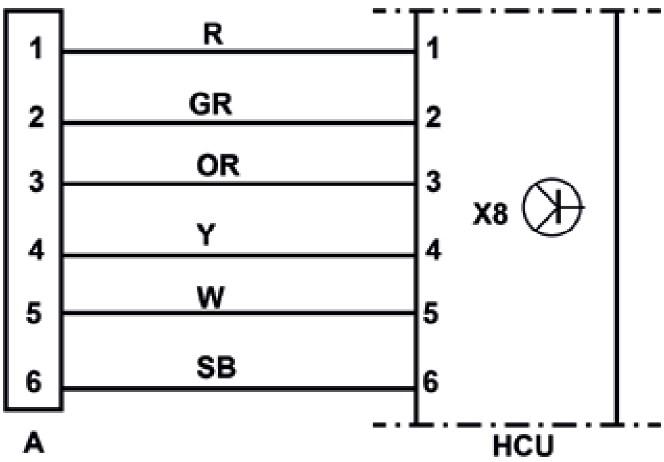

Figure 110

Legend:
1. Positive
2. CAN L for helm system
3. Negative
4. Positive, back-up
5. CAN H for helm system
6. Negative, back-up

A – joystick connector oh helm system

The image above shows the steering control bus system measured on a PCU. The steering control bus CAN H and CAN L signals mirror each other. The CAN H signal has a typical operating range of 4.1-0 V whereas the CAN L signals have a typical operating range of 1.3-5 V.

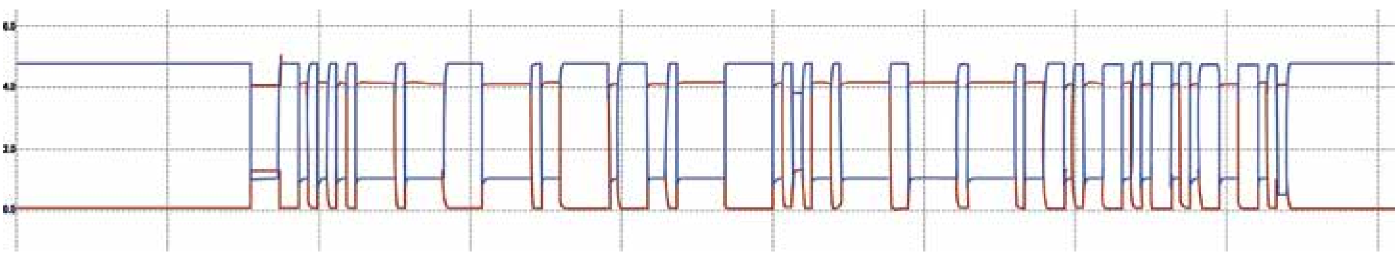

Figure 111: Steering control bus signals

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6.2.5 Data transmission line: LIN bus

The LIN bus is a single-wire bus that is used for transmissions that do not require high speed or particular interference-safe systems. The transmission speed is 19.2 kbit/s and the bus is active with the ignition ON.
This bus is used, for example, by the electronic key panel or the AKI (Analogue Key Interface)
Info note
The electronic key panel also uses the multilink bus for redundancy reasons and to download the software in the key panel.

Legend:
Left HCU, X4: 1-8
1. CAN L
2. CAN H
3. Negative from key
4. Positive from key
5. Positive CAN
6. Negative CAN
7. Not used
8. LIN comunication

Right HCU, X4: 1-4
1. Negative to pannel key
2. Positive to pannel key
3. Not used
4. LIN comunication

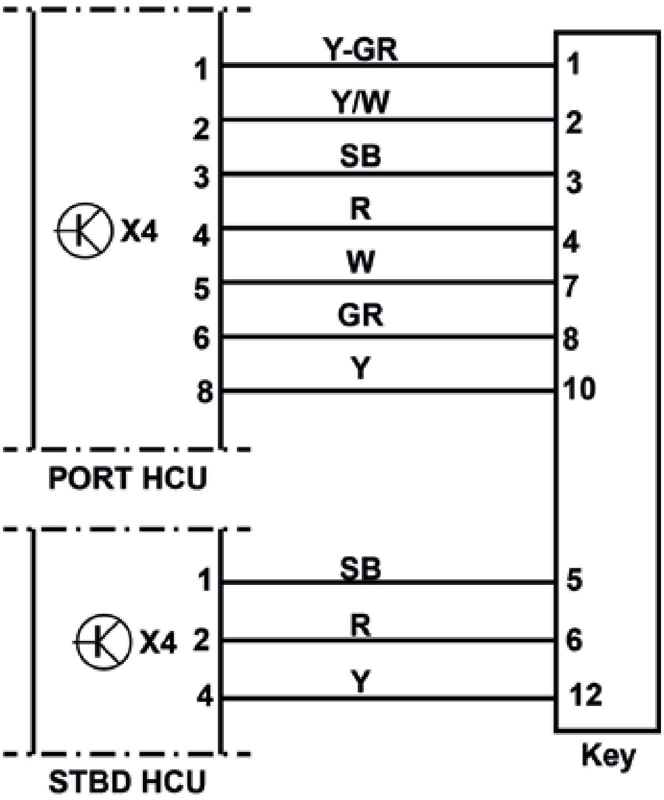

Figure 112

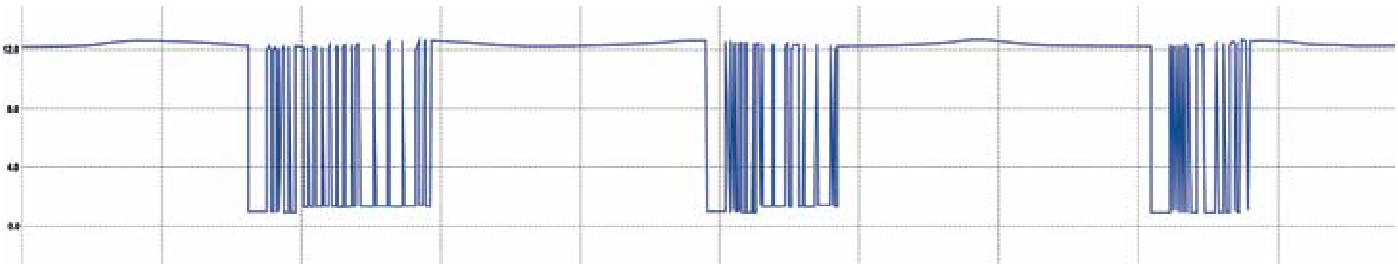

Figure 113: LIN signals

6.3 Electronic control units composing the EVC system

The EVC (Electronic Vessel Control) is a distributed system based on electronic control units, called nodes, installed throughout the vehicle. Each node is positioned near controlled actuators and sensors. All the control units that belong to the EVC network contain software and support the download through the diagnostic tool. Each node has an identification number in the network and communicates through the EVC bus.
The EVC network nodes are:

- PCU (Powertrain Control Unit), MID number 187.
- HCU (Helm Control Unit), MID number 164.
- SUS (Steering Unit Servo), MID number 250.
- SCU (Steering Control Unit), MID number 250.
- CPM (Corrosion Protection Module), MID number 200.
- ICM (Interceptor Control Module), MID number 194.

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All the nodes in the same powertrain network must have the same ID as the VIN. Each node is assigned the VIN during the programming sequence, except for the HCU, which is assigned the VIN through the PCU loading when the network is configured automatically.

6.3.1 PCU (Powertrain Control Unit)

The PCU is available for each powertrain, it acts as an interface with the engine control unit and manages the transmission towards an inboard/outboard or reverse gear installation. The PCU also acts as a gateway for the control units on its own network that do not support the J1708/J1587 protocol, in order to allow them to communicate with diagnosis. A PCU is composed of:

- an electronic hardware component (electronic board with built-in controller)
- a software component
  - o Bootloader (a non-reprogrammable factory software)
  - o MSW (reprogrammable software)

The MSW of the PCU is different according to the engine control unit it is connected to.
The interfaces used by the PCU are:

- EVC CAN bus
- AUX CAN bus
- Diagnostic tool bus
- Engine CAN bus

The PCU has the following inputs:

- Power Trim angle
- Fuel level
- Fresh water level
- Rudder indicator
- Transmission oil pressure
- Output shaft speed
- Transmission oil temperature
- Shift actuator position
- Ignition ON
- EVC system power supply input

All these inputs, except the output speed shaft, are analogue inputs. For the output shaft speed, the input is a frequency.

The PCU has the following outputs:

- Power Trim control
- Gearshift/slip control
- CWES motor control
- Trolling control

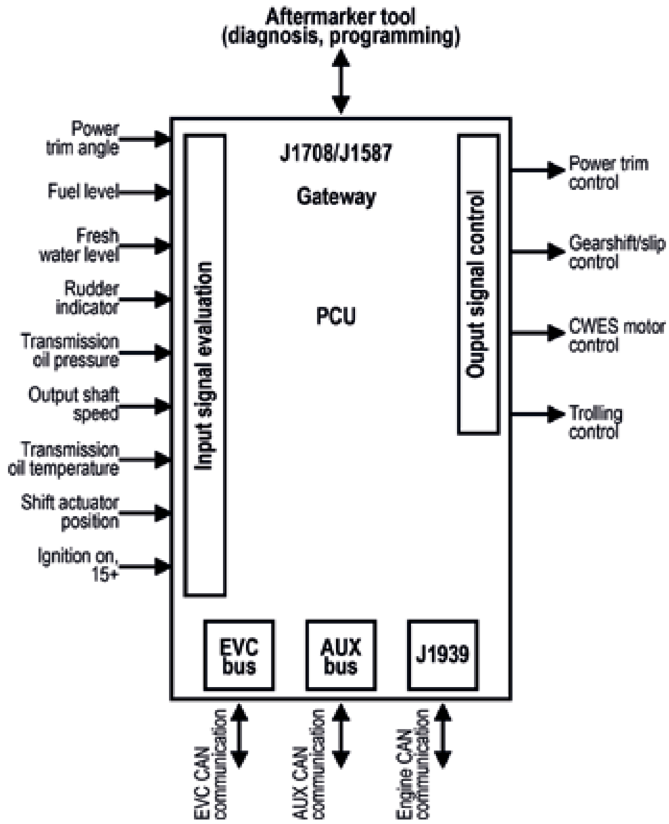

Figure 114: PCU data exchange diagram

Since its introduction in 2003, the PCU has the same interfaces, with a connector, X2, that manages the interface with the EVC system and a connector, X3, that manages the interface towards the engine and the transmission. The PCU hardware and design have been modified over the EVC generations. The image shows the changes in the PCU design between EVC-A and EVC-D. As the PCU software varies over different PCU generations, it is not possible to programme any PCU with any PCU software.

Figure 115: EVC-A PCU

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Figure 116: EVC-E PCU

6.3.2 HCU (Helm Control Unit)

The HCU is responsible for the user interface, managing all information from and to the driver. There is an HCU for each powertrain of each helm station. Through the multilink bus, the HCU is responsible for the autopilot and the DPS interface. The HCU can be integrated with a lever control or used as independent unit. An HCU combines the following:

- an electronic hardware component
  - o Electronic board with built-in controller
- a software component
  - o Bootloader (a non-reprogrammable factory software)
  - o MSW (reprogrammable software)

The HCU interfaces are:

- EVC CAN bus
- Steering control CAN bus
- LIN bus
- Multilink CAN bus

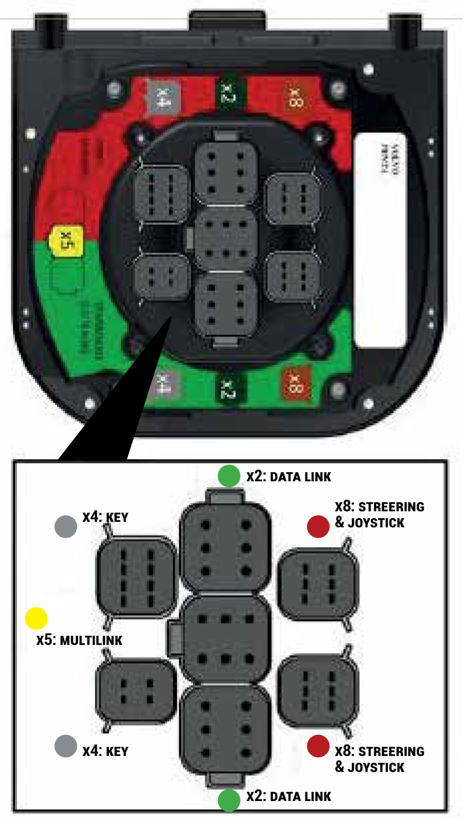

Figure 117: HCU connectors

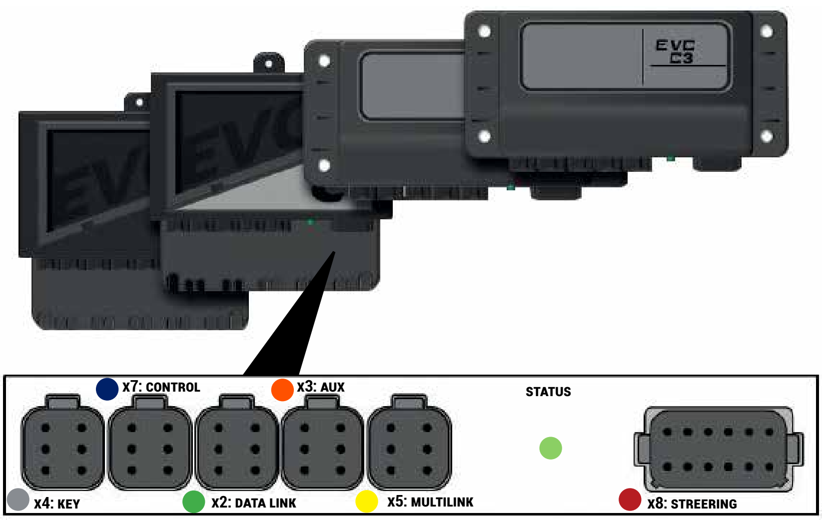

Figure 118: HCU evolution

There are changes in the HCU design between EVC-B2 and EVC-C3. As the HCU software varies over different HCU generations, it is not possible to programme any HCU with any HCU software.

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Figure 119: HCU, EVC-C3

6.3.3 SUS (Steering Unit Servo)

The SUS unit controls the IPS transmission steering angle. Besides the electronics and software, the SUS has a mechanical hardware component: a three-phase permanent magnet brushless motor.

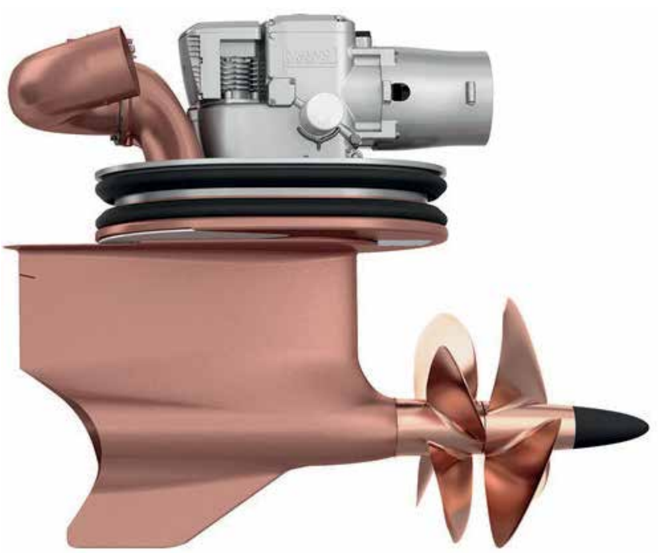

Figure 120: SUS unit

A SUS unit is composed of:

- an electronic hardware component (electronic board with built-in controller)
- a mechanical hardware component
    - o Three-phase permanent magnet brushless motor
    - o An electro-mechanical brake
- a software component.
    - o Bootloader (a non-reprogrammable factory software).
    - o MSW (reprogrammable software)

As interface, the SUS only uses the EVC CAN bus.
The SUS has two inputs:

- Permanent magnet motor power supply input
- Transmission position sensor input (resolver)

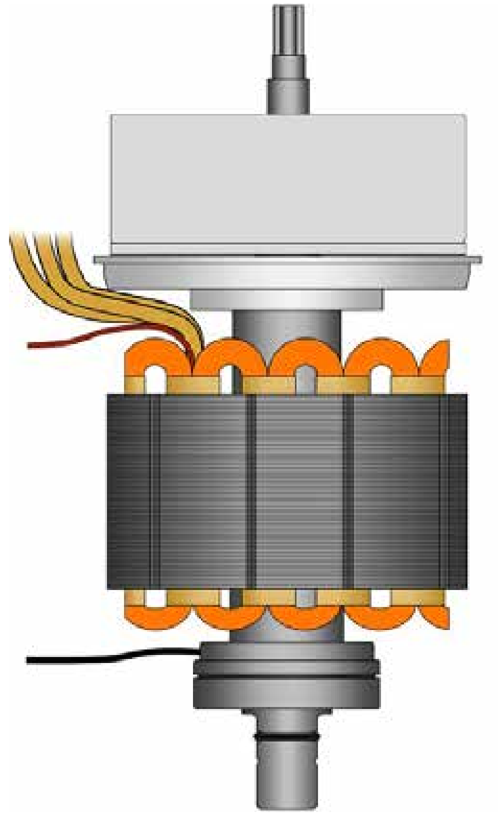

Figure 121: SUS details. 1 - Electro-mechanical brake, 2 - Stator windings, 3 - Stator winding temperature sensor, 4 - Speed and incremental sensor built into the bearing (for SUS 2 only)

The SUS unit is protected against overtemperature. In the two permanent magnet motor windings and near the control unit there are temperature sensors. The control unit will compare the two temperature values. In the event of a significant difference between the two values, a sensor fault DTC will be set. The control unit monitors any overheating of the permanent magnet motor by constantly checking the winding's temperature. The control unit also checks if the surrounding temperature is too low for the permanent magnet motor to perform a safe start. A DTC is set whenever an abnormal temperature is detected.

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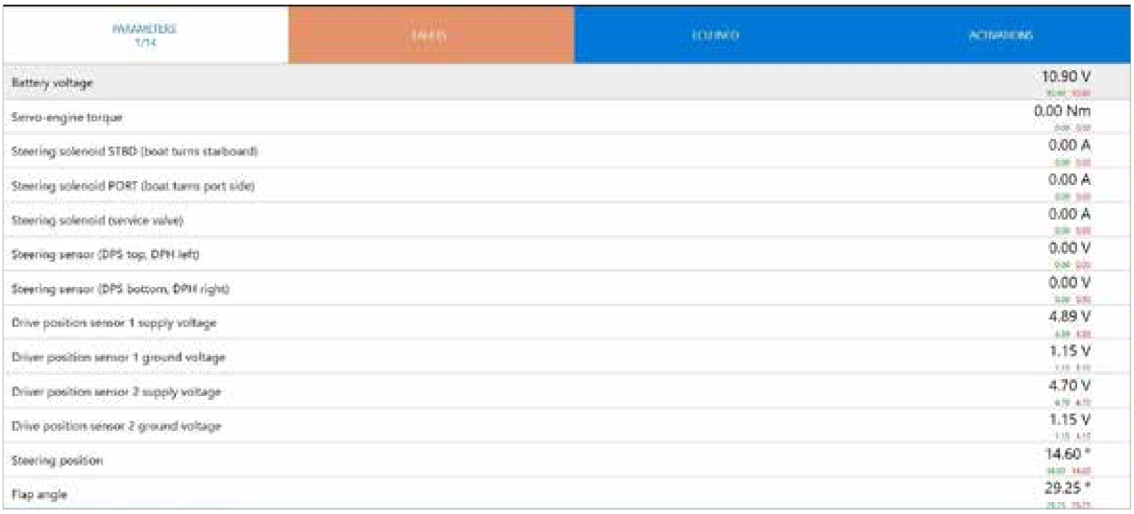
SUS1
The permanent magnet motor in the SUS1 can deliver a max torque of 3.5 Nm. The result is approximately 3750 Nm on the stern drive.
The SUS1 supply voltage must range between 10 and 36 V. The direct current is approximately 50 A. The peak current value is 120 A for 0.2 seconds.

SUS2
The permanent magnet motor in the SUS2 can deliver a max torque of 7 Nm. The result is approximately 7500 Nm on the stern drive.

An electro-mechanical brake is connected to the permanent magnet motor output shaft and, in case of emergency or fault, it brakes the permanent magnet motor output shaft and therefore locks the transmission in the current position.
The SUS unit manages a communication interface of the EVC bus and a signal interface of the resolver.
The SUS communicates with the EVC system through the EVC CAN bus. A steering angle request by the driver will be translated from the HCU to the SUS. The stern drive rudder angle is measured by a resolver. The resolver is mounted on the upper gear.



Battery voltage	10.90 V
Servo-engine torque	0.00 Nm
Steering solenoid STBD (boat turns starboard)	0.00 A
Steering solenoid PORT (boat turns port side)	0.00 A
Steering solenoid (service valve)	0.00 A
Steering sensor (DPS top, DPH left)	0.00 V
Steering sensor (DPS bottom, DPH right)	0.00 V
Drive position sensor 1 supply voltage	4.89 V
Driver position sensor 1 ground voltage	1.15 V
Driver position sensor 2 supply voltage	4.70 V
Drive position sensor 2 ground voltage	1.15 V
Steering position	14.60 °
Flap angle	29.25 °

Figure 122: SUS control unit electronic diagnosis.

Legend:
The image shows the signal flow in the IPS steering system.

Brown = Steering control CAN bus
Yellow = Multilink CAN bus
Green = EVC CAN bus

1. A steering angle change request is sent by the steering wheel or joystick on the steering control bus.
2. The HCU sends the request to the SUS through the EVC bus.
3. The permanent magnet motor rotates the transmission.
4. The transmission angle is monitored by the resolver.
5. The resolver value is transformed by the SUS unit into an angle value and sent to the HCU through the EVC bus.
6. The HCU sends the angle value to the display through the multilink bus.

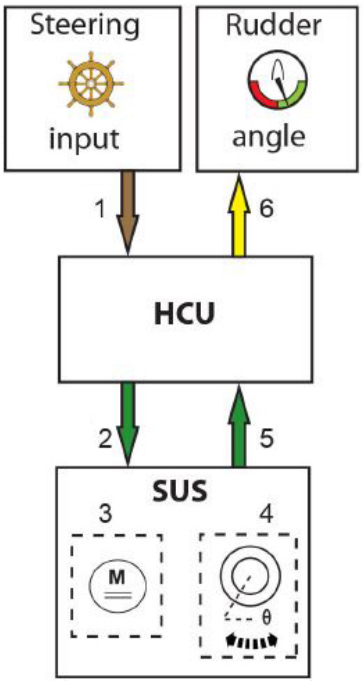


Figure 123

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6.3.4 SCU (Steering Control Unit)

Each powertrain with a steer-by-wire installation has an SCU available. The SCU manages the transmission steering through a hydraulic system, intervening with electro-hydraulic valves. A steering angle feedback is reported through a sensor. As the HCU, the SCU manages all information from and to the driver.

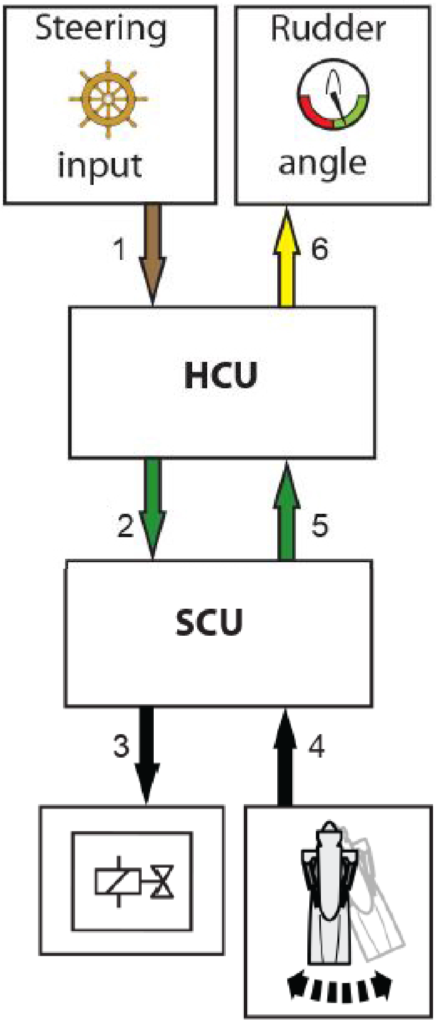

Figure 124: Electronic steering signal flow

Legend:
The image illustrates the signal flow in the electronic steering system.
Brown = Steering control CAN bus
Yellow = Multilink CAN bus
Green = EVC CAN bus
Black = Analogue signal wiring

1. A steering angle change request is sent by the steering wheel or joystick on the steering control bus.
2. The HCU sends the request to the SUS through the EVC bus.
3. One of the steering solenoids on the valve plate is activated and the hydraulic oil pressure is applied to one of the transmission steering cylinders and the transmission rotates.
4. The transmission steering angle is monitored by the sensors installed on the steering cylinders.
5. The voltage value of the transmission position sensors is transformed by the SUS unit in a steering angle value and sent to the HCU through the EVC bus.
6. The HCU sends the angle value to the display through the multilink bus.

As interface, the SCU uses the EVC CAN.
The SCU has the following inputs:

- Hydraulic oil temperature signal
- Feedback signal from the port and starboard position sensors
- 12V dedicated power supply with fuse

The SCU has the following outputs:

- Steering solenoid control
- Service solenoid control

6.3.5 CPM (Corrosion Protection Module)

The CPM (Corrosion Protection Module) is part of the ACP (Active Corrosion Protection). Two types of CPM modules are available, single-channel or dual-channel. The dual-channel variant is used when 2 ACPs are required. In order for the system to work properly, the CPM must always be connected to the port outside engine through protocol J1708/J1587.

The purpose of the ACP (Active Corrosion Protection) is to manage the potential between the stern drives and the water, in order to prevent corrosion from forming on the stern drives. The system consists of two main components, a transom and a control unit. The ATU (component of the ACP system) is installed on the transom.

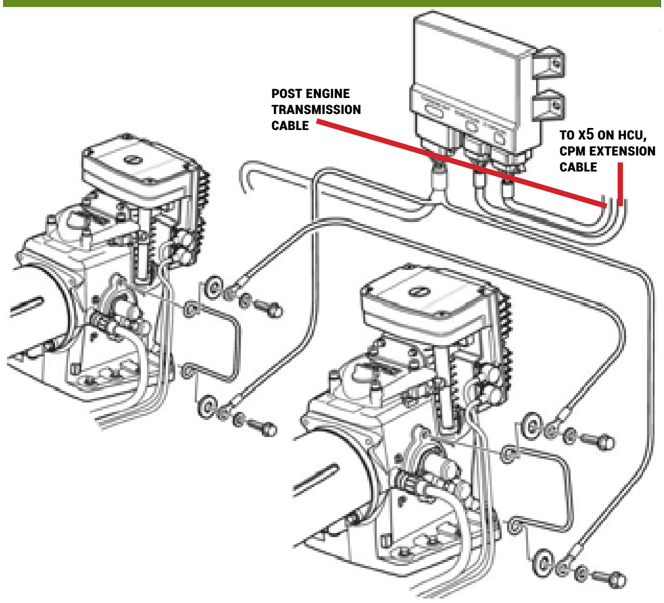

Figure 125: CPM control unit connection

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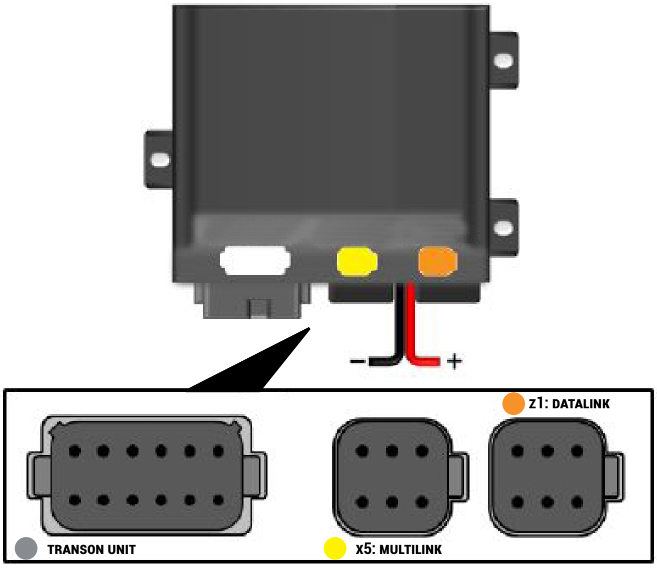

Figure 126: Connectors on the CPM control unit

The CPM has two interfaces:
- Multilink CAN bus / AUX CAN bus
- Diagnostic tool bus (J1708/J1587)

The CPM has the following inputs:
- 3 reference electrodes
- 2 inputs for potential equalisation wire
- Dedicated power supply

The CPM has the following outputs:
- Active anode signal
- Passive anode signal with fuse

Information to the driver and interaction with the EVC system are carried out through the multilink bus or, as for the EVC-E, through the auxiliary bus (light blue). For interaction with the diagnostic tool, the AUX bus is used.
For powering the ACP system, a specific power adapter is required. For a correct protection, all the stern drives must be potential equalized with each other (violet wiring) properly.

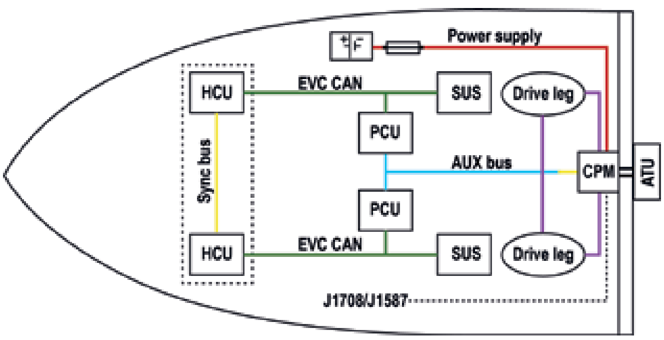

Figure 127: Main data transmission lines for Volvo Penta EVS

6.3.6 ICM (Interceptor Control Module)

The ICM is the Interceptor Control Module. It manages the blade position through a servo unit and acts as an interface towards the EVC system. The ICM is an irreparable component. The ICM cannot be reprogrammed.
As interfaces, the ICM uses:
- AUX CAN bus
- Servo unit CAN bus

As inputs, the ICM uses:
- 12/24V dedicated power supply with fuse

The ICM requires continuous power supply to be able to clean the interceptor blades.

Figure 128: ICM control unit

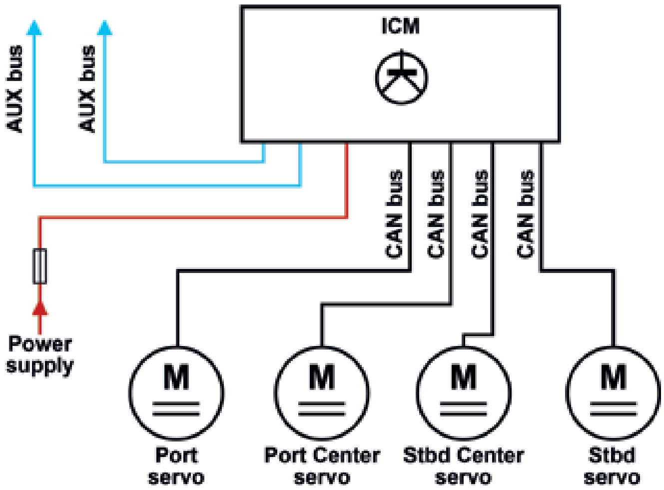

Figure 129: ICM control unit and data connection

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6.4 EVC system components

6.4.1 Control lever

The EVC system's HCU is integrated in the control lever. The control lever uses two sensors to determine the lever's angular movement and neutral position:

1. A contact sensor is used for angular movement
2. An optical sensor is used for the neutral

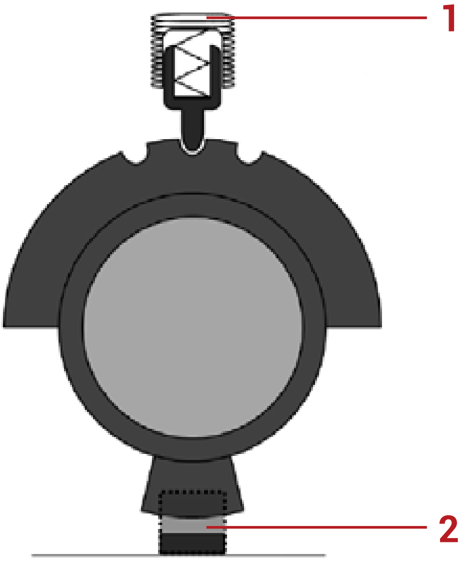

Figure 130: Control lever sensor position diagram

6.4.2 Steering wheel

The steering wheels is used in IPS installations and in the electronic steering system for DPH and DPS transmissions.
The purpose of the steering wheel is:

- Communicate the steering angle request by the driver
- Report the steering end stop feedback

The steering wheel consists of three parts:

- A rotation angle detection device
- A braking unit
- An electronic board with built-in controller

6.4.3 Shift actuator

There are two types of shift actuator.
One is used by D4/D6 engines on DPH/DPR transmissions, the other is used by D3 petrol engines on DPS/XS transmissions.
The basic operation of the two types of shift actuator is the same.

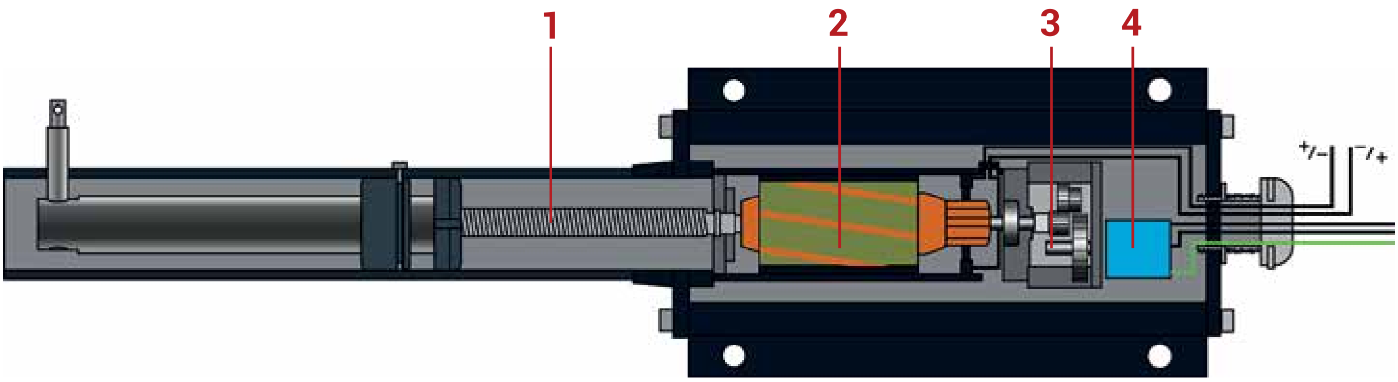

Figure 131: Shift actuator; 1) Ball screw 2) Electric motor 3) Gearshift 4) F ntiometer

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6.4.4 Power Trim system

The Power Trim system allows changing the transmission position and display its angle on analogue indicators or displays, from the primary or secondary control cabin.

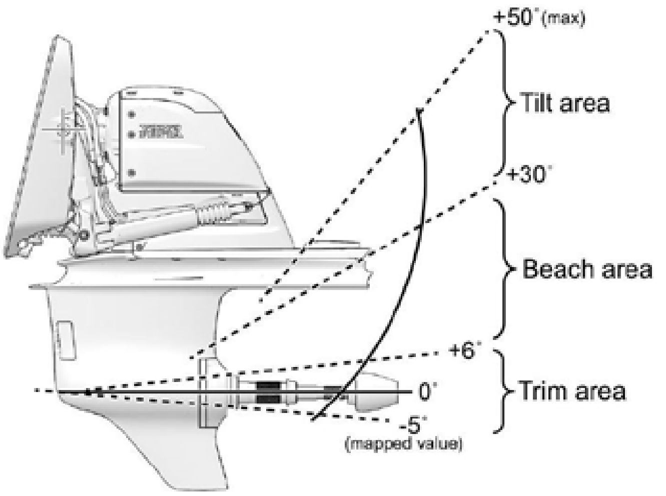

Figure 132: Power Trim: transmission positions

6.4.5 Electronic steering system

The electronic steering system (ES) is an electric-to-hydraulic steering system. The system is integrated in the EVC.

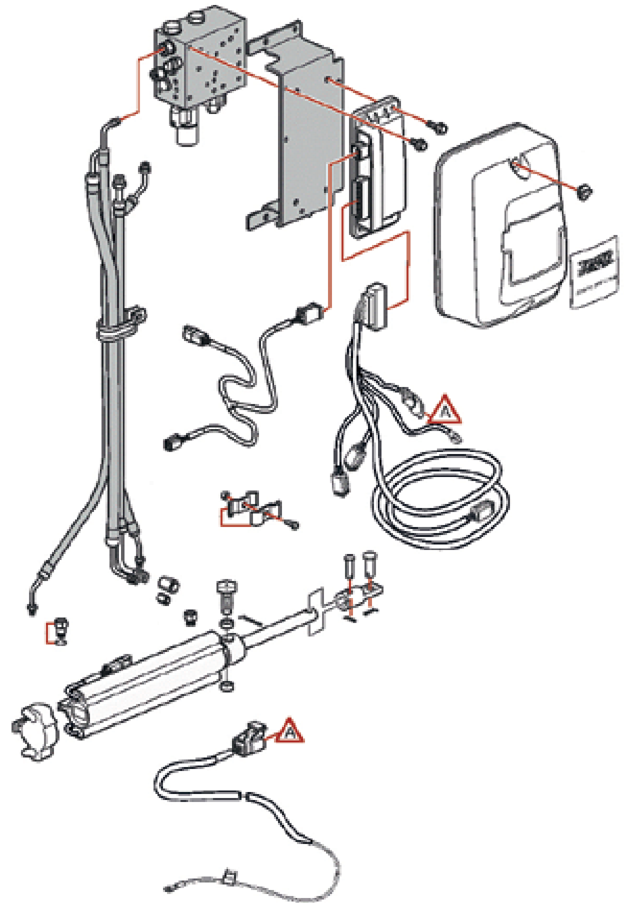

Figure 133: Electronic steering system. The SCU control unit is number 5

6.4.6 Electronic key system

The electronic key system consists of two main components: the key panel and the remote control.
The key panel houses a RFID reader that includes an antenna, a transceiver, a power source and a modulation unit.
The remote control combines a RFID tag and includes an antenna, a transceiver and a modulation unit. Power supply is not required as the RFID tag is powered when close to the key panel.

Figure 134: RFID key: 1) Antenna 2) Transceiver and modulation unit

6.4.7 Interceptor system

The interceptor system is used to adapt and optimise the vessel's trim and roll angles. The system has two operating modes: automatic and manual. In automatic mode, the trim and roll angle are managed by the ICM and the driver can make changes. In manual mode, the trim and roll angle are only managed by the driver.

Figure 135: Interceptor blades mounted on the transom

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6.4.8 ACP system

The purpose of the ACP is to prevent corrosion from forming on the stern drives by managing the potential between the stern drives and the water.

Figure 136: ACP position

Figure 137: ACP system

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7. MERCRUISER DATA TRANSMISSION SYSTEMS

7.1 CAN network

The CAN control network is composed of a 14-pin wiring connected to the engine and to the control module wiring, which in turn is connected to the steering. These wirings include the CAN lines, i.e. the essential communication lines for the Digital Throttle and Shift (DTS) system. The CAN lines are called CAN 1 (CAN P), CAN 2 (CAN X), CAN 3 (CAN V) and CAN H.

The CAN 1 (**CAN P**) lines consist of blue and white wires that connect the engine and the control module to the instrumentation. The engine data such as temperature, pressure, depth, speed, tank levels and engine speed are transmitted to the steering equipment via the CAN 1 (CAN P) bus. Each installation has a single CAN 1 (CAN P) bus, regardless of the number of engines or steering units.

The CAN 2 (**CAN X**) lines consist of yellow and brown wires and are isolated between the engine and the control module; they are used to transmit the throttle and shift data. Each installation has a single CAN 2 (CAN X) bus, regardless of the number of engines or steering units. If the CAN 2 (CAN X) connection is cut off, the throttle and shift data is sent via the CAN 1 (CAN P) lines. This bus is used as backup system to avoid a complete loss of control on the throttle and engine. The engine goes into Guardian mode and the engine power is automatically reduced.

The CAN 3 (**CAN V**) lines consist of orange and green wires; on 2005 and 2006 engine models, they run inside the 14-pin data wiring, whereas on 2007 models the CAN V (CAN 3) lines are arranged in a separate, sheathed two-pin wiring.

The **CAN H** lines consist of orange/green and green/orange wires and their purpose is to transport the data transmitted from the joystick to the steering.

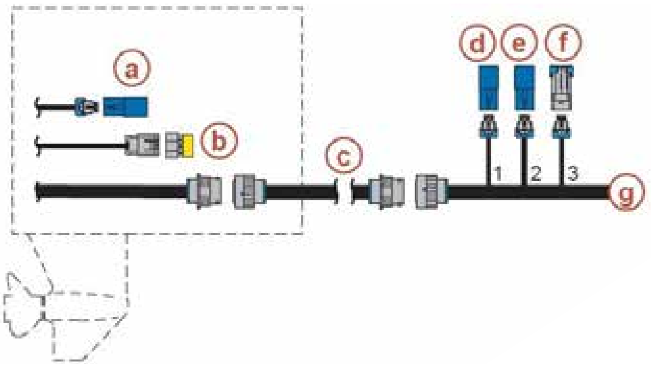

Figure 138: Example of data connection for MerCruiser

Legend:
a. Termination resistor on CAN 2 (CAN X)
b. Termination resistor on CAN 1 (CAN P)
c. 14-pin data wire (from the engine)
d. CAN 1 (CAN P) (blue and white) – terminator
e. CAN 2 (CAN X) (brown and yellow) – terminator
f. CAN 3 (CAN V) (orange and green) – waterproof cap
g. Steering control module 1 wiring

7.2 Termination resistor

The DTS system termination resistor acts as a CAN line signal adapter. The resistor is a known load (120 ohm each) on the CAN line to guarantee adequate communication between the control module and the powertrain control module (PCM). In a single-engine application, there are two CAN 1 (CAN P) terminators: a 10-pin yellow terminator for the engine and a 2-pin blue terminator for the steering. There are also two CAN 2 (CAN X) terminators: a 2-pin blue terminator for the engine and a 2-pin blue for the steering.

In every DTS application there is only one CAN 1 (CAN P) network, regardless of the number of engines or steering units. The CAN 1 (CAN P) network has two terminators, one on each end of the CAN 1 (CAN P) network. For example, in a twin-engine application, on the CAN 1 (CAN P) line there is one terminator for the port engine, the port and starboard CAN 1 (CAN P) lines are connected through a 2-pin CAN wiring, and the CAN 1 (CAN P) line has another terminator for the starboard engine.

Figure 139: Termination resistor, internal side (CAN P, CAN X network)

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Figure 140: Termination resistor, closing cap (CAN P, CAN X network)

In every DTS application there is a CAN 2 (CAN X) network for each engine, regardless of the number or steering units. Each CAN 2 (CAN X) line has two terminators for each engine, one for the engine and one for the steering unit that is the farthest from that engine. For example, in a twin-engine application, on the CAN 2 (CAN X) line there is one terminator for the port engine, one for the 2-pin CAN 2 (CAN X) port engine connector on the control module wiring, one for the starboard engine and another one for the 2-pin CAN 2 (CAN X) starboard engine connector on the control module wiring.
For all the multiple-steering unit applications, the CAN 1 (CAN P), if applicable, and CAN 2 (CAN X) lines have terminators in correspondence of the steering unit that is the farthest from the engines. The termination resistors on the control module wirings used for the closest steering units are replaced by waterproof caps.

Figure 141: CAN P and CAN H line termination resistor

Figure 142: CAN V termination resistor

7.3 CAN line terminals

10-PIN CAN LINE TERMINAL
There are 3 different 10-pin terminals, which can be identified by the colour of their cap:

- Yellow for the CAN P line (pins J, K) and CAN X line (pins G, H);
- Red for the CAN P line (pins J, K) and CAN H line (pins E, G);
- Blue for the CAN P line (pins J, K) and CAN V line (pins C, D);

Each pin has two 120 ohm resistances ±5%

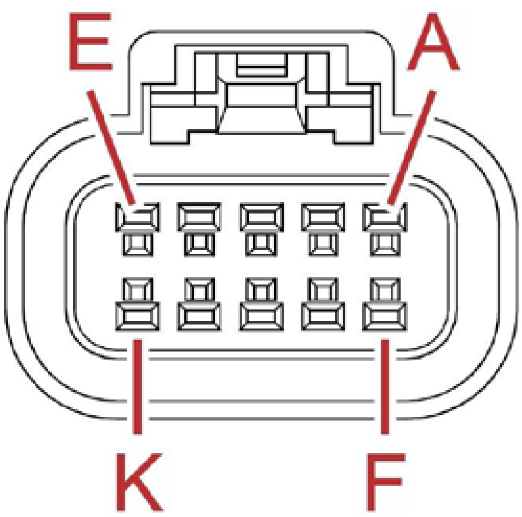

Figure 143

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2-PIN TERMINAL
It provides access to a CAN P, CAN X or CAN H line. Each terminal has a 120 ohm resistance ±5%

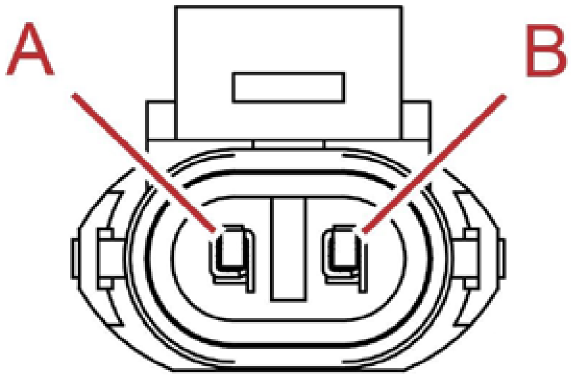

Figure 144

7.3.1 Engine side CAN P termination resistance check

Remove the 10-pin termination resistor from the engine and connect the probes to the connector on the engine wiring as shown in the diagram.

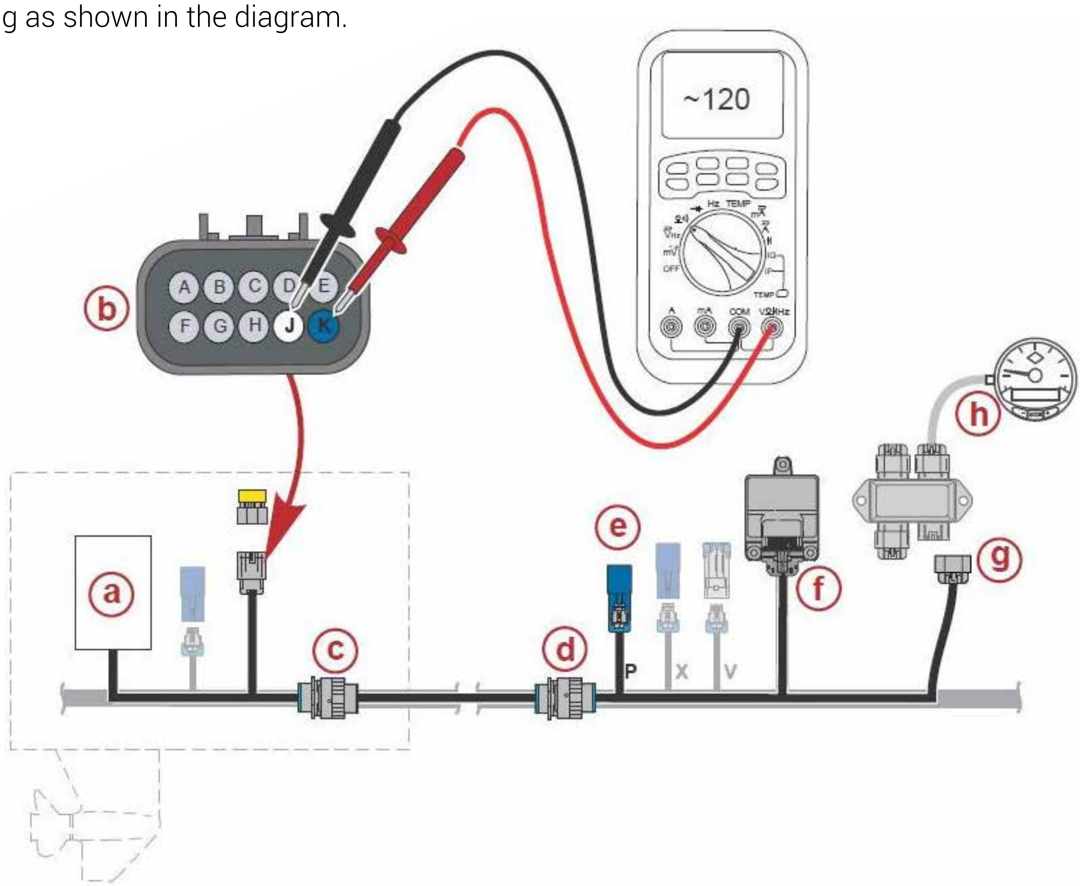

Figure 145: Example of measurement that must be carried out to check the integrity of the engine side CAN P network (120 Ω ± 5%)

Legend:
a. PCM Powertrain Control Unit
b. 10-pin CAN P termination resistance connection
c. 14-pin engine connection
d. 14-pin steering unit connection
e. 2-pin CAN P termination resistance
f. Control module
g. 10-pin junction box connection
h. Display connection

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Legend:
a. PCM Powertrain Control Unit
b. 10-pin CAN P termination resistance connection
c. 14-pin engine connection
d. 14-pin steering unit connection
e. 2-pin CAN P termination resistance
f). Control module
g). 10-pin junction box connection
h). Display connection

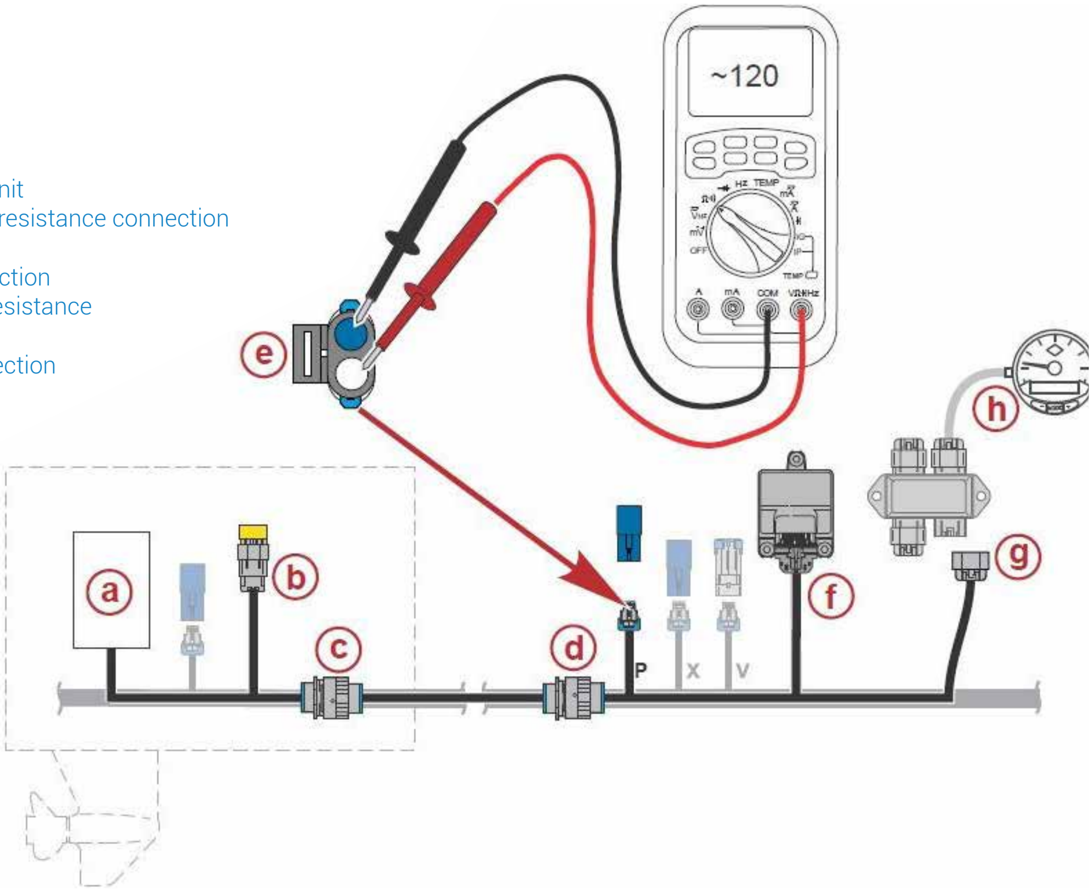

Figure 146: Example of measurement that must be carried out to check the integrity of the steering side CAN P network (120 Ω ± 5%)

7.3.4 Steering side CAN X termination resistance check

Legend:
a. PCM Powertrain Control Module
b. 2-pin engine side CAN X termination connection
c. 14-pin engine connection
d. 14-pin steering unit connection
e. 2-pin steering side CAN X termination connecti
f). Control module

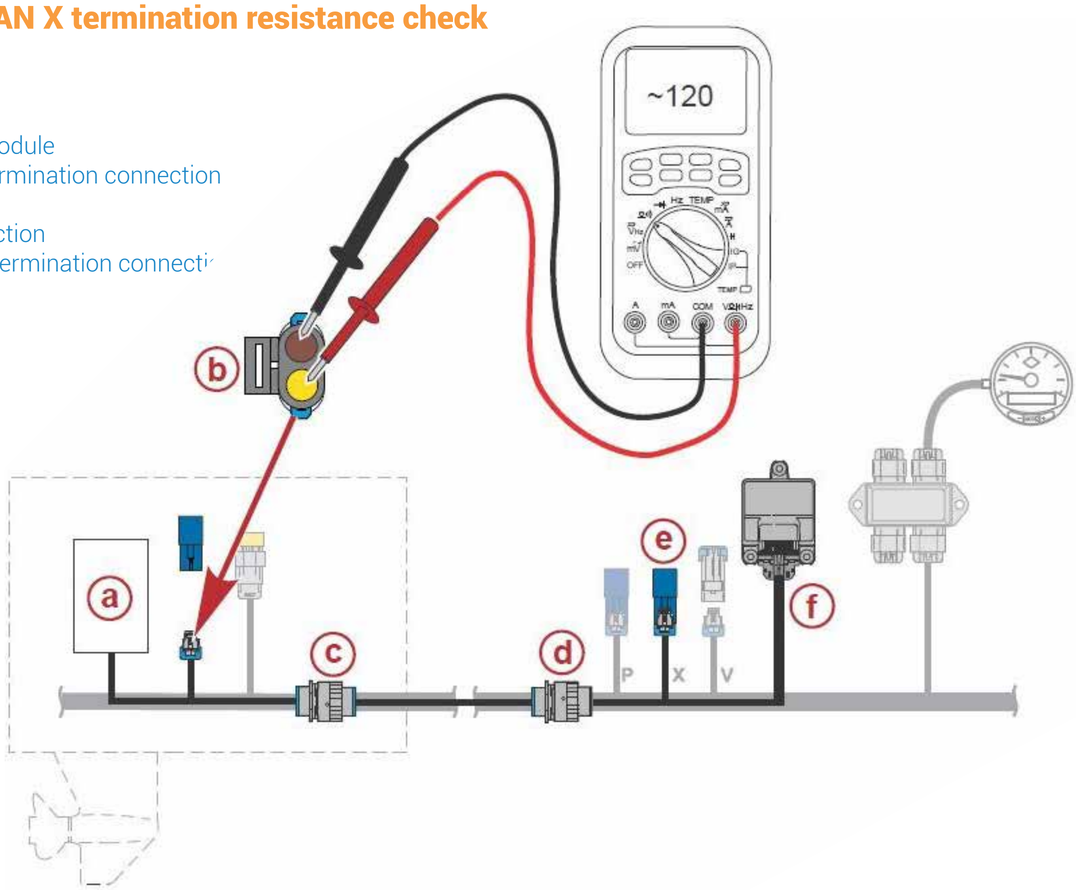

Figure 147: Example of measurement that must be carried out to check the integrity of the engine side CAN X network (120 Ω ± 5%)

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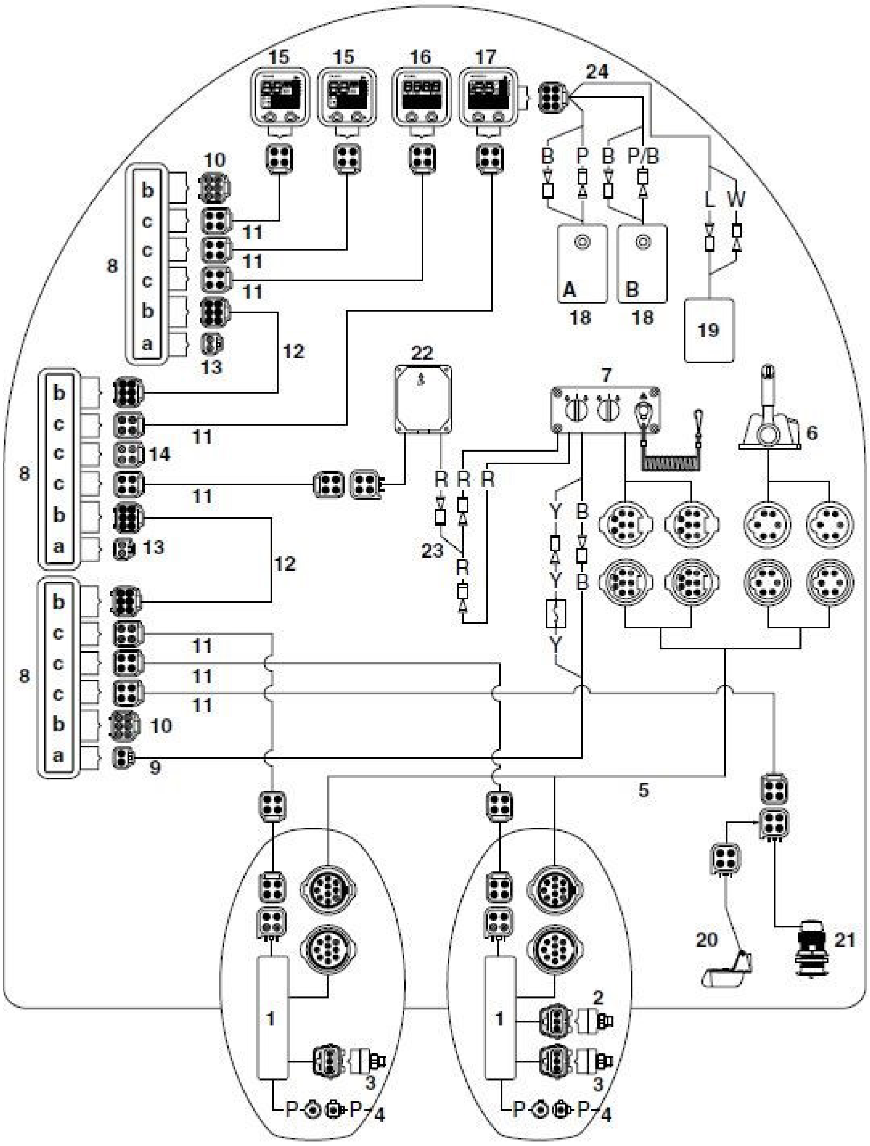
8. YAMAHA CONNECTION AND DATA TRANSMISSION DIAGRAM



Ref.	Part name
1	ECM Engine Control Module
2	Speed sensor kit
3	Water pressure sensor kit
4	Trim sensor
5	Main wiring
6	Remote control box
7	Main switch
8	**Multiple hub**
9	Power supply cable
10	Resistance cap
11	**Twisted wire**
12	**Main bus line wiring**
13	Waterproof cap
14	Waterproof cap
15	Tachometer
16	Fuel management gauge
17	Speed gauge
18	Fuel tank (fuel level sensor)
19	GPS
20	Transom multi-sensor
21	Thru-hull multi-sensor 1 Thru-hull multi-sensor 2
22	Immobiliser
23	Immobiliser power distribution cable
24	Fuel tanks
a	Supply port
b	**Data bus transmission port**
c	Device port

Figure 148: Yamaha twin-engine application. Multiple hub connectors b CAN transmission

Figure 149: CAN network termination connection (without closing cap).

Figure 150: CAN network termination connection (with closing cap).

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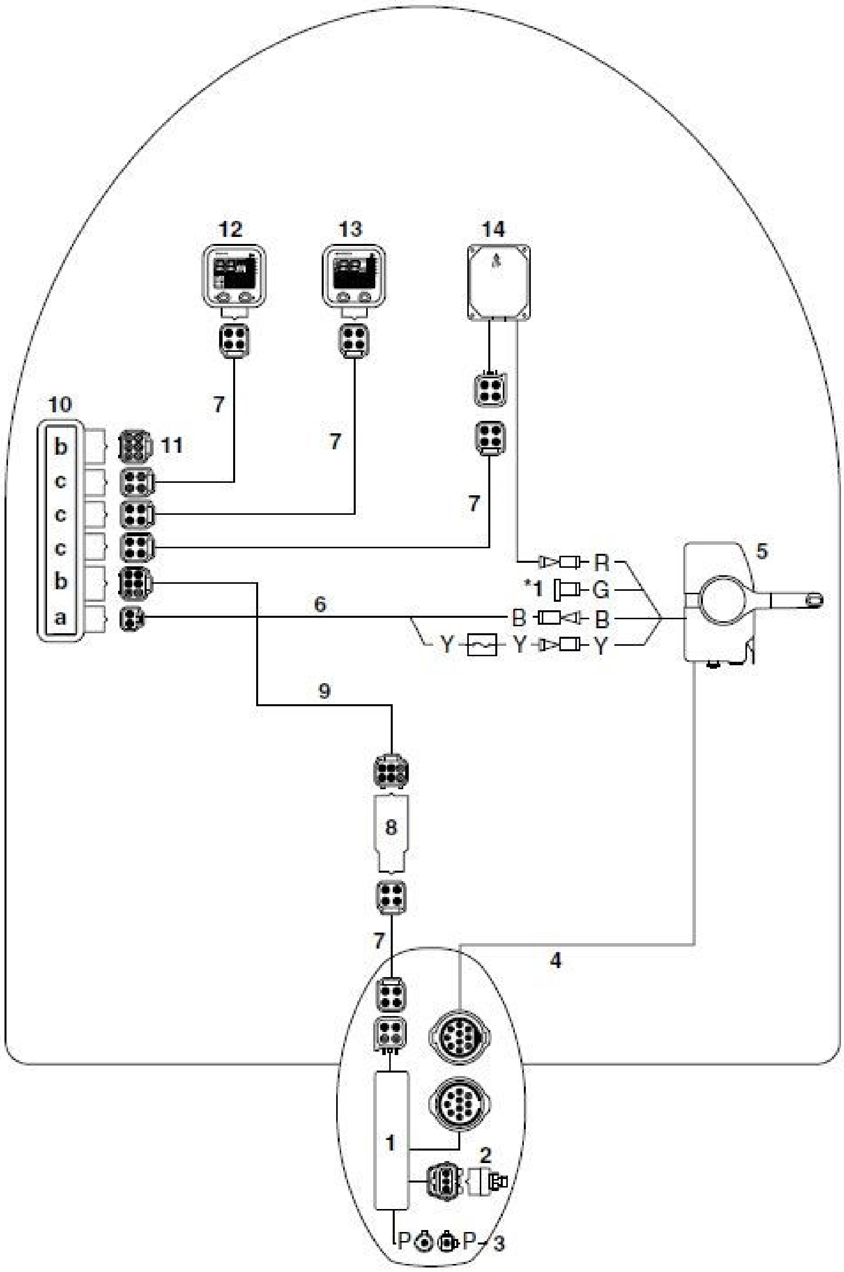

Ref.	**Part name**
1	ECM Engine Control Module
2	Speed sensor kit
3	Trim sensor
4	Main wiring
5	Remote control box
6	Power supply cable
7	**Twisted wire**
8	**Single hub**
9	**Main bus line wiring**
10	**Multiple hub**
11	**Resistance cap**
12	Tachometer
13	Speed gauge
14	Immobiliser
a	Supply port
b	**Data bus transmission port**
c	Device port

Figure 151: Yamaha single-engine application. Multiple hub connectors b CAN transmission, 9 main bus line wiring

Figure 152: Multiple hub with termination cap

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